Cairncross Waste Management Facility

Concept Design Report

2018

PORT MACQUARIE
HASTINGS

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REVISION HISTORY

No	Issue Date	Revision Notes	Prepared By	Approved By
1	19/12/2016	Draft - stakeholder review	B. Farr	G. Cameron
2	20/02/2017	Final Draft	B. Farr	G. Cameron
3	10/03/2017	Final	B. Farr	G. Cameron
4	15/12/2017	Final – updated figures 9,10,11	G. Cameron	G. Cameron
5	12/10/2018	Final – updated stormwater strategy	B. Farr	G. Cameron
6	02/11/2018	Final – minor edits	B. Farr	G. Cameron
7	21/11/2018	Final – minor edits	B. Farr	G. Cameron

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1. INTRODUCTION

Port Macquarie-Hastings Council (PMHC) has prepared this concept design for the Cairncross Waste Management Facility.

This report details the existing landfill stage and the concept design of the future stages of the landfill to supplement an Environmental Impact Statement (EIS) for a State Significant Development (SSD) application (SSD13-5792).

1.1 Background

The Cairncross Waste Management Facility (CWMF) was granted approval for the current stage (Stage E) in 1999 and commenced operations in September 2001, however the approval was time limited to 20 years. In February 2013, an extension of 5 years was sought on the original approval and subsequently granted. The current approval is now due to conclude in 2026.

Council is now seeking an approval for all future landfill stages shown in the **Appendix C - Future Stage Concept Plans**. This report details the concept design of the future stages of the landfill and has been prepared to supplement the State Significant Development application.

1.2 Scope of Report

The purpose of this report is to:

- Detail the information used to produce the concept design
- Outline the assumptions used in the concept design
- Specifically the report details:
  - The updated design elements so as to comply with the EPA's *Environmental Guidelines: Solid Waste Landfills (2016).*
  - Reviews staging boundaries based on topographical and operational requirements.
  - Confirms the landfill volumes including earthworks balance.
  - Confirms stormwater management and sediment basin sizes.
  - Confirms leachate management including collection and disposal.

The report structure is generally set out in accordance with the EPA's *Environmental Guidelines: Solid Waste Landfills (2016).*

2. SITE OVERVIEW

2.1 Site Location

The CWMF landfill area is located on Lot 7, DP 1041766, and the site is owned and operated by Port Macquarie-Hastings Council (PMHC). The site is zoned SP2 (Waste or Resource Management Facilities) by the *Port Macquarie-Hastings Local Environment Plan 2011*. The site location is shown in **Figure 1** below.

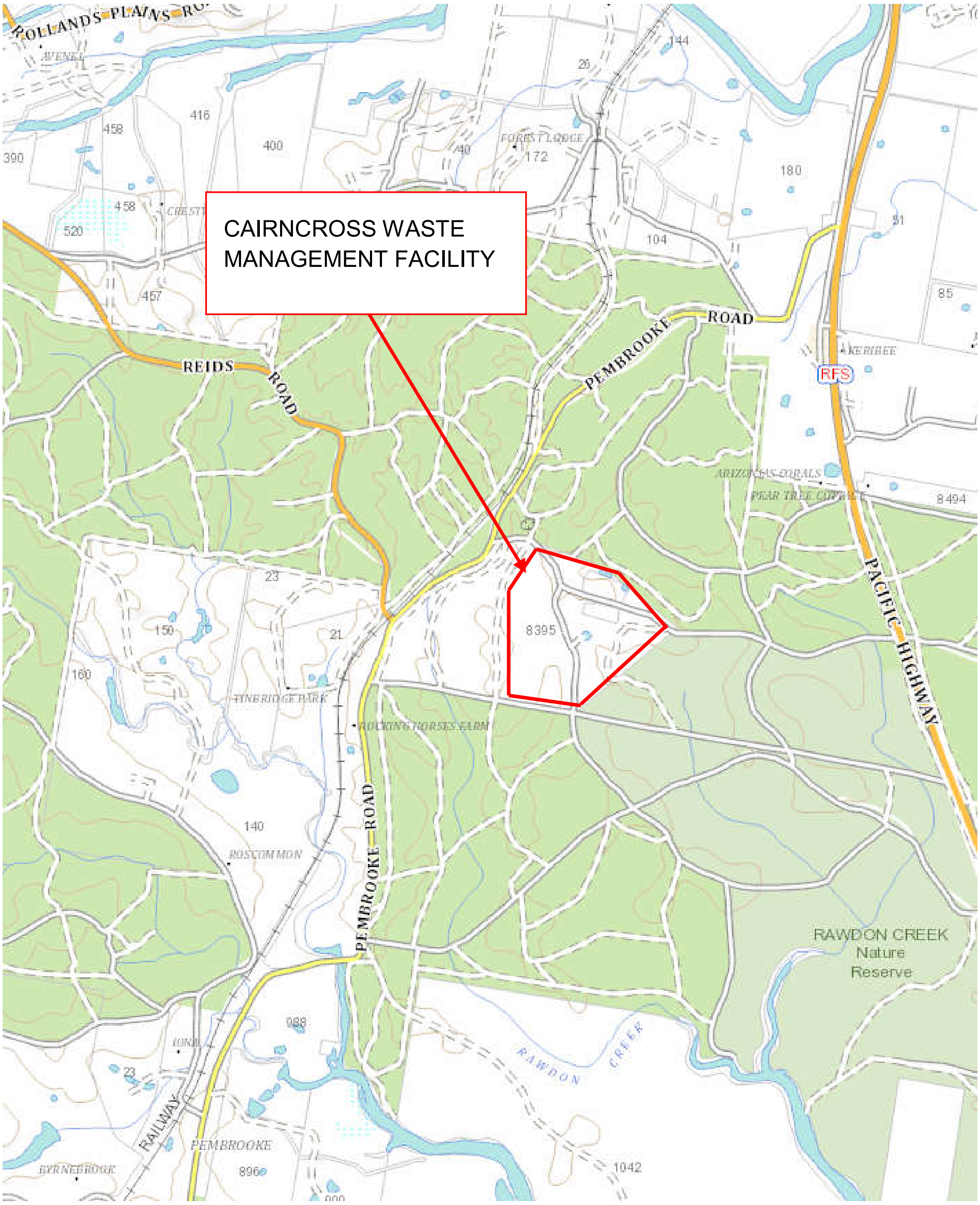


Figure 1: Site Location (SIX Maps, 2016)

2.2 Topography and Drainage

The existing capped and grassed landfill area slopes to the north and west via ephemeral gullies C and D.

To the south are the future landfill areas which slope to the south and south east and are drained by ephemeral gullies A and B. Gullies A and B both drain to Rawdon Creek via ephemeral watercourses and join approximately 2.0 km to the south of the CWMF.

Site slopes are generally in the range of 1% to 10%.

Refer to **Figure 2** for the overall topography of the site.

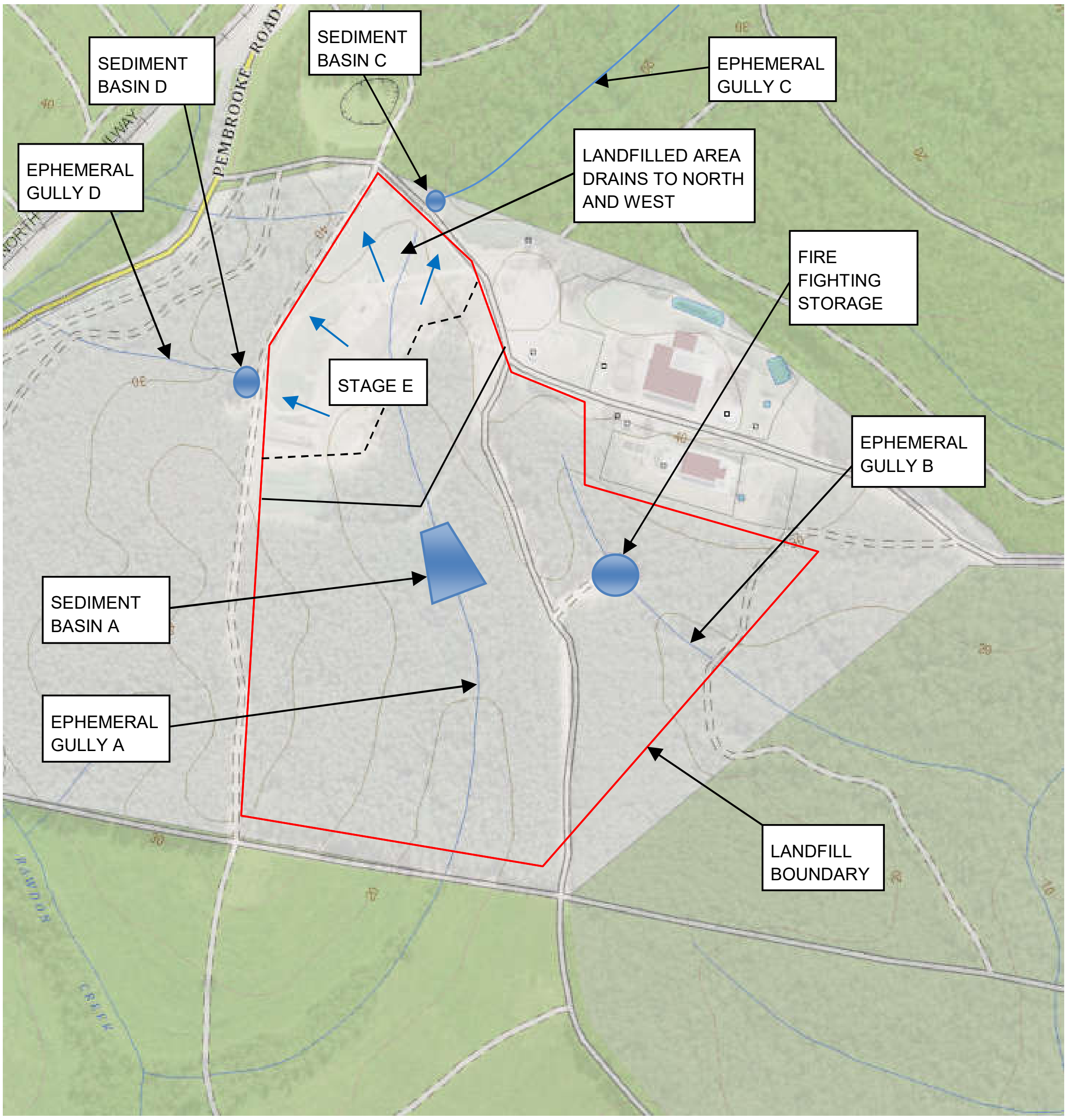


Figure 2: Site Topography (*Six Maps, 2016*)

The underlying site soils are generally clayey with low permeability and high potential for runoff.

The completed capped and grassed areas of the existing landfill stage (Stage E) generally drain to the west and north to small sediment basins (Sediment Basins C and D) which discharge to ephemeral gullies C and D. Once completed, the eastern corner of Stage E will drain to the existing fire fighting storage and then into ephemeral gully B. The Stage E operational area drains to Sediment Basin A which in turn discharges to ephemeral gully A. Refer to Table 1 for details on each sediment basin.

A leachate collection system services the active landfill area.

Table 1: Existing Sediment Basin Details

Sediment Basin	Area (m^2)	Estimated Depth (m)	Estimated Capacity (m^3)
A	4,500	1.2	5,200
C	350	1.5	525
D	800	1.5	1200
Fire Storage	1300	2.0	2600

Refer to **Appendix A - Stage E (Existing) Concept Plan** for additional details.

2.3 Geology and Soils

A geotechnical investigation was undertaken by GHD-Longmac Pty Ltd in 1998. The report (*Hydrogeological Investigation of Proposed Cairncross landfill*) described the regional geology as follows:

> *The regional geology within the vicinity of the site consists of Quartenary Alluvial material and sedimentary bedrock (Refer to the Tamworth-Hastings 1:250,000 metallogenic sheet). The Quartenary Alluvial material consists of mud, silt, sand and gravel deposits. The sedimentary bedrock consists of rock types of the early permian to carboniferous age of the Hastings Block. This comprises the Macleay Group, Byabarra beds, and the Youdale, Kullatine, Majors Creek, Mingaletta and Cooperabung formations. The rock types within these units include the lithic sandstone, mudstone, calcareous mudstone, siltstone, limestone, conglomerate and tuff.*

The investigation revealed the following subsurface conditions for the landfill site:

- Topsoil of 0.1m to 0.2m depth was encountered across the site and consisted primarily of medium plasticity clay.
- Residual Clays of high plasticity were encountered to depths of 1.5m to 2.0m on the ridges, and up to 5.0m within the lower areas and gullies.
- Siltstone bedrock was encountered below the residual clays across the site. The siltstone was generally highly weathered and very weak to weak in strength. The siltstone stratum was in the range of 4m to 5m thick.
- Shale bedrock of weak to medium strength was encountered below the siltsone.

Excavations within Stage E of the landfill has found the sub-surface soils to be consistent with the geotechnical report by GHD-Longmac Pty Ltd, and therefore no further geotechnical investigations were considered necessary for the concept design of future landfill stages.

2.4 Groundwater

A further hydrogeological assessment for the site was completed by Trace Environmental (*Hydrogeological Assessment - Cairncross Landfill Expansion*) in October 2016.

The assessment addressed the following:

- Regional and local groundwater system characterisation
- Depth to groundwater across the site
- Details of the site monitoring network and monitoring program
- Assessment of the predicted inflow rates into the proposed landfill cells

- Impact of the proposed landfill expansion on groundwater heads and groundwater quality on the groundwater systems, ecosystems, surface water system (Rawdon Creek) and groundwater users
- Landfill design with respect to groundwater
- Description of trigger levels for groundwater quality and head monitoring
- Recommendations for future monitoring and reporting
- Project compliance with State and Commonwealth regulations.

A summary of the findings is presented below:

- Three geological units are identified within the landfill site, namely clay/colluvium (silty clay), weathered rock (siltstone) and fractured rock (shale).
- The weathered rock and fractured rock represent one hydrostratigraphic unit.
- The clay is discontinuous across the site. Its major characteristic is the retardation of recharge to the underlying aquifer.
- Groundwater recharge occurs via minor seepage through the clay or lateral flow through the shale/siltstone unit. The groundwater flow direction is from the north and west to the east and south-east, with average velocity of 0.008m/day.
- Based on the groundwater chemistry it is concluded that there is presently no mixing of leachate with groundwater.
- Identified sensitive receptors within a 3km radius of the landfill are private groundwater bores, surface water bodies, and areas with moderate potential for groundwater interaction with the presence of surface Groundwater Dependent Ecosystems (GDEs) that rely on subsurface expression of groundwater.

2.5 Climate

The Port Macquarie-Hastings area has a warm temperate climate with warm wet summers and mild dry winters. The closest historical rainfall gauge is located at Farawells Road, Telegraph Point [Bureau of Meteorology (BOM) Station 60031]. The average annual rainfall for this gauge is 1,317mm. The mean monthly rainfall is shown in **Table 2**.

Table 2: Mean Monthly Rainfall - Telegraph Point

Month	Median Rainfall (mm)	Month	Median Rainfall (mm)
January	139	July	67
February	176	August	59
March	164	September	60
April	128	October	83
May	105	November	110
June	109	December	115

Average areal potential evapotranspiration for the site has been estimated from BOM online mapping and is presented in **Table 3**.

Table 3: Average Areal Potential Evapotranspiration (Monthly)

Month	Average Areal Potential Evapotranspiration (mm)	Month	Average Areal Potential Evapotranspiration (mm)
January	150	July	55
February	125	August	85
March	115	September	100
April	95	October	125
May	65	November	135
June	55	December	155

The predominant winds on the site are from the north-east in the spring and summer and from the west and south-west during winter. Autumn is a transitional season with the majority of winds from the south and west.

3. EXISTING SITE OPERATIONS

The following section describes the existing landfill operations (Stage E) as approved in 1999.

3.1 Site Access

Access to the CWMF is from the Pacific Highway via a sealed private access road. NB: the new Pacific Highway is under construction and when complete the existing highway will become a local council road.

Main internal roads are sealed through to the main facility including the weighbridge, Organic Resource Recovery Facility (ORRF), Material Recycling Facility (MRF), transfer station and to the site work shed.

The landfill area is accessed via gravel roads/tracks from the site work shed, which are maintained to an all weather two wheel drive vehicle standard. A wheel wash is located at the exit from the landfill.

3.2 Waste Filling Operations

The existing Stage E cell has a total landfill volume of approximately 1,436,000m^3 and is expected to be completed in 2019.

Refer to **Appendix A - Stage E (Existing) Concept Plan**.

The earthworks materials balance and landfill volume for Stage E is detailed in **Table 4**.

Table 4: Materials Balance Summary for Stage E

Description	Quantity
Area (m2)	101,921
Topsoil Stripping Volume (m3) (1)	30,576
Clay Excavation Volume (m3)	554,219
Leachate Barrier Clay Vol (m3)	91,729
Cap Clay Volume (m3)	81,537
Vegetation Layer Topsoil Vol (m3)	30,576
Landfill Void Volume (m3)	1,438,196
Day Cover Clay Required (m3) (10% of void) (2)	143,820
Actual Landfill Void Volume (m3) (less day cover volume)	1,294,376
Total Clay Required (m3)	317,085
Clay Balance (m3) (-ve = deficit)	237,133

(1) Assumes 300mm depth of topsoil
(2) Based on actual measured volumes within Stage E needed to achieve 150mm daily cover

The excavation of sub-cells is undertaken progressively with excavated clay stockpiled for future use as cell liner, day cover, intermediate cover and final capping material.

Waste is placed in layers and compacted. The *Cairncross Waste Management Facility Landfill Environment Management Plan (2001)* detailed a landfill compaction density of 850kg/m^3 for the site. Field testing indicates that this level of compaction has been achieved in completed landfill cells.

The capping layer for Stage E comprises a 600mm compacted clay layer which is topped by a 500mm topsoil layer. The compacted clay is to have a permeability of less than $1x10^{-8}$m/s.

The existing landfill stage commenced in the north of the site and is progressing south. Stage E is due for completion in 2019.

3.3 Leachate Management

A leachate barrier system is installed within the floor of all Stage E sub-cells to restrict the migration of leachate to groundwater, soils and substrata. The leachate barrier comprises compacted clay 900mm thick with maximum permeability of $1x10^{-9}$m/s.

A leachate collection system comprising a series of slotted drainage lines (2 x 100mm PVC) will convey leachate to a collection tank where leachate is pumped to leachate infiltration basins in the crown of the landfill. Leachate is recirculated through the landfill via these infiltration basins to provide biological and chemical treatment. When leachate volumes exceed infiltration capacities, leachate is transported off site to a sewer treatment plant (STP). Volumes transported off site are recorded.

The existing leachate collection tank location is being encroached by the landfill and construction of new leachate collection tanks was commenced in 2016 and is expected to be completed in early 2017. This new location (within Stage 2) is in accordance with the *Cairncross Waste Management Facility Landfill Environment Management Plan (2001)* and *Cairncross Waste Management Facility Operational Environment Management Plan (2008),* and is expected to be operational for the remainder of Stage E and Stage 1 filling operations. The new leachate tanks are sized for two (2) days storage at the maximum predicted leachate flow (39.45m^3/day or 1.64m^3/hr).

The leachate tanks will initially be pumped via rising main to the existing infiltration basins. However, PMHC will shortly commence construction of a new sewerage treatment plant (STP) to be built within the CWMF Industrial Precinct. Once complete, the leachate from Stage E (and future stages) will be pumped to the STP for treatment and disposal from the site.

3.4 Stormwater Management

There are currently a number of surface water management features in place at the site. The primary objective of the surface water management features are to ensure that relevant water quality objectives are achieved for stormwater discharged from the site. The following is a summary of the existing surface water management features in place at the site:

- Internal roads are gravelled to prevent softening and erosion during wet weather.
- Roadside table drains and drainage channels are constructed where required to direct stormwater away from erosion prone areas.
- Table drains and channels are grassed or rock armoured to prevent scouring.
- Sediment traps are used where possible to collect sediment prior to stormwater reaching the sediment basin.
- A large sediment basin is utilised as end-of-line treatment for all stormwater runoff from the site. The basin outlet is controlled via a manual valve which is generally released five (5) days after a rainfall event to ensure maximum sediment capture. The basin is cleaned as required.
- Covering of waste (day cover) is completed with compacted clay, trimmed and graded to encourage runoff of rainwater.
- Final contouring of landfill areas is designed to assist water runoff and direct water to relevant stormwater sediment basins before being discharged from the site.

- Maintenance is carried out on all stormwater infrastructure to ensure control measures are operational prior to rainfall events.
- Clearing and stripping of new landfill sub-cells is done progressively to limit runoff and control sediment runoff.

3.5 Water Quality Monitoring

The following section details the existing water quality monitoring program.

3.5.1 Leachate Monitoring

PMHC currently undertakes routine leachate composition monitoring on a quarterly basis by sampling and testing leachate from the main collection tank within Stage E and infiltration basins. The sampling locations are shown on the **Appendix B - Water Quality Monitoring Locations**, and are identified as CL1, CL2 and CL3. PMHC's *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 18 (SOP27) details the sampling and field procedures.

Parameters tested are generally in accordance with the EPA's *Environmental Guidelines, Solid Waste Landfills*. **Table 5** details the current leachate monitoring parameters.

Table 5: Leachate Monitoring Parameters

Parameter		
Temperature	Potassium (dissolved)	1.1-Dichloropropylene
pH	Manganese (dissolved)	Carbon Tetrachloride
Electrical Conductivity	Iron (dissolved)	1.2-Dichloroethane
Electrical Conductivity	Fluoride	Trichloroethene
Hydroxide Alkalinity as CaCO3	Ammonia as N	Dibromomethane
Carbonate Alkalinity as CaCO3	Nitrite as N	1.1.2-Trichloroethane
Bicarbonate AlkalinityasCaCO3	Nitrate as N	Dibromochloromethane
Total Alkalinity as CaCO3	Nitrite + Nitrate as N	Bromoform
Sulfate as SO4	Total Anions	1.3-Dichloropropane
Chloride	Total Cations	Tetrachloroethene
Calcium (dissolved)	Ionic Balance	1.1.1.2-Tetrachloroethane
Magnesium (dissolved)	Total Organic Carbon (TOC)	trans-1.4-Dichloro-2-butene
Sodium (dissolved)	Phenols (Total)	Bromodichloromethane
2.2-Dichloropropane	cis-1.4-Dichloro-2-butene	Iodomethane
1.2-Dichloropropane	1.1.2.2-Tetrachloroethane	trans-1.2-Dichloroethene
cis-1.3-Dichloropropylene	1.2.3-Trichloropropane	1.1-Dichloroethane
trans-1.3-Dichloropropylene	Pentachloroethane	cis-1.2-Dichloroethene
1.2-Dibromoethane (EDB)	1.2-Dibromo-3-chloropropane	1.1.1-Trichloroethane
Dichlorodifluoromethane	Hexachlorobutadiene	1.2-Dichlorobenzene
Chloromethane	Chlorobenzene	1.2.4-Trichlorobenzene
Vinyl chloride	Bromobenzene	1.2.3-Trichlorobenzene
Bromomethane	2-Chlorotoluene	Chloroform
Chloroethane	4-Chlorotoluene	Bromodichloromethane
Trichlorofluoromethane	1.3-Dichlorobenzene	-----
1.1-Dichloroethene	1.4-Dichlorobenzene	-----

3.5.2 Stormwater Monitoring

Appendix B - Water Quality Monitoring Locations show the locations of surface water monitoring undertaken on the site. Sampling is undertaken on a quarterly basis when surface water is present.

PMHC's *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 18 (SOP38) details the sampling and field procedures.

The current minimum stormwater parameters are identified in **Table 6**.

Table 6: Surface Water Monitoring Parameters

Parameter	
Volatile halogenated compounds	Nitrate
Alkalinity	pH
Ammonia	Total phenolics
Calcium	Potassium
Chloride	Sodium
Fluoride	Sulphate
Iron	Total Organic Carbon
Magnesium	Total Suspended Solids
Manganese	---

3.5.3 Groundwater Monitoring

Nine (9) groundwater monitoring bores are currently located within CWMF and are monitored on a quarterly basis. PMHC's *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 18 (SOP18) details the sampling and field procedures.

Refer to **Appendix B - Water Quality Monitoring Locations** for details of the groundwater monitoring bore locations.

The current minimum groundwater parameters are identified in **Table 7**.

Table 7: Groundwater Monitoring Parameters

Parameter	
Absorbable organic halogens (AOX)	Manganese
Alkalinity	Nitrate
Ammonia	pH
Calcium	Total phenolics
Chloride	Potassium
Fluoride	Sodium
Iron	Sulphate
Magnesium	Total Organic Carbon

3.5.4 Landfill Gas Management and Monitoring

Landfill gas surface emissions monitoring, sub-surface monitoring and gas accumulation monitoring is currently undertaken at CWMF.

PMHC's *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 19 (SOP19) details the landfill gas monitoring procedures including use of the gas monitoring equipment (eg. detector, wind speed monitor) and EPA reporting threshold levels.

Sub-surface monitoring is currently undertaken on a quarterly basis within groundwater monitoring boreholes. Groundwater monitoring boreholes range in depth from 10m to up to 30m and have been considered a suitable 'surrogate' for gas monitoring bores. Refer to **Appendix B - Water Quality Monitoring Locations** for details of the groundwater monitoring bore locations. Detection of methane above 1.25% (12,500 ppm) (v/v) requires notification to the EPA, further investigation and potential corrective action.

Surface monitoring is undertaken using a 25m grid survey over completed (capped and grassed) landfill areas. Surface monitoring is undertaken on a monthly basis. The threshold concentration for closer investigation is 0.05% (500 ppm) (v/v) of methane at any point on the landfill surface.

Accumulation monitoring also occurs within structures located within 250m of deposited waste. Detection of methane above 1.25% (12,500 ppm) (v/v) notification to the EPA, further investigation and potential corrective action.

EPA's *Environmental Guidelines, Solid Waste Landfills (2016)* has revised the threshold levels as follows:

- **Sub-surface monitoring:** 1.0% methane (v/v) and 1.5% carbon dioxide (v/v).
- **Surface monitoring**: 1.0% methane (v/v).
- **Accumulation monitoring**: 1.0% methane (v/v).

PMHC's *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 19 (SOP19) will be revised to reflect the new threshold levels.

4. CONCEPT DESIGN

The following section describes the proposed concept design for Stages 1, 2, and 3.

4.1 Landfill Capacity

The CWMF landfill has been divided into four (4) main cells (stages). **Figure 3** shows the existing landfill (Stage E), and future Stages 1, 2 and 3.

The staging boundaries have been modified from the original design contained within the *Cairncross Waste Management Facility Landfill Environment Management Plan (2001)* to better reflect the natural, final and floor levels of the landfill site, expected waste volumes and operational requirements. A general equal/even distribution of area was also considered in the final stage layout.

The area consisting of Stage 1 and Stage 2 are within a catchment that drains south to land owned by State Forests NSW (Forestry Corp). The area within Stage 3 is located in a catchment which drains to the east through Rawdon Creek Nature Reserve. The final leachate collection system also dictated the need to split catchments and define stages as shown below.

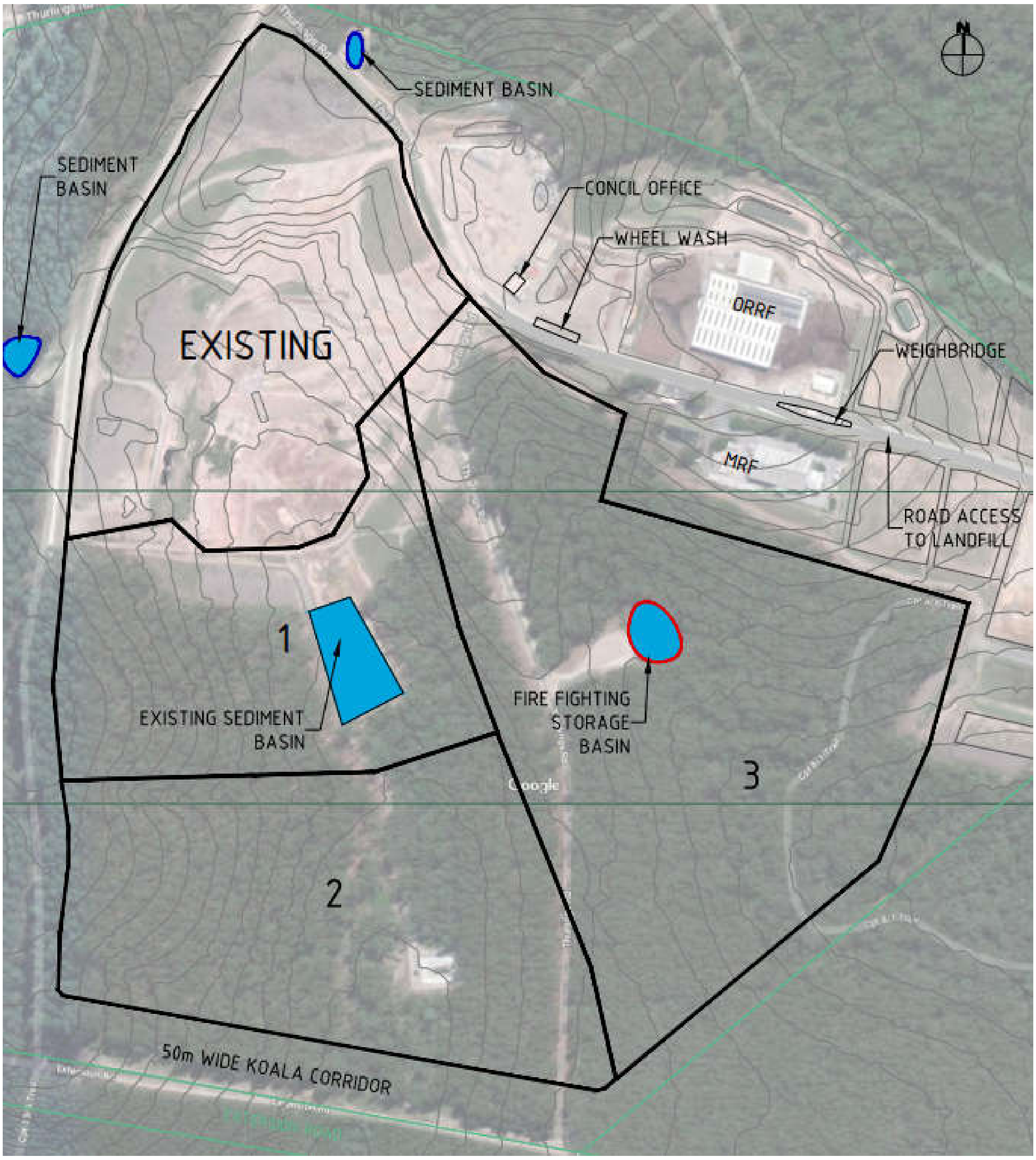


Figure 3: Site Layout

The staging boundaries have also been modified to allow for a 50m wide Koala corridor to allow for the movement of Koalas in the south-east to the north-west of the site.

Refer to **Appendix C - Future Stage Concept Plans** for details of the future stages.

The Stage E land is progressing south and is due for completion in 2019.

The *Cairncross Landfill Expansion, Future Disposal Capacity Requirements* (2016) report details a range of scenarios incorporating potential increases in waste generation, changes to diversion rates and the potential for CWMF to accept tonnages from outside its local government area.

Table 8 shows the estimated landfill volumes for each stage and the estimated completion year based on 'Scenario 4'. Scenario 4 assumes PMHC would, *achieve 75% kerbside diversion rate by 2015-16 and 40% diversion of C&I by 2021-22; no change to C&D / Other MSW diversion rates*. Scenario 4 was considered the most 'likely' and has been adopted for this design.

The estimated completion year for Stages 1, 2 and 3 are 2040, 2047 and 2056 respectively.

Table 8: Landfill Stage Volumes

Stage	Landfill Void Volume (m^3)	Estimated Completion Year
Existing	1,438,000	2019
1	1,610,000	2040
2	1,005,000	2047
3	1,490,000	2056

4.2 Sequencing of Stages

Landfill excavation, liner construction and the installation of the leachate collection systems will continue to be undertaken in a staged manner to allow progressive capping of the previous landfill cell. To manage the operational aspects of this process, each stage has been further divided into sub-stages. Refer to **Appendix D - Future Stage Concept Plans - Sub Stages**.

The sub-stage areas have been selected based on operation experience gained from Stage E. The timeframes are considered suitable to be operationally efficient for clearing, excavation, liner preparation, waste filling, capping and closure (of the relevant sub-cell).

The sub-stages also include the benefit of minimising disturbed areas by reducing stormwater runoff and erosion, and limiting leachate generation by controlling the active landfill area.

A 'typical' development sequence is detailed in **Figure 4**.

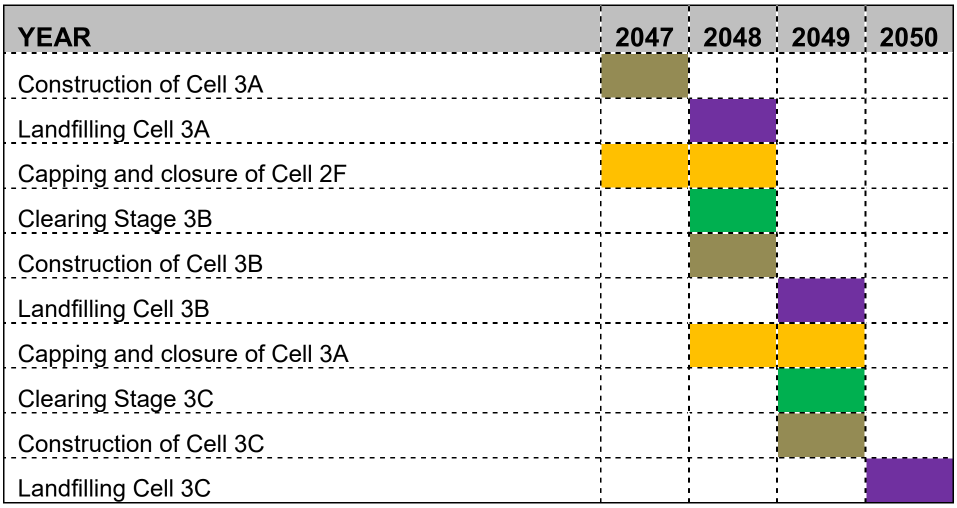


Figure 4: Typical Development Sequence

4.3 Landfill Floor Level

The landfill floor level for Stages 1, 2 and 3 has been modified from the original design contained within the *Cairncross Waste Management Facility Landfill Environment Management Plan (2001)* to better reflect groundwater conditions, maximisation of landfill void volume, and longitudinal/transverse floor gradients.

Trace Environmental prepared the *Hydrogeological Assessment, Cairncross Landfill Expansion (2016)* report, that identifies 'average' long term groundwater and 'maximum' groundwater levels across the site. The adjusted floor level was set a minimum of 2.0m above the average long term groundwater level. This design parameter is in accordance with best practice requirements from the Victorian EPA guidelines, *Siting, Design, Operation and Rehabilitation of Landfills; Best Practice Environmental Management, Publication 788.3 (August 2015)*. See Victorian EPA document link:- http://www.epa.vic.gov.au/~/media/Publications/788%203.pdf. The Victorian EPA guidelines were used given NSW EPA did not have any groundwater clearance/buffer guidelines at the time.

Floor levels were further adjusted where possible to maximise the landfill void volume whilst maintaining longitudinal gradients >1%, and transverse gradients >3%.

Refer to **Appendix E - Landfill Floor Excavation Levels**.

4.4 Groundwater Interception

As noted in Section 4.3 above, the revised landfill floor level was generally set at 2.0m above the 'average' long term groundwater level as detailed in the *Hydrogeological Assessment, Cairncross Landfill Expansion (2016)*.

During above 'average' groundwater level conditions, Trace Environmental (2016) identified that the excavation of the landfill cells may intercept groundwater, particularly in the south western corner of the site (Stages 1 and 2).

Figure 5 shows the estimated depths and locations where groundwater may be encountered by the landfill excavation.

In order to avoid any risk of groundwater infiltration into the landfill cells, a concept design of a groundwater interception system has been completed by Arcadis. This system consists of a series of collection trenches containing high-permeability granular material and perforated pipework in a herringbone pattern designed to relieve hydrostatic uplift pressure to the bottom of the landfill lining in the event of maximum potentiometic (Refer to report by Arcadis: *Groundwater Collection System – Cairncross Landfill, Conceptual Design, September 2018*).

For further information on groundwater conditions refer to *Hydrogeological Assessment, Cairncross Landfill Expansion* (2016).

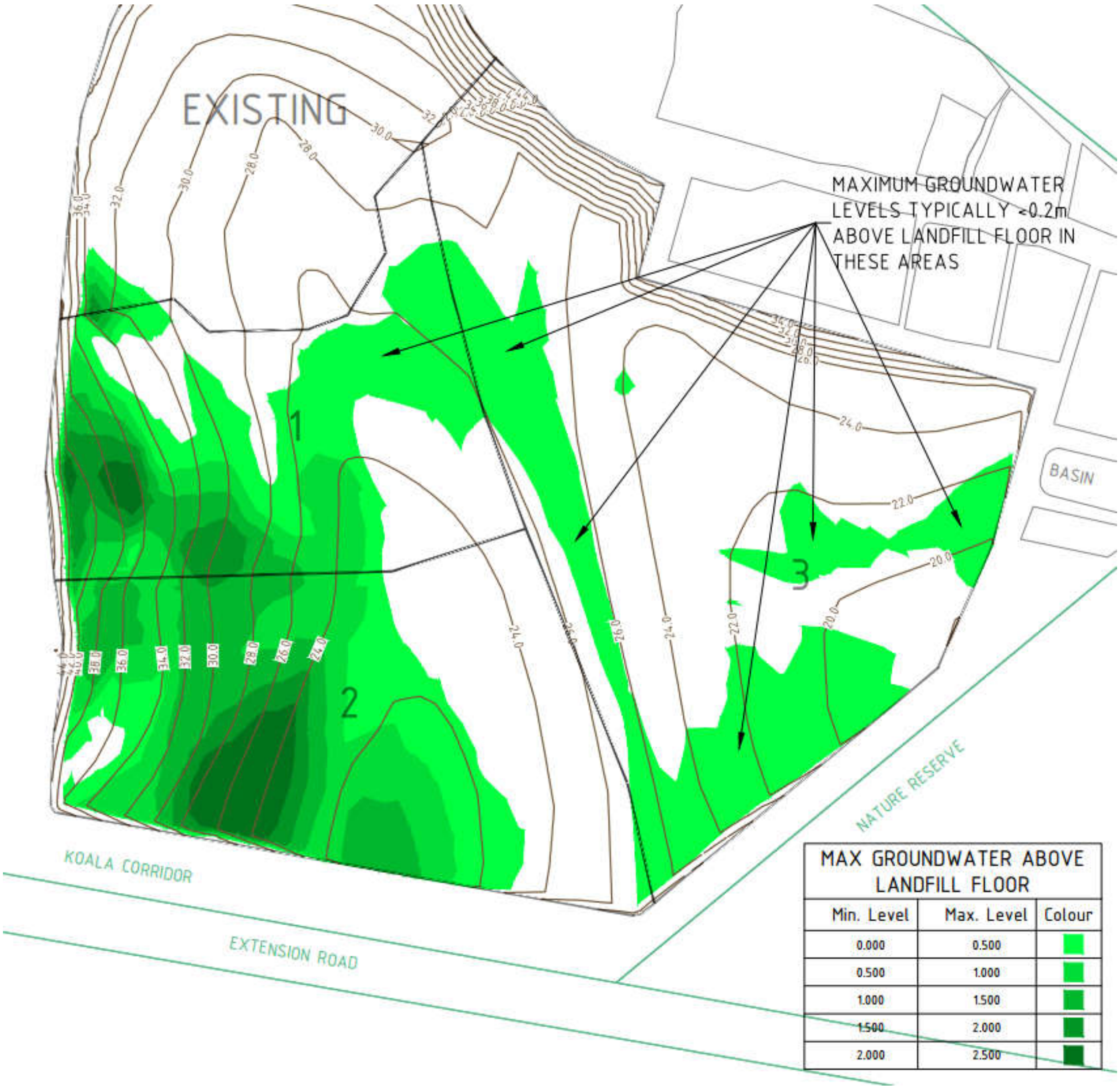


Figure 5: Areas where maximum groundwater levels are above the landfill floor level

4.5 Final Waste Landform

The original final landform for the existing and future stages was presented in the *Cairncross Waste Management Facility Landfill Environment Management Plan (2001)*. This final landform profile has been reviewed and amended in accordance with the EPA's *Environmental Guidelines - Solid Waste Landfills' Second Edition (2016)* for future Stages 1, 2 and 3.

The following slope criteria were used to refine the final landform design:

- Maximum finished landform slope of 1V:5H (20% grade) to reduce the risk of erosion and allow maintenance (mowing) of finished surface after capping.
- Minimum finished landform slope of 1V:20H (4% grade) to ensure rainfall sheds from the surface and does not infiltrate the landfill.
- A temporary batter of 1V:2H will be used between stages to ensure leachate and waste is contained appropriately and to limit the use of excess fill.

Refer to landfill typical sections in **Appendix C - Future Stage Concept Plans** and **Appendix F - Landfill Final Landform Levels.**

4.6 Earthworks and Materials Balance

Table 9 presents the estimated earthworks and materials balance for the existing and future landfill stages. While every care has been taken to estimate these volumes, actual volumes may vary following the detailed design and construction.

Table 9: Materials Balance Summary

Stage	E	1	2	3
Area (m^2)	101,921	79,453	105,840	161,894
Topsoil Stripping Volume (m^3) (1)	30,576	23,836	31,752	48,568
Clay Excavation Volume (m^3)	554,219	288,437	290,822	692,350
Leachate Barrier Clay Vol (m^3)	91,729	79,453	105,840	161,894
Cap Clay Volume (m^3)	81,537	127,125	169,344	259,030
Vegetation Layer Topsoil Vol (m^3)	30,576	23,836	31,752	48,568
Landfill Void Volume (m^3)	1,438,196	1,610,290	1,005,030	1,490,289
Day Cover Clay Required (m^3) (10% of void) (2)	143,820	161,029	100,503	149,029
Actual Landfill Void Volume (m^3) (less day cover volume)	1,294,376	1,449,261	904,527	1,341,260
Total Clay Required (m^3)	317,085	367,607	375,687	569,953
Clay Balance (m^3) (-ve = deficit)	237,133	-76,170	-84,865	122,397

(3) Assumes 300mm depth of topsoil
(4) Based on actual measured volumes within Stage E needed to achieve 150mm daily cover

A summary of each stage's earthworks is presented below:

Stage E

- Excess clay excavated is in the order of 237,000m^3. This clay is presently stockpiled on site for use within future stages.

Stage 1

- Clay deficit for this stage is due to reduced excavation depth, increased final capping thickness and higher day cover volume (compared with Stage E)
- The estimated clay deficit will be addressed by the excess clay stockpile from Stage E.

Stage 2

- Clay deficit is due to reduced excavation depth, increased final capping thickness (compared with Stage E)
- Reduced landfill void volume due to floor and final landform intersecting existing ground levels.
- The estimated clay deficit will be addressed by the excess clay stockpile from Stage E.

Stage 3

- Excess clay excavated from this stage is in the order of 122,000m^3.
- Overall excess clay from all stages expected to be in the order of 195,000m^3. PMHC anticipate this excess VENM will be removed from site and used on future council civil or road work projects.

5. LEACHATE BARRIER SYSTEM

The following section describes the proposed leachate barrier system for Stages 1, 2, and 3.

5.1 Landfill Cell Liner Details

The landfill cell liner (leachate barrier system) is to be constructed in accordance with the NSW EPA's *Environmental Guidelines, Solid Waste Landfills* (2016). The liner is to comprise of the following:

- 200mm thick compacted clay sub-base
- 1,000mm thick compacted clay liner (hydraulic conductivity <1x10^{-9}m/s)
- 2mm thick HDPE flexible membrane liner
- Cushion geotextile fabric to protect the HDPE liner
- 300mm thick gravel leachate collection drainage layer including leachate collection pipes (2 x 100mm slotted HDPE at intervals of 25m). NB: Refer to Pacific Environment Limited report *Cairncross Landfill Leachate Generation Modelling (2016)* for sizing details.
- Separation geotextile fabric to reduce the ingress of fines from the overlying waste.

Refer to **Figure 6** for a typical section of the proposed leachate barrier system.

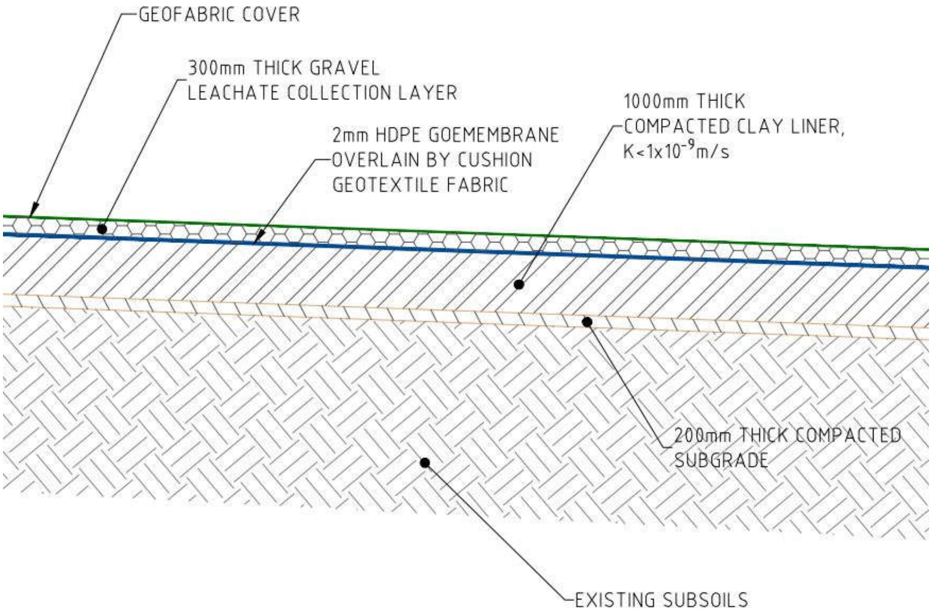


Figure 6: Cell Liner Typical Section

5.2 Leachate Collection

The leachate collection network has been designed in accordance with the NSW EPA's *Environmental Guidelines, Solid Waste Landfills (2016)*. Refer to **Appendix C - Future Stage Concept Plans** for the leachate collection system layout.

The *Cairncross Landfill Leachate Generation Modelling (2016)* report has assessed slotted HDPE pipe sizes and confirmed; *that leachate reticulation pipes utilised for Stage E (2 x 100mm diameter pipes), will be suitable for all future stages with regards to discharge velocity and flow rate.*

The *Cairncross Landfill Leachate Generation Modelling (2016)* report also provides information on leachate flow rates for each stage/catchment. These flow rates are summarised in **Table 10**.

Table 10: Leachate Flow Rates

Catchment	Flow Rate (m3/day)	Flow Rate (L/s)
Stage E, 1 & 2	39.45	0.45
Stage 3	36.58	0.42

As such, 2 x 100mm slotted PVC pipes has been adopted. NB: 2 x 100mm slotted HDPE pipes has been adopted due to local supply constraints sourcing 150mm HDPE slotted pipe.

The leachate collection system will comprise a network of 2 x 100mm slotted HDPE pipes within a 300mm thick gravel layer covering the landfill liner. The slotted HDPE pipes will complying with the requirements of *Australian Standard AS 2566.1-1998 (Buried flexible pipelines – Structural design)*.

The maximum spacing of leachate pipes will be 25m, laid at longitudinal grades of >1%, and >3% transverse grade.

6. LEACHATE STORAGE AND DISPOSAL

The *Cairncross Landfill Leachate Generation Modelling (2016)* report detailed the following with respect to leachate storage:

> *It is recommended that leachate is stored in above ground bunded tanks in preference to sumps. Above ground bunded tanks must have sufficient leachate storage volume, as determined by using a water balance methodology. The bunded tanks must have a visible marker to indicate the bottom depth of the required freeboard. If the freeboard is exceeded, the occupier must re-establish and maintain the required freeboard. The tanks and associated connection points must be surrounded by a bund with a capacity of at least 110% of the tanks volume.*

The leachate collection system for each stage will drain by gravity via a series of slotted pipes (2 x 100mm HDPE) to a leachate tank and pump system. Refer to **Appendix C - Future Stage Concept Plans**.

The leachate storage tanks are sized to accommodate two (2) days storage of leachate at the maximum predicted leachate flow rate detailed in the *Cairncross Landfill Leachate Generation Modelling (2016)* report. Refer to **Table 10** for a summary of flow rates.

Figure 7 presents a typical layout and section for the proposed leachate storage tanks.

Construction commenced in 2016 for a new leachate tank location to serve the remainder of Stage E and for Stage 1. **Table 11** details the proposed leachate storage tank capacities for each stage.

Table 11: Leachate Tank Capacities

Stage	Capacity (m3)
Remainder of Stage E & Stage 1	76
Stage 2	77
Stage 3	74

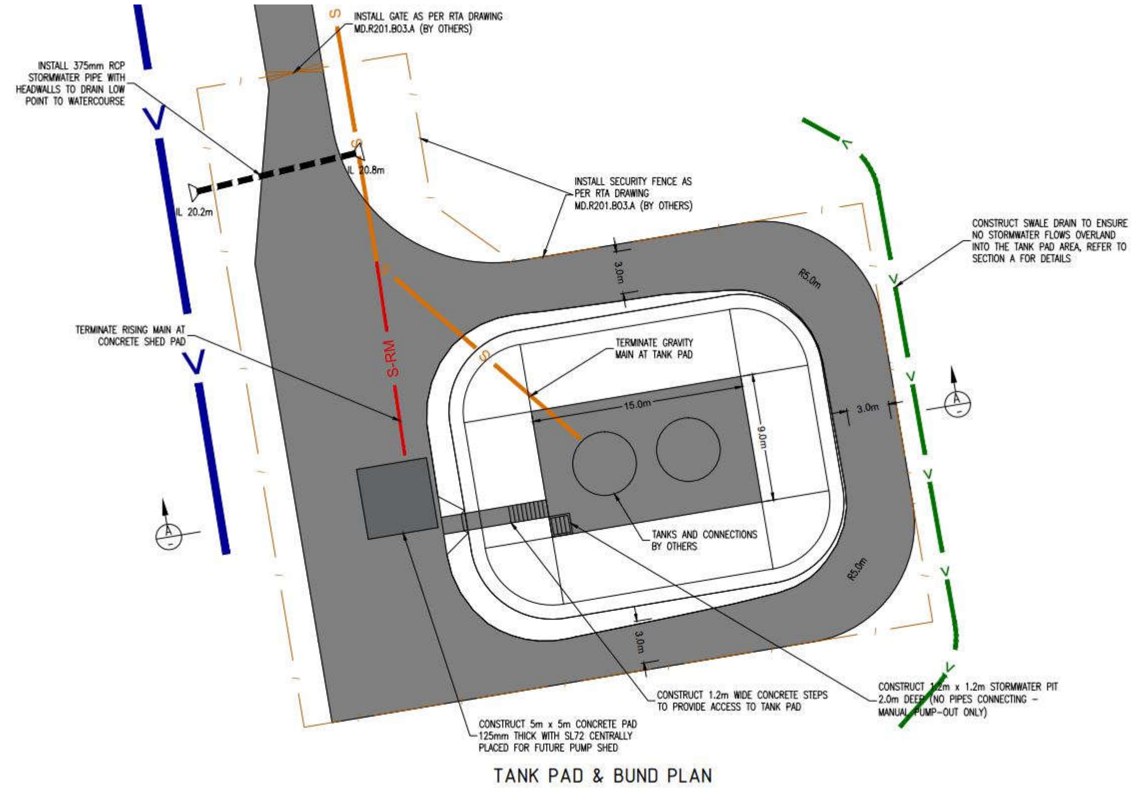
PMHC will shortly commence construction of a new sewerage treatment plant (STP) to be built within the CWMF Industrial Precinct. Once complete, all leachate from Stages E, 1, 2 and 3 will be pumped via a 110mm HDPE rising main to the STP for treatment and disposal from the site.

The new STP will be managed by PMHCs Water and Sewer section and is being specifically designed to accommodate the leachate characteristics and estimated flow rates. The new STP will provide sufficient treatment to allow disposal of effluent (including treated leachate) to the environment in accordance with the *Protection of the Environment Operations Act 1997* (POEO Act) administered by the NSW EPA.

Leachate volumes will be measured by flow meters before entering primary holding tanks within the STP. These holding tanks are expected to provide further storage capacity if required.

Figure 7 presents a typical layout and section for the proposed leachate storage tanks.

Figure 8 and **Figure 9** present the STP functional layout and process diagram indicating the leachate input. NB: the plant may change based on tenders received and possible different configurations proposed by tenderers.



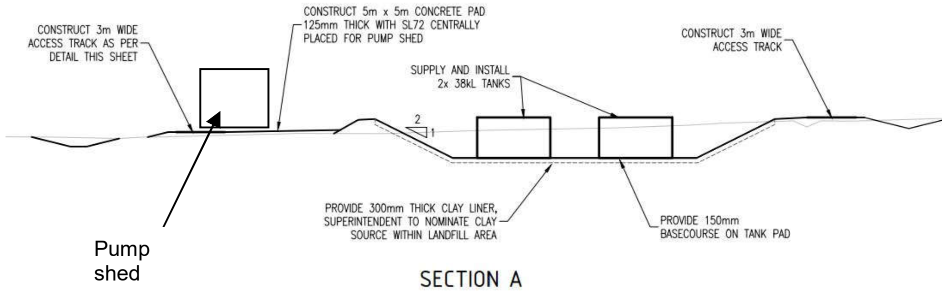


Figure 7: Typical Drawing - Leachate Collection Tank

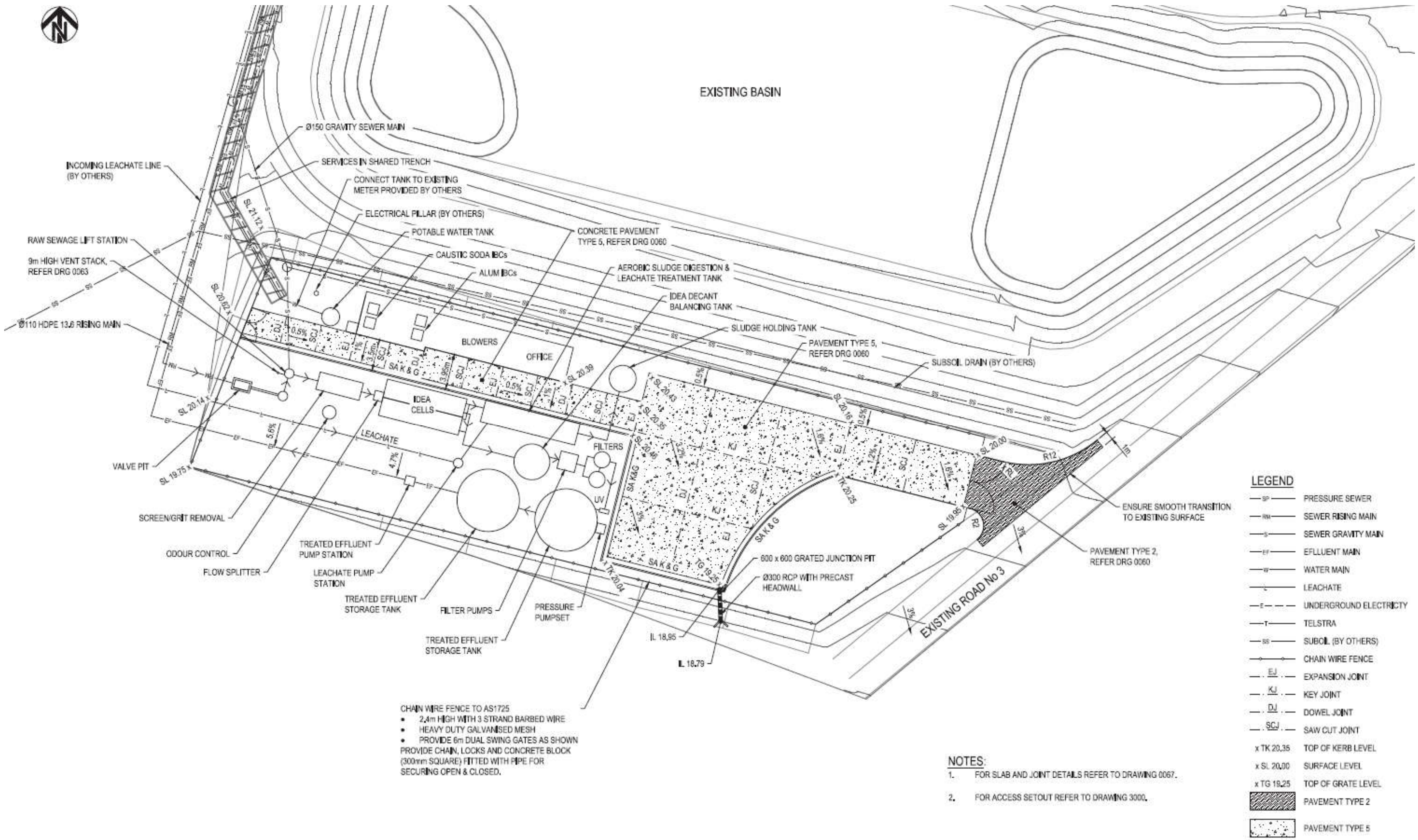


Figure 8: Sewer Treatment Plan - Layout

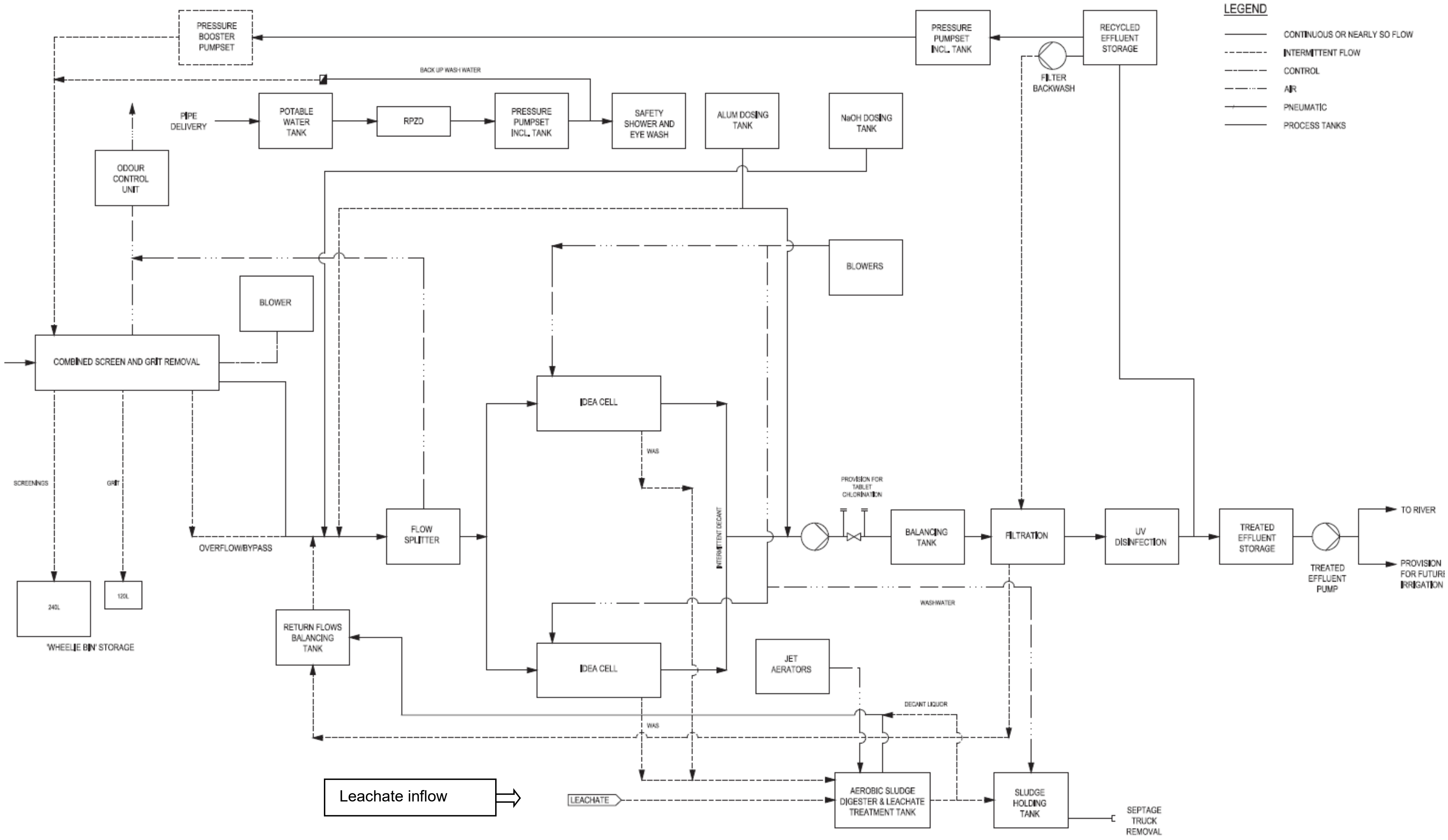


Figure 9: Sewer Treatment Plan - Process Diagram

7. STORMWATER MANAGEMENT

The following section describes the proposed stormwater management system for the CWMF landfill.

7.1 Stormwater Concept Designs

Appendix C - Future Stage Concept Plans includes stormwater management details for all future stages.

Stage 1 and Stage 2 drain via a broad ephemeral gully (A) south via a culvert under Extension Road to land owned by State Forests NSW (Forestry Corp). While Stage 3 drains via an ephemeral gully (B) to Rawdon Creek Nature Reserve in the east.

The final landform (Refer to **Appendix F - Landfill Final Landform Levels**) will redirect stormwater runoff from the western ephemeral gully (A) to the eastern ephemeral gully (B). At the completion of filling operations approximately 4.3ha will be redirected from the eastern ephemeral gully A catchment to the eastern ephemeral gully B catchment.

This small redirection of stormwater runoff is not considered to be significant and not expected to impact the downstream environments given both gullies (A) and (B) ultimately drain to Rawdon Creek approximately 2km to the south of the CWMF via generally ephemeral watercourses. In addition, the overall catchment size is approximately 1,000ha, and the redirection of 4.3ha represents only 0.4% reduction in the local sub-catchment.

The stormwater management strategy for Stage 1, 2 and 3 will maintain existing techniques successfully implemented in the existing Stage E area. The general approach for stormwater management at each future stage will include the following aspects:

- Internal roads are gravelled to prevent softening and erosion during wet weather.
- Roadside table drains and drainage channels are constructed where required to direct stormwater away from erosion prone areas.
- Table drains and channels are grassed or rock armoured to prevent scouring.
- Sediment traps are used where possible to collect sediment prior to stormwater reaching the sediment basin.
- A large sediment basin is utilised as end-of-line treatment for all stormwater runoff from the site. The basin outlet is controlled via a manual valve which is generally released five (5) days after a rainfall event to ensure maximum sediment capture. The basin is cleaned as required.
- Covering of waste (day cover) is completed with compacted clay, trimmed and graded to encourage runoff of rainwater.
- Final contouring of landfill areas is designed to assist water runoff and direct water to relevant stormwater sediment basins before being discharged from the site.
- Maintenance is carried out on all stormwater infrastructure to ensure control measures are operational prior to rainfall events.
- Clearing and stripping of new landfill sub-cells is done progressively to limit runoff and control sediment runoff.

7.2 Stormwater Management Strategy (Water Balance)

Arcadis completed a water balance investigations for the expansion of CWMF (*Memo - Carincross Landfill Expansion - Site Water Balance*, August 2016). The water balance considered rainfall and runoff for the existing and proposed stormwater storage basins within the site, along with the water demands on the site for dust suppression etc. The results of the water balance are summarised below:

- The results show that, in all months with average rainfall conditions, there is a surplus of water available for dust suppression. This applies throughout all stages of the proposed landfill operation. Under average rainfall conditions, the driest month is September, and this corresponds with the minimum surplus during Stage 1, for the fire fighting storage dam on its own. If all four basins are considered, the surplus increases significantly.
- The results also show that under 10th percentile rainfall conditions there is a potential water deficit during July and August in all three stages. A deficit of similar magnitude is also predicted by the water balance for the existing landfill for 10th percentile rainfall conditions. Discussions with Council identified that a water deficit has not previously been experienced at the landfill, even when there have been serious rainfall deficiencies (eg; August and September 2009 were consecutive months of less than 10th percentile rainfall). This is most likely due to the significant water storage provided in the existing basins. The existing fire fighting basin alone has a significant storage volume, which is well in excess of the required fire fighting storage requirement and also the maximum monthly water demand.
- The investigation found that a water deficit is considered unlikely to occur except in extreme drought conditions, and could be mitigated by the ability to draw water from all storage basins.

Refer to **Appendix H - Site Water Balance** for details.

Note: As a result of submissions received during public exhibition of the EIS a number of changes have been made to the Proposal. The site concept design has been refined and basin sizes have generally increased in accordance with the EPAs *Environmental Guidelines: Solid Waste Landfills (2016*). With increased basin sizes, the findings of the 2016 report remain valid (ie. that a water deficit is considered unlikely to occur except in extreme drought conditions).

7.3 Erosion Control

The following measures are to be implemented to minimise the volume of sediment-laden stormwater generated from the disturbed areas of the site during rainfall events:

Minimise the area of exposed soils - The disturbed area (cleared, exposed and un-vegetated) should be minimised to reduce areas that can generate suspended solids when water runs over the areas.

Stabilise exposed areas - Exposed areas should be stabilised as soon as possible. All completed areas of the landfill should be progressively revegetated. Note that stormwater runoff from rehabilitated areas where approximately 70% of the groundcover has been re-established is considered to be ‘clean’ runoff and does not need further treatment. Other stabilisation measures include the use of mulching, etc.

Reduce erosive effect of stormwater. Concentrated stormwater flows can be managed by using diversions, armouring channels to provide scour protection (e.g. with rip rap), check dams, batter drains, grade control structures and flumes, outlet dissipation structures, and revetments.

Protect stockpiles - Stockpiles should be located away from concentrated stormwater flow. They should be protected by up-slope diversion banks, be stabilised with vegetative cover or mulches or matting products, and be provided with sediment control fencing.

Manage unsealed roads - Erosion potential from internal roads should be minimised by considering:

- route selection,
- construction and post-construction erosion control measures,

- undertaking design which includes consideration of road grades, clearing widths, batters, surface drainage, table drains, culverts, revegetation, road surface materials.

Detailed guidance on erosion and sediment control for access tracks is provided in *Managing Urban Stormwater: Soils and Construction Volume 2C Unsealed Roads* (NSW DECC, 2008b).

Landfill exit controls - A permanent submerged shaker pad and wheel wash is located adjacent to the PMHC works shed and used to prevent transport of sediment off site. This submerged shaker pad and wheel wash will operate for all future stages.

Maintenance - All erosion control structures must be maintained. Controls must be inspected regularly and after any significant rainfall (more than 10 mm in a day), and must be repaired as necessary.

7.4 Sediment Control

The main source of sediment control for the CWMF is generally provided by sediment basins and staged clearing of landfill areas. The staged clearing minimises disturbed areas by reducing stormwater runoff and erosion. Other measures may include vegetative buffers and silt fences.

7.4.1 Sediment Basin Design Requirements

Sediment control for the landfill area needs to consider the staging of the filling operations. For each stage a sediment basin is to be implemented to ensure stormwater discharged from the site is of suitable quality.

The EPA's *Environmental Guidelines, Solid Waste Landfills (2016)* requires that sediment basins are designed in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (the Blue Book). The following design parameters have been adopted for the sediment basins:

- The sediment basins are to be designed to capture and treat all sediment-laden runoff during a 90th-percentile 5-day rainfall event, with the exception of Stage 3 where a 95th-percentile 5-day rainfall event will be used to allow for the sensitive receiving environment.
- The settling volume shall be such that the suspended solids settle out to a concentration of less than 50mg/L before the treated stormwater is discharged.
- The water level should be drawn down to a level just above the sediment storage zone within five (5) days of the end of any significant rainfall to restore the basin's capacity to contain runoff from the next rainfall event.

Managing Urban Stormwater: Soils and Construction Volume 2B Waste Landfills also contains relevant information for the design of sediment control measures. Refer to **Table 12** for the minimum design criteria as recommended by Volume 2B.

Table 12: Recommended minimum design criteria for sediment control measures at waste landfill sites

Table 6.1 Recommended minimum design criteria for temporary erosion and sediment control measures at waste landfill sites

	Minimum average recurrence interval (ARI) of design storm event (unless otherwise indicated)							
Duration of disturbance	< 6 months		6–12 months		1–3 years		> 3 years	
Sensitivity of receiving environment ('standard' or 'sensitive')[1]	standard	sensitive	standard	sensitive	standard	sensitive	standard	sensitive
Temporary drainage (erosion) controls[2]								
– designed to have a non-erosive hydraulic capacity to convey	2 yrs	5 yrs	5 yrs	10 yrs	10 yrs	20 yrs	20 yrs	20 yrs
Temporary sediment control measures[3]								
– should be constructed to remain structurally sound in:	2 yrs	5 yrs	5 yrs	10 yrs	10 yrs	20 yrs	20 yrs	20 yrs
Type C sediment retention basin								
– designed to achieve required water quality for flows up to:	0.5 x 1 yr	1 yr	1 yr	2 yrs	1 yr	2 yrs	1 yr	2 yrs
– embankment and spillway designed to be structurally sound in[4]:	10 yrs	20 yrs	20 yrs	50 yrs	50 yrs	100 yrs	50 yrs	100 yrs
Type F or D Sediment retention basin								
– designed to achieve required water quality for storms up to nominated five-day duration percentile event:[5]	75th	80th	80th	85th	80th	85th	90th	95th
– designed to achieve required water quality for storms up to nominated five-day duration percentile event with enhanced erosion controls[6]:	75th	75th	75th	80th	75th	80th	90th	95th
– embankment and spillway designed to be structurally sound in[4]:	10 yrs	20 yrs	20 yrs	50 yrs	50 yrs	100 yrs	50 yrs	100 yrs

1 A 'sensitive' receiving environment is one that has a high conservation value, or supports human uses of water that are particularly sensitive to degraded water quality.
2 e.g. diversion banks, perimeter banks, catch drains, level spreaders, check dams, batter drains and chutes.
3 e.g. sediment fences, stacked rock sediment traps etc. on small catchments where used as a 'last line of defence' (i.e. without a down-slope sediment basin).
4 This is indicative only – consider the risks of basin failure for each basin to determine appropriate spillway design flow.
5 For a five-day management period. Adjustment factors to the five-day volumes for alternate management periods are 85% for two-days, 125% for 10 days and 170% for 20 days.
6 Enhanced erosion controls are described on **vol.1** section 6.3.4(g).

Table 12 confirms that for disturbance of >3 years, Type F or D sediment basins should be designed for the 90th-percentile 5-day rainfall event (standard receiving environment) and 95th-percentile 5-day rainfall event (sensitive receiving environment). A *standard* receiving environment was selected for Stages E, 1 and 2 due to the considerable logging operations undertaken in the downstream catchment. The catchment is considered 'modified' due to these historical and current operations.

Sediment basins will be designed without a low level outflow, so as to capture the entire storm event and allow settlement of sediment prior to release to the downstream environment. For storm events larger than the basins design capacity, a weir or spillway is provided to release the stormwater without causing damage to the basin.

7.4.2 Sediment Basin Design Parameters

A geotechnical investigation was completed at the CWMF in June 2013 by Regional Geotechnical Solutions (*RGS20194.2-AC*). This investigation revealed conditions consistent with the report by Longmac (1998).

Site soils are generally clayey with low potential for infiltration. The geotechnical investigation results are presented in **Table 13**.

Table 13: Soil Analysis

Parameter	Value
% sand (faction 0.02 to 2.00 mm	10%
% silt (fraction 0.002 to 0.02 mm)	16%
% clay (fraction finer than 0.002 mm)	73%
Dispersion percentage	11%
Soil Erodibility K-Factor	0.042
Soil Texture Group	F

Additional sediment basin design parameters are shown in **Table 14**.

Table 14: Sediment Basin Design Parameters

Parameter	Value	Reference
The 90th-percentile 5-day rainfall event	70mm	Blue Book
The 95th-percentile 5-day rainfall event	106mm	Blue Book
Rainfall intensity for 2 year 6 hour storm	14.9mm/h	BOM IFD data
Erosion Control Practice P-Factor	1.3	Blue Book
Ground Cover C-Factor	1.0	Blue Book

Table 15 provides the specific design parameters for each catchment. Refer to **Appendix C - Future Stage Concept Plans** for details of each Stage, including the catchment boundaries, overland flow paths, and sediment basin locations.

Based on existing practical operational experience, it is assumed that at any one time a maximum disturbed area of 6.0 ha would be serviced by a basin. With the implementation of the erosion control methods detailed in **section 7.3**, this area is likely to be reduced, however 6.0 ha is considered a conservative area.

Table 15: Catchment Parameters

Parameter	Stage 1 south basin	Stage 1 north basin	Stage 2	Stage 2 final sub-cells #	Stage 3	Stage 3 final sub-cells #
Grassed Catchment Area (capped landfill) (ha)	3.9	11.1	11.5	1.0	16.6	0.2
Forested Catchment Area (ha)	7.5*	0	0	0	0	0
Impervious Catchment Area (ha)	0	0	0	0	0.6	0
Disturbed Catchment Area (ha)	6.0	1.5 (1 sub-cell disturbed)	6.0	4.0	6.0	4.0
Total Catchment Area (ha)	17.4	12.6	17.5	5.0	23.2	4.2
Slope Length (m)	250	300	250	190	250	180
Slope Gradient (%)	6	5	6	3	3	3
Length/Gradient LS-Factor	2.91	2.53	2.91	0.97	1.11	0.95

* Assumed 80% of forested area is diverted around basin (clean water) for calculations shown in Table 16.
# allows for clean water bypass from capped and grassed sub-cells, only treats run-off from final sub-cells disturbed area

7.4.3 Sediment Basin Design

Sediment basin sizes were calculated using the spreadsheet method supplied with *Managing Urban Stormwater: Soils and Construction Volume 2B Waste Landfills* (the Blue Book). Detailed calculations are presented in **Appendix G - Blue Book Spreadsheet Calculations.**

Table 16 summarises the sediment basin sizes.

All basins are sized based on a 12 month de-silting period.

Table 16: Sediment Basin Size Summary

Volume	Stage 1	Stage 1 north basin	Stage 2	Stage 2 final cells	Stage 3	Stage 3 final cells
2 month sediment storage volume (m^3)	615	134	615	137	234	134
12 month sediment storage volume (m^3)	3690	804	7380	1644	2808	1608
Settling Zone Volume (m^3)	3990	4410	6125	1750	12319	2230
Total Basin Volume (m^3)	7680	5214	13505	3394	15127	3838

7.5 Flooding

7.5.1 Hastings River Floodplain

The *Hastings River Flood Study (2006)* identifies the lower tributaries of Rawdon Creek as affected by backwater flooding from the Hastings River during a 100 year ARI (average recurrence interval) flood event. This flooding occurs approximately 2.0 km downstream from the site and as such the site is considered flood free from river flooding.

7.5.2 Local (Stormwater) Flooding

The proposed sediment basis will also provide a stormwater detention function.

An analysis of the performance of the sediment basins for Stages 1, 2 and 3 (in Table 16) with respect to pre and post development flows from the site, was undertaken using *DRAINS* stormwater modelling software. *DRAINS* is an industry standard stormwater modelling and design program and is generally accepted throughout Australia.

Stages 1, 2 and 3 were modelled using the catchment data defined in **Table 15**.

Industry standard Mannings 'n' values were adopted and are shown in **Table 17**.

Table 17: Mannings 'n' Values for Overland Flow

Catchment Type	Mannings 'n'
Forested (undeveloped area)	0.10
Grassed (capped landfill)	0.08
Impervious (buildings, roads)	0.02
Disturbed (operational area)	0.035

Storm events for the 1, 2, 5, 10, 20, 50 and 100 year ARI were modelled for storm durations up to 6 hours. The critical *time of concentration* (Tc) for the subject catchments was calculated to be less than 6 hours and therefore peak flow rates for each storm event will occur within the 6 hour storm duration period. The results are shown **Table 18**.

Table 18 shows that generally for all storm events, the post-development peak flows are estimated to generally reduce from the peak pre-development flows, with the exception of Stage 1 (North Basin) and Stage 2 (Final Stages), where minor increases (+2% to +4%) in flows are estimated during the less frequent 100 year ARI event.

The primary purpose of the basins is to capture sediment, however they also provide an on-site detention (OSD) function. The results above in **Table 18** show that the size of the sediment basins generally provides effective OSD for events up to the 100 year ARI for all stages of development. Due to the infrequent nature of the estimated minor increases in post-development peak flow, the sediment basin design is considered appropriate in terms of providing sediment control and OSD.

Spillways are to be provided to the sediment basins and designed for major storm events (up to 100 year ARI).

Refer to **Figure 10** and **Figure 11** for typical sediment basins plan and cross sections.

Table 18: Pre and Post Development Storm Events

Storm Event (ARI)	Outflow from development to Rawdon Creek catchment (m^3/s)																	
	Stage 1 (North Basin)			Stage 1 (South Basin)			Stage 2			Stage 2 (Final Stages)			Stage 3			Stage 3 (Final Stages)		
	Pre-Dev	Post-Dev	% change	Pre-Dev	Post-Dev	% change	Pre-Dev	Post-Dev	% change	Pre-Dev	Post-Dev	% change	Pre-Dev	Post-Dev	% change	Pre-Dev	Post-Dev	% change
1 year	0.59	0.16	-73%	0.54	0.00	-100%	0.50	0.00	-100%	0.18	0.00	-100%	0.86	0.00	-100%	0.22	0.00	-100%
2 year	0.87	0.40	-54%	0.80	0.00	-100%	0.72	0.00	-100%	0.26	0.00	-100%	1.26	0.05	-96%	0.31	0.00	-100%
5 year	1.26	0.89	-29%	1.16	0.38	-67%	1.06	0.42	-60%	0.39	0.19	-51%	1.86	0.78	-58%	0.46	0.02	-96%
10 year	1.53	1.24	-19%	1.42	0.53	-63%	1.28	0.72	-44%	0.46	0.26	-43%	2.26	1.16	-49%	0.57	0.14	-75%
20 year	1.94	1.73	-11%	1.80	0.86	-52%	1.58	1.11	-30%	0.57	0.44	-23%	2.79	1.72	-38%	0.72	0.21	-71%
50 year	2.46	2.36	-4%	2.27	1.33	-41%	1.94	1.59	-18%	0.73	0.67	-8%	3.57	2.51	-30%	0.89	0.36	-60%
100 year	2.85	2.90	2%	2.63	1.78	-32%	2.26	2.09	-8%	0.85	0.88	4%	4.15	3.19	-23%	1.03	0.47	-54%

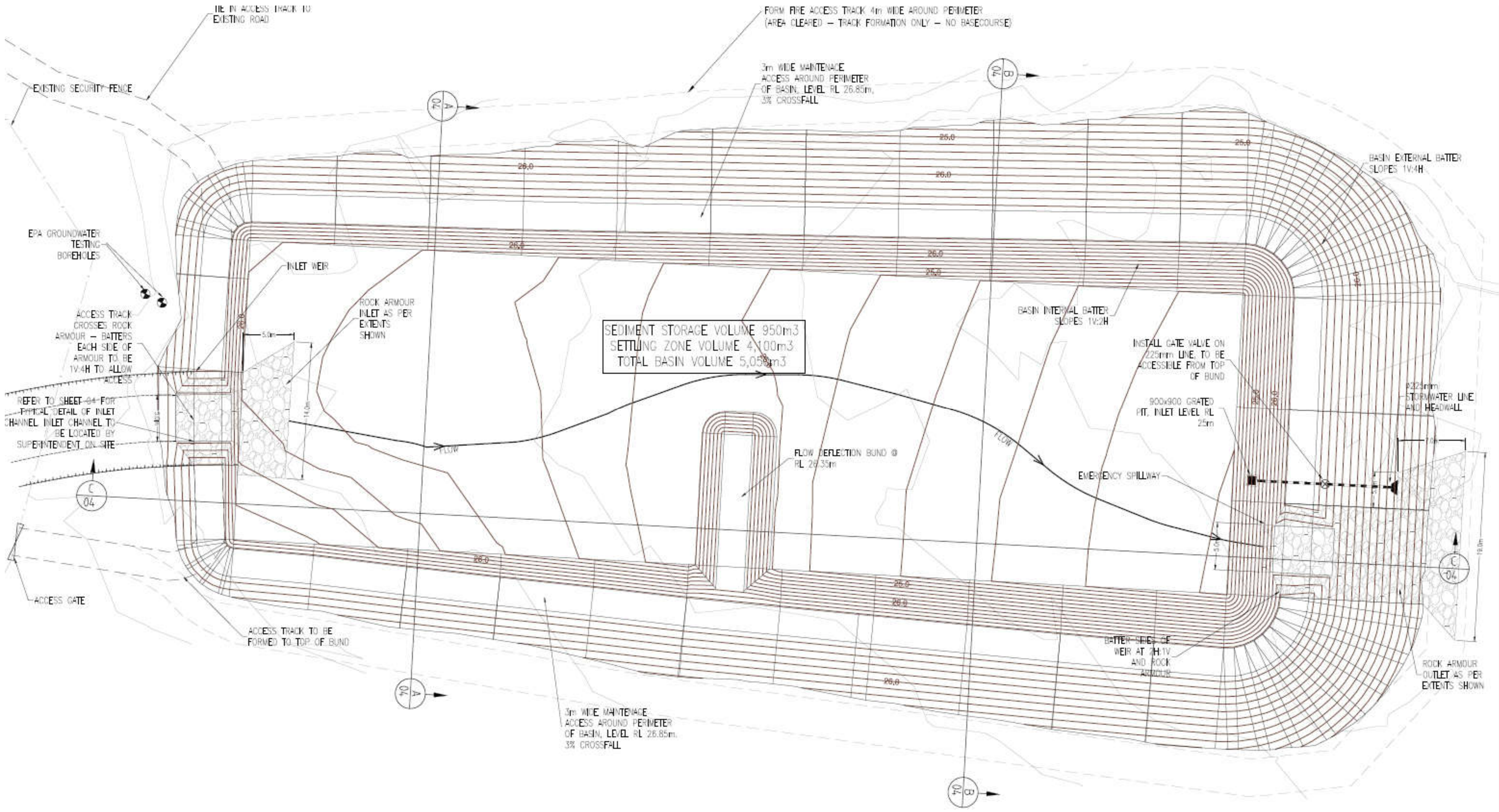


Figure 10: Typical Sediment Basin Plan

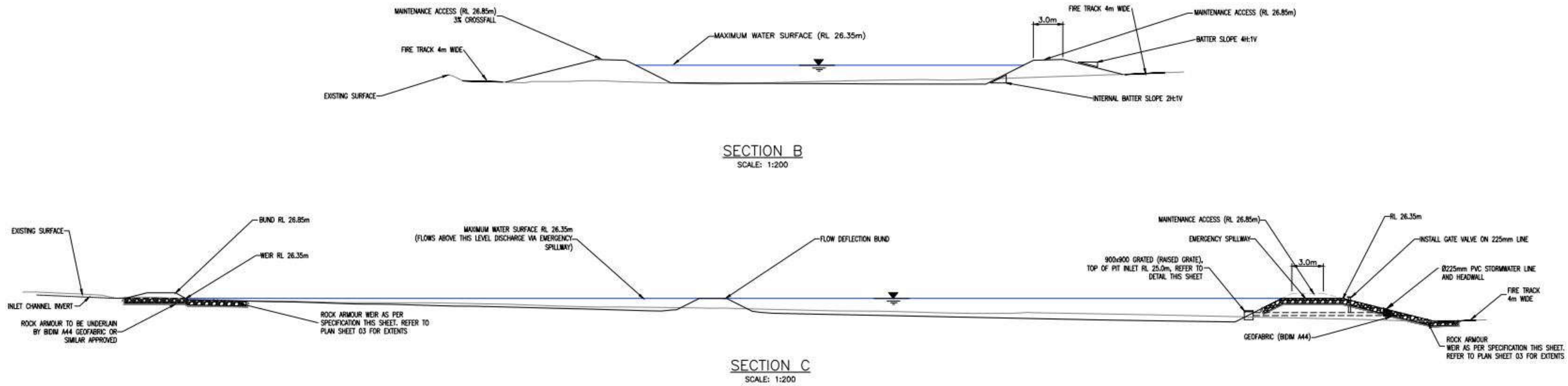


Figure 11: Sediment Basin Typical Sections

8. WATER QUALITY MONITORING

The following section describes the proposed water quality monitoring program for the CWMF landfill. The monitoring program will address ground water, surface water and leachate quality.

8.1 Leachate Monitoring

PMHC (water and sewer section) will shortly commence construction of a new sewerage treatment plant (STP) to be built within the CWMF Industrial Precinct. Once complete, the leachate from the site will be pumped to the STP for treatment and disposal.

Leachate flow and volume monitoring will be undertaken in accordance with the requirements of the STP licence. In addition leachate composition monitoring will also be undertaken to ensure the proper operation of the STP.

PMHC (waste section) currently undertakes routine composition (laboratory) monitoring on a quarterly basis by sampling and testing leachate from the main collection tank site within Stage E. This program will be continued for Stages 1, 2 and 3 as each stage is activated and leachate collection tanks are constructed.

Parameters tested are generally in accordance with the EPA's *Environmental Guidelines, Solid Waste Landfills*. **Table 5** details the current leachate monitoring parameters.

A leachate extraction and level-control system will be considered within future stages to include a collection sump and leachate riser(s) to facilitate extraction of leachate from each cell. The leachate extraction system is designed to achieve a maximum level of leachate of 300 mm over the upper liner and be able to continue to function effectively until the landfill is considered stable.

8.2 Stormwater Monitoring

PMHC currently undertakes routine surface water monitoring on a quarterly basis in main sediment and stormwater basins by sampling and testing when surface water is present. The stormwater monitoring program seeks to detect cross contamination of stormwater with landfill leachate.

The existing program will continue for Stages 1, 2 and 3 as each stage is activated and stormwater basins are constructed.

Parameters tested are generally in accordance with the EPA's *Environmental Guidelines, Solid Waste Landfills*. Typically the monitoring will include; total suspended solids (or related measures such as turbidity) and indicators of leachate contamination (e.g. ammonia, total organic carbon and conductivity). **Table 6** details the current surface water monitoring parameters.

8.2.1 Sediment Basins

In addition to routine composition testing, PMHC will also monitor sediment basins to ensure excess sediment loads in the stormwater are captured and not leaving the site.

- **Sampling from sediment basins**: The contents of sediment basins will be monitored quarterly to demonstrate that the size and design of the dam are adequate
- **Discharges from sediment basins**: Manually drained discharges will be periodically sampled before release off-site to ensure that discharge criteria are met. Uncontrolled overflows will be sampled (where practicable). Records will be kept detailing uncontrolled overflows, including time, duration and estimated volume, as well as the rainfall event preceding each overflow.

8.2.2 Ambient Surface Water Monitoring

An ambient (surrounding area) surface water monitoring program will be developed to detect any contamination in off-site surface water bodies by leachate or by sediment-laden stormwater from the landfill.

The ambient surface water monitoring program will need to consider the ephemeral nature of downstream watercourses and the difficulty sampling if rainfall has not occurred. Where sampling is not possible within downstream water bodies, sampling within the on-site sediment basins will be reviewed to ensure water quality discharges to downstream watercourses is appropriate.

8.3 Groundwater Monitoring

Nine (9) groundwater monitoring bores are currently located within CWMF (refer to Appendix B for bore locations. Groundwater monitoring is currently undertaken at CWMF in accordance with PMHC's *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 18 (SOP18). Groundwater parameters tested are presented in Table 7.

Trace Environmental prepared a *Hydrogeological Assessment, Cairncross Landfill Expansion (October 2016)* report and recommended that the current groundwater monitoring program is slightly altered in terms of frequency and parameters analysed to ensure consistency with the EPA's *Environmental Guidelines, Solid Waste Landfills (2016).* Refer to **Table 19** for the monitoring schedule and parameters to be tested.

Table 19: Monitoring Schedule for Groundwater (*Trace Environmental 2016*)

Period	Location	Parameters	Frequency
Excavation Stages 1-3	All groundwater monitoring bores	As per EPA NSW (2016) guidelines: • Field parameters (pH, temperature and redox) and • Laboratory parameters (total dissolved solids, major anions and cations, total organic carbon, ammonia, nitrate, nitrite and phosphorous)	Quarterly
	Selected groundwater monitoring bores*	Groundwater head monitoring	Monthly
	Groundwater monitoring bores CG9 and CG10	Groundwater head monitoring	Quarterly
	Drainage trench monitoring location (CG15)	As per EPA NSW (2016) guidelines: • Field parameters (pH, temperature and redox) and • Laboratory parameters (total dissolved solids, major anions and cations, total organic carbon, ammonia, nitrate, nitrite and phosphorous)	Quarterly
	In pit sump	Volumes	in accordance with DPIWater licensing requirements
	Leachate at each of the sumps in each of the Stages	As per current water quality sampling parameters plus level and flow monitoring, in accordance with any applicable TWA/EPL	Quarterly
Operation Stages 1-3	All groundwater monitoring bores	As per EPA NSW (2016) guidelines: • Field parameters (pH, temperature and redox) and • Laboratory parameters (total dissolved solids, major anions and cations, total organic carbon, ammonia, nitrate, nitrite and phosphorous)	Quarterly
	All groundwater monitoring bores and drainage trench monitoring point (CG15)	Groundwater head monitoring	Quarterly

	Drainage trench monitoring location (CG15)	As per EPA NSW (2016) guidelines: • Field parameters (pH, temperature and redox) and • Laboratory parameters (total dissolved solids, major anions and cations, total organic carbon, ammonia, nitrate, nitrite and phosphorous)	Quarterly
	Leachate	• As per current water quality sampling parameters, plus level and flow monitoring, in accordance with any applicable TWA/EPL	Quarterly
	All groundwater monitoring bores and drainage trench location (CG15)	Metals: aluminium, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, and zinc, and organic contaminants: phenols, petroleum hydrocarbons, PAH, monoaromatic hydrocarbons	Annually
Post closure Stages 1-3	All groundwater monitoring bores and drainage trench monitoring point (CG15)	As per EPA NSW (2016) guidelines: • Field parameters (pH, temperature and redox) and • Laboratory parameters (total dissolved solids, major anions and cations, total organic carbon, ammonia, nitrate, nitrite and phosphorous) Note: this can and will likely be modified based on the performance during the operational stages and following a groundwater performance report.	Quarterly
	All groundwater monitoring bores and drainage trench monitoring point(CG15)	Metals: aluminium, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, and zinc, and organic contaminants: phenols, petroleum hydrocarbons, PAH, monoaromatic hydrocarbons	Annually
	All groundwater monitoring bores and drainage trench monitoring point(CG15)	Groundwater head monitoring	Quarterly
	Leachate at the sump at each of the Stages 1 to 3	As per current water quality sampling parameters plus level and flow monitoring, in accordance with any applicable TWA/EPL	Quarterly

As a result of submissions received during public exhibition of the EIS a number of changes have been made to the Proposal.

The site concept design has been refined and the Drainage Trench removed and replaced with a series of collection trenches containing high-permeability granular material and perforated pipework in a herringbone pattern. The monitoring recommended by Trace Environmental for the Drainage Trench (see table above) will be undertaken within the revised groundwater interception system.

In addition to the monitoring parameters volatile halogenated compounds will be measured, on a quarterly basis.

During the development of Stage 1 existing groundwater bores CG104 and CG105 will be removed and replaced. Four (4) additional groundwater bores will be installed at the south-western and south-eastern boundary of Stages 2 and 3, respectively. The additional and replacement bores will form part of the total monitoring network.

A groundwater assessment report will be prepared at least once every five (5) years, or should the groundwater monitoring program detect a possible failure of the leachate containment system.

9. LANDFILL GAS MANAGEMENT AND MONITORING

The following section describes the proposed landfill gas management and monitoring program for the CWMF landfill.

9.1 Landfill Gas Control

In December 2012, Mike Ritchie and Associates completed a *Carbon Pricing Mechanism and Council Landfill* report for the Midwaste Regional Waste Group (of which PMHC is a member). The purpose of the report was to estimate landfill emissions and investigate the potential liabilities and opportunities presented to Midwaste Councils as a result of the *Clean Energy Act 2012* (now repealed).

The report identified the following with respect to CWMF:

- Legacy waste emissions would not exceed 25,000t CO_2-e.
- Greenhouse gas emissions from the future landfilling would peak in 2084 at approximately 86,000t CO2-e for the year.

In March 2016, Arcadis completed a *Preliminary Greenhouse Gas Assessment* for the Cairncross Landfill Expansion EIS. The results from the assessment found that:

- Legacy waste (in this case referring to waste disposed of prior to the proposed landfill expansion commencing) would generate approximately 25,000 tCO_2-e per year in the period 2016-2019.
- Greenhouse gas emissions from the proposed landfill expansion would peak in 2067, with approximately 218,000 t CO_2-e generated in that year.

Since the landfills inception in 2000, all domestic organic material has been processed in the Organics Resource Recovery Facility (ORRF). In addition, an Alternate Waste Technology (AWT) facility also operated until 2012. The AWT treated organic material in the general waste stream to create an “inert” material that was then placed in landfill.

As such the existing landfill is not “typical” and therefore the methane generation rate is difficult to predict. The above variations in assessment of future greenhouse gas emissions highlighted the difficulty in modelling the emissions, and the need for a landfill gas pumping trial at CWMF.

PMHC has commenced a landfill gas pumping trial at CWMF. The pumping trial is being conducted to assess the actual rate of methane generation from a ‘typical’ zone within the landfill, the concentration of methane during active extraction, and will provide a forecast of future extraction rates / concentrations within the landfill. The trial will also make recommendations on the future landfill gas management at the site. The bores used in the trial have been installed across the filled areas within the existing (Stage E) landfill cell in close proximity to the active landfill tip face. Results of the trial will be captured from mid-2019 when the bores are at an appropriate separation distance from the active landfill tip face.

The extent of gas controls to be designed and implemented for the existing and future stages of landfill will be guided by the results of the gas pumping trial. PMHC will develop a landfill gas management plan based on the findings of the trial.

9.2 Landfill Gas Monitoring

Landfill gas surface emissions monitoring, sub-surface monitoring and gas accumulation monitoring is currently undertaken at CWMF.

PMHC’s *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 19 (SOP19) details the landfill gas monitoring procedures including use of the gas monitoring equipment (eg. detector, wind speed monitor) and EPA reporting threshold levels.

Sub-surface monitoring is currently undertaken on a quarterly basis within groundwater monitoring boreholes. Groundwater monitoring boreholes range in depth from 10m to up to 30m and have been considered a suitable ‘surrogate’ for gas monitoring bores. Refer to **Appendix B - Water Quality Monitoring Locations** for details of the groundwater monitoring bore locations. Detection of methane above 1.25% (12,500 ppm) (v/v) requires notification to the EPA, further investigation and potential corrective action.

Surface monitoring is undertaken using a 25m grid survey over completed (capped and grassed) landfill areas. Surface monitoring is undertaken on a monthly basis. The threshold concentration for closer investigation is 0.05% (500 ppm) (v/v) of methane at any point on the landfill surface

Accumulation monitoring also occurs within structures located within 250m of deposited waste. Detection of methane above 1.25% (12,500 ppm) (v/v) notification to the EPA, further investigation and potential corrective action.

EPA’s *Environmental Guidelines, Solid Waste Landfills (2016)* has revised the threshold levels as follows:

- **Sub-surface monitoring:** 1.0% methane (v/v) and 1.5% carbon dioxide (v/v).
- **Surface monitoring**: 1.0% methane (v/v).
- **Accumulation monitoring**: 1.0% methane (v/v).

PMHC’s *Operational Policies, Standard Operating Procedures and Safe Work Method Statements (February 2013)*, Standard Operation Procedure 19 (SOP19) will be revised to reflect the new threshold levels.

It is proposed to maintain the landfill gas monitoring program for Stages 1, 2 and 3 as each stage is activated.

However, following the gas pumping trial and the development of a landfill gas management plan, based on the findings of the trial, it is anticipated that future stages will require the implementation of specific gas monitoring boreholes around the perimeter of the landfill area. The assessment and future design of a gas monitoring bore network will be in accordance with the EPA’s *Environmental Guidelines, Solid Waste Landfills (2016)*.

10. COVERING OF WASTE

The following section describes the proposed covering of waste at the CWMF landfill.

10.1 Daily Cover

In order to minimise odour, litter, dust, the presence of scavengers/vermin, fire, infiltration of rainfall and emissions of landfill gas, daily cover will be applied to the waste each day before the close of business.

Daily cover comprises natural site soils and is applied at a minimum thickness of 150mm. Existing daily cover is sourced from clay stockpiled from the Stage E landfill excavation. During filling of Stages 1 and 2, a clay deficit is expected for each stage, however clay stockpiled from Stage E will be available for daily cover during filling of Stages 1 and 2. For Stage 3, sufficient clay is expected to be available for daily cover from the landfill excavation.

Refer to **Table 9** for details on the overall site material balance.

10.2 Intermediate Cover

Intermediate cover may be required occasionally where a cell will not receive additional waste (or will not be finally capped) for some time. Any waste-filled areas that have not been filled for more than 90 days will have intermediate cover applied that will meet the following requirements:

- Minimum 300mm thick clay (VENM)
- Saturated hydraulic conductivity of less than $1x10^{-5}$m/s
- Compaction 95% SMDD (standard maximum dry density).

Refer to **Table 9** for details on the overall site material balance.

11. FINAL CAPPING AND REVEGETATION

All completed landfill cells are to be capped and revegetated within six (6) months of the final delivery of waste to the cell. The following section describes the final capping and revegetation program for the CWMF landfill.

11.1 Capping Details

The final landfill cap is to be constructed in accordance with the NSW EPA's *Environmental Guidelines, Solid Waste Landfills* (2016), and is to comprise the following:

- 300mm thick seal bearing surface (compacted clay)
- 600mm thick composite sealing layer of (compacted clay hydraulic conductivity $<1x10^{-9}$m/s)

Appendix D - Future Stage Concept Plans - Sub Stages details the staged approach used at the CWMF. This staging will allow for the progressive excavation and capping of the previous sub-stage while the current sub-stage is being filled. A 'typical' development sequence is detailed in **Figure 4**.

Material volume calculations estimate sufficient capping material for Stages 1, 2 and 3. Refer to **Table 9** for details on the overall site material balance.

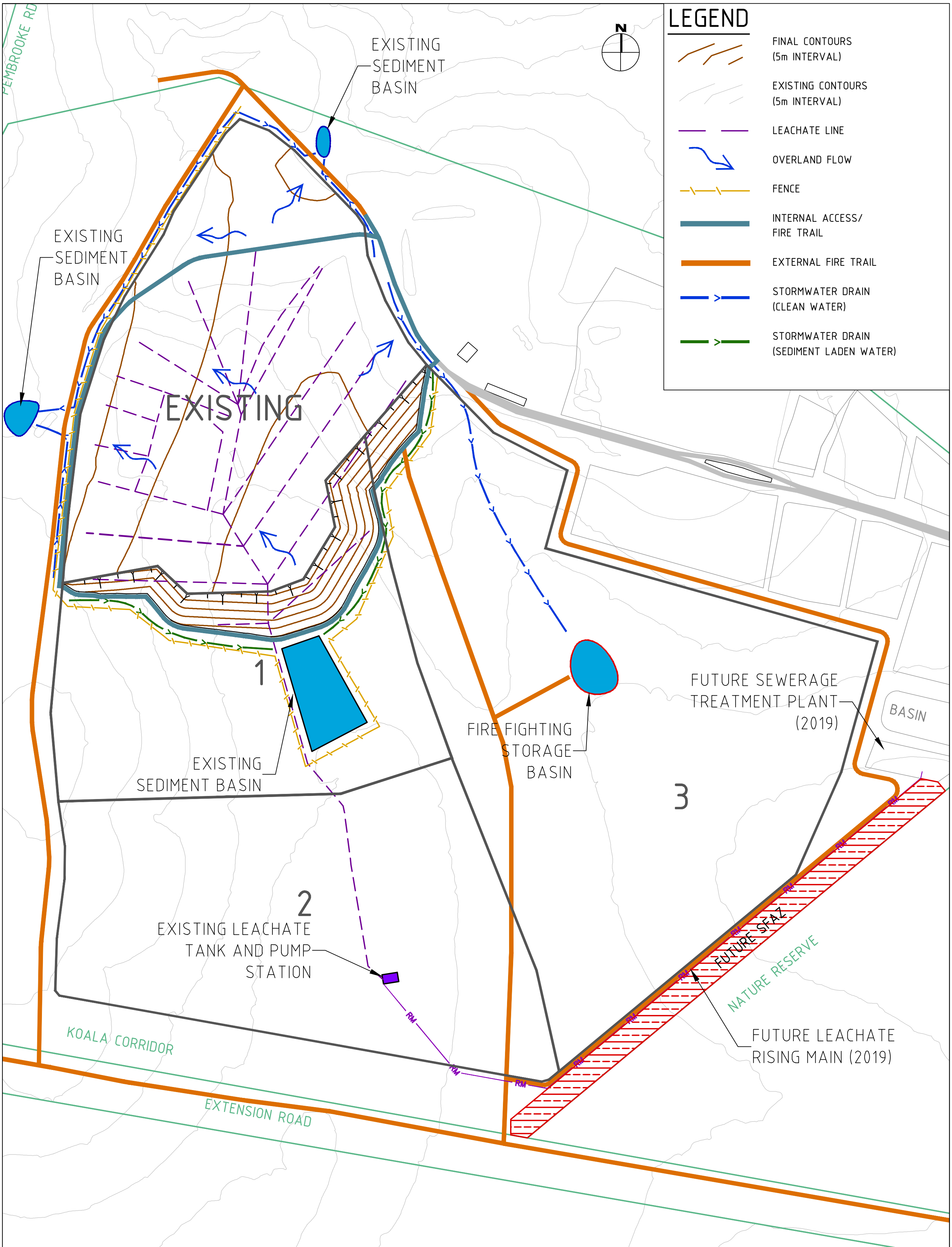
11.2 Revegetation

A revegetation layer is to be placed over the clay capping layer and will be in accordance with the NSW EPA's *Environmental Guidelines, Solid Waste Landfills* (2016). The revegetation layer is to comprise the following:

- 1,000mm thick revegetation layer comprising 700mm clay (lower) and 300mm topsoil (upper)
- Revegetation is to comprise grass cover of suitable native species.

Refer to **Table 9** for details on the overall site material balance.

APPENDIX A - STAGE E (EXISTING) CONCEPT PLAN



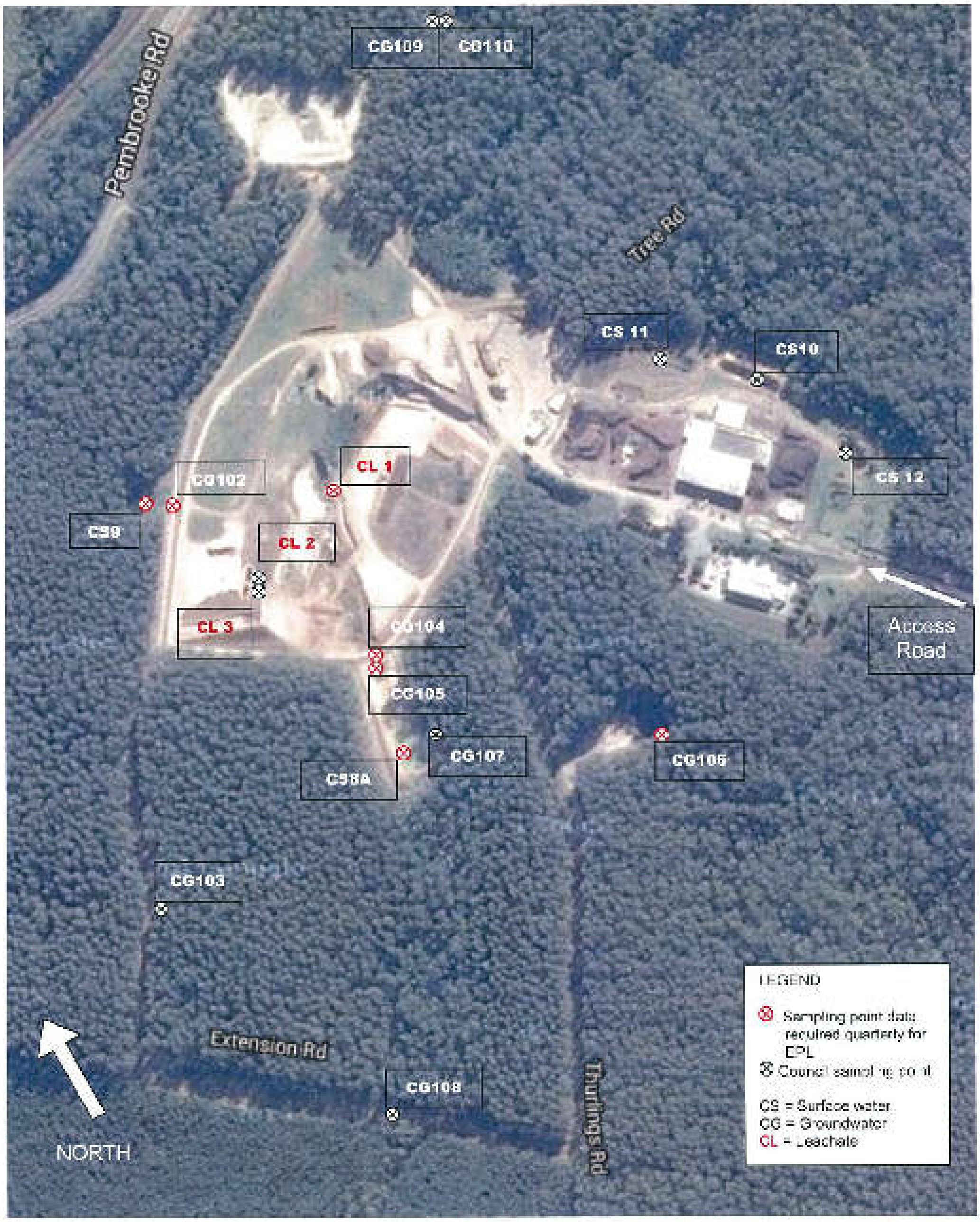
PORT MACQUARIE HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE E (EXISTING)
CONCEPT PLAN

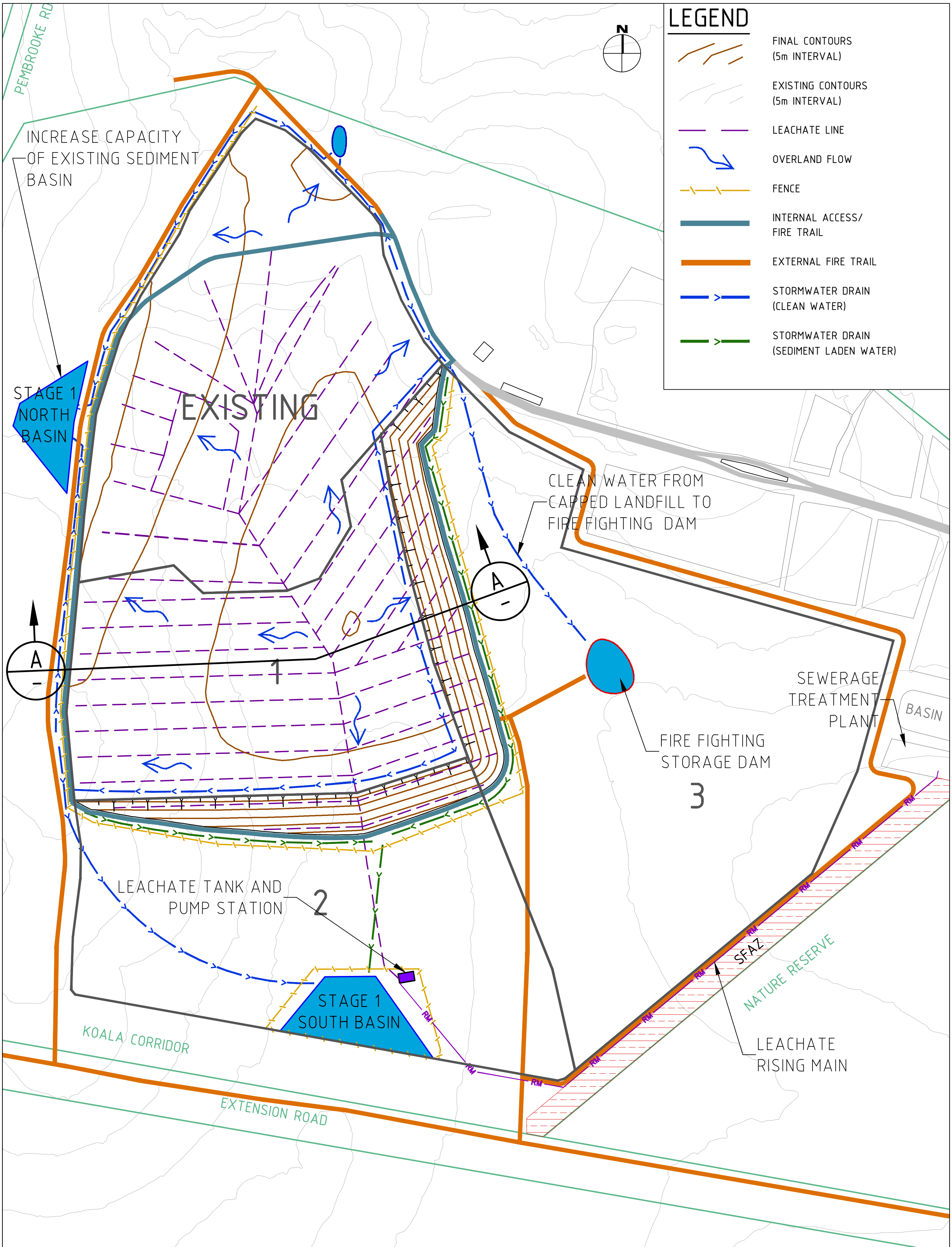
0 50 100 200 300
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)

APPENDIX B - WATER QUALITY MONITORING LOCATIONS

Cairncross Landfill - Bore and Surface Water Monitoring Point Locations



APPENDIX C - FUTURE STAGE CONCEPT PLANS



PORT MACQUARIE HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE 1
CONCEPT PLAN

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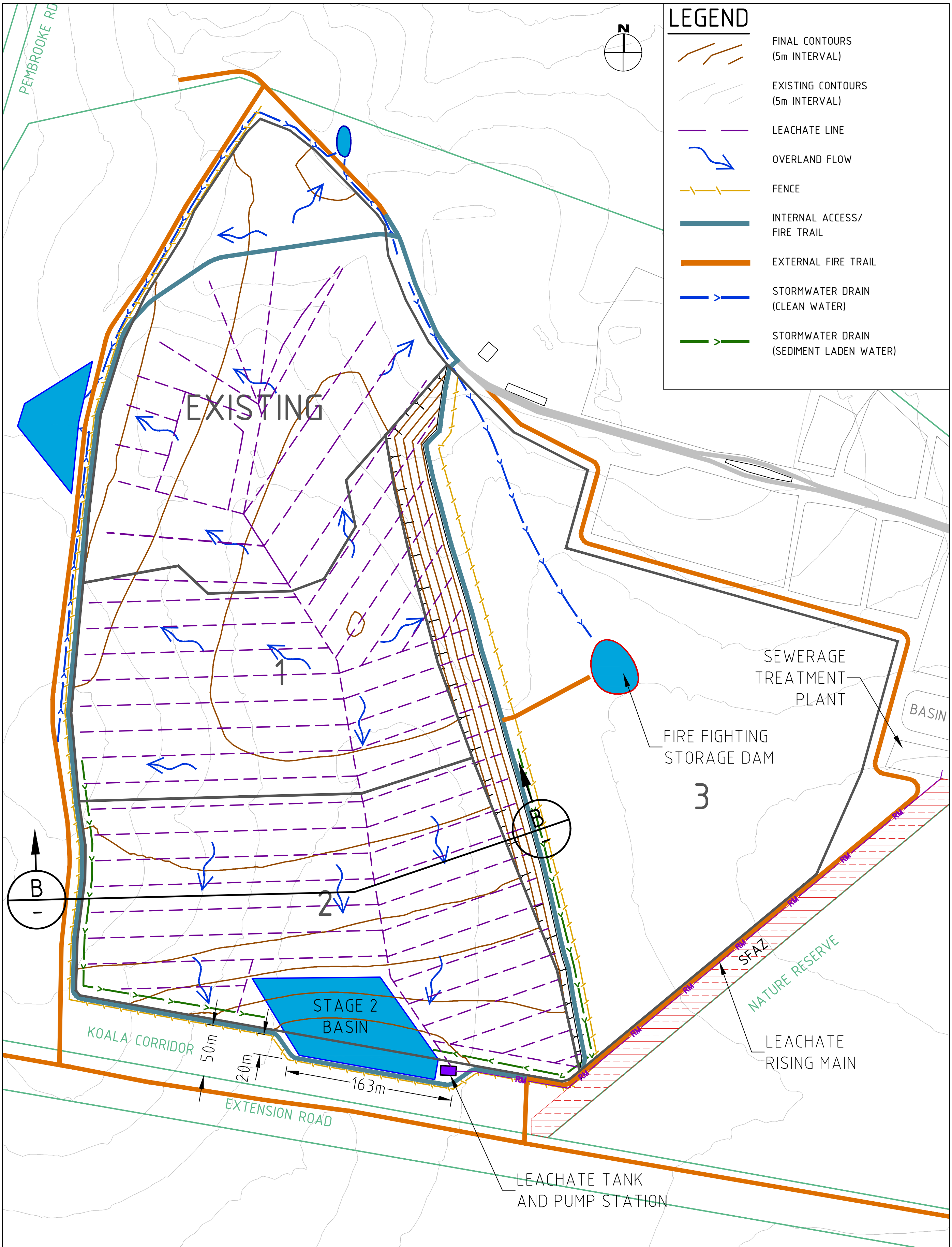
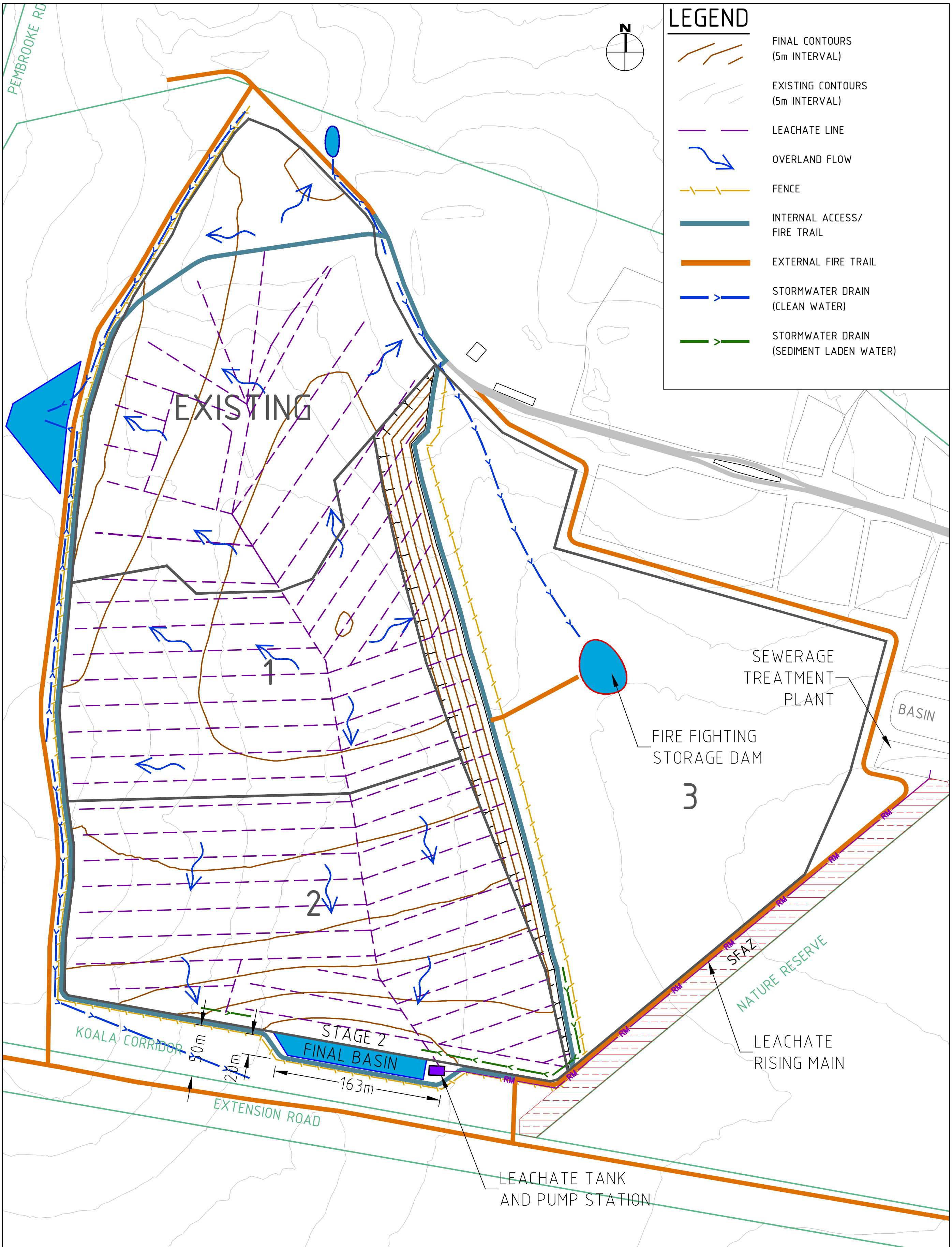
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)



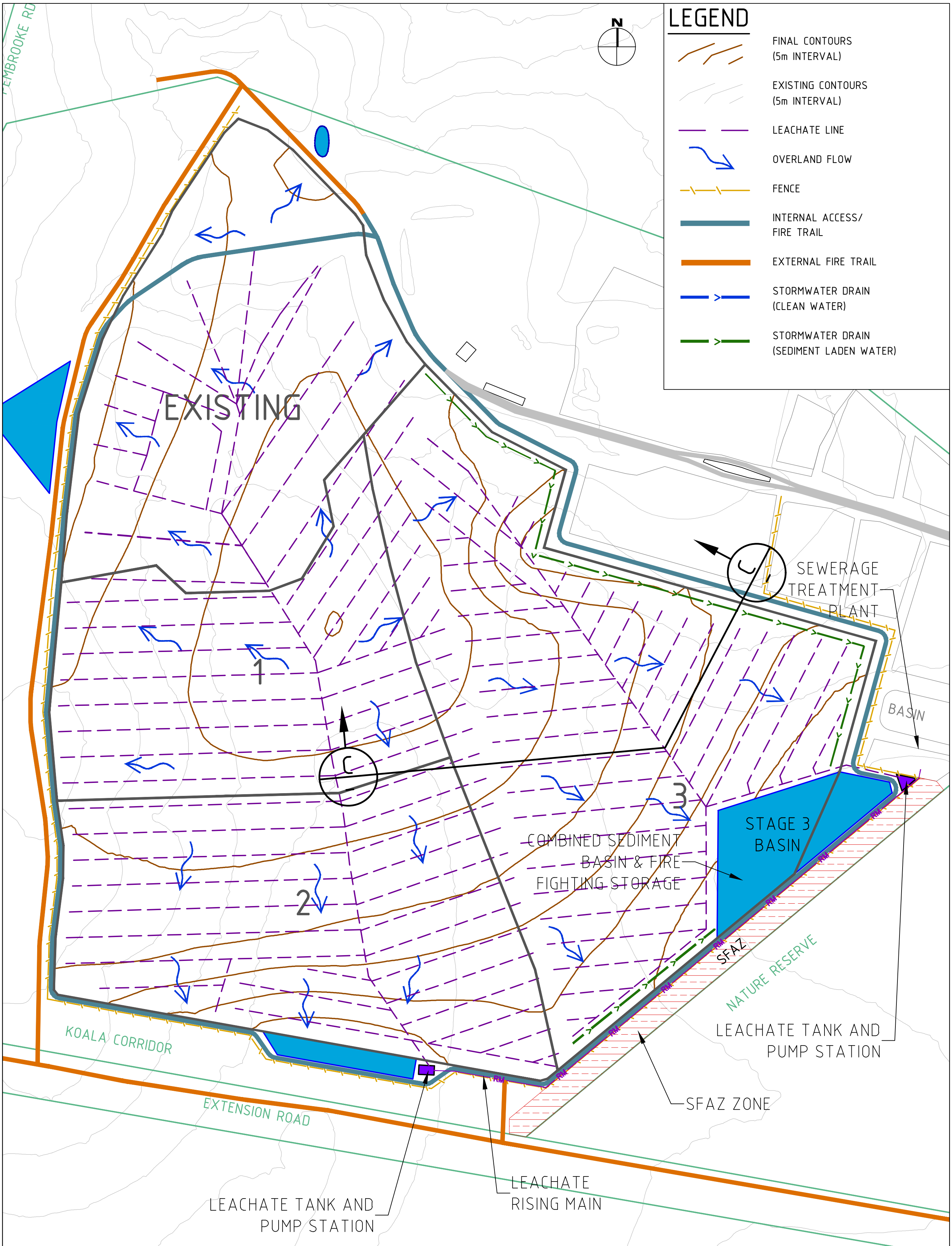
PORT MACQUARIE HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE 2
CONCEPT PLAN



PORT MACQUARIE HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE 2 - FINAL SUB-STAGES
CONCEPT PLAN



PORT MACQUARIE HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY STAGE 3 CONCEPT PLAN

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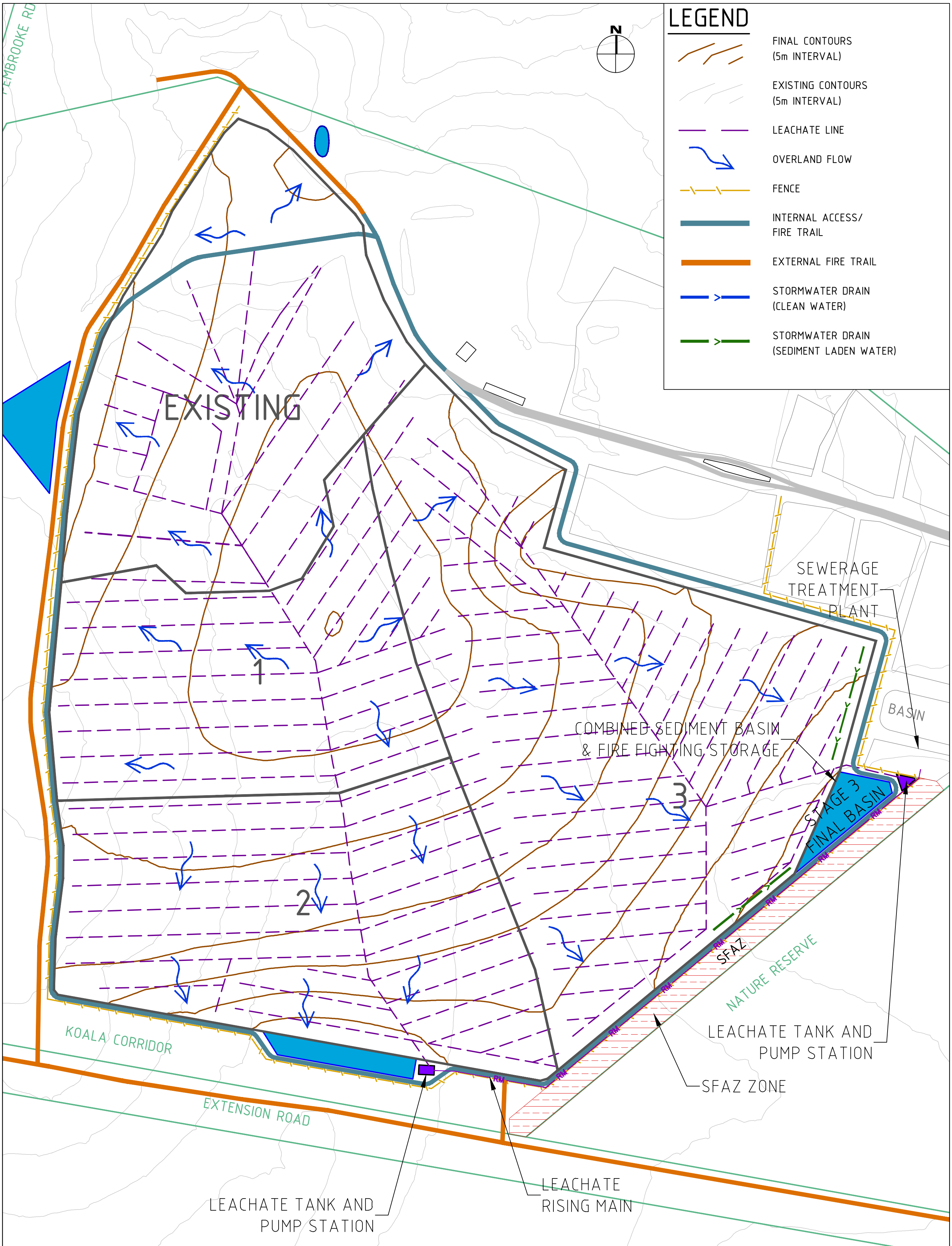
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)



PORT MACQUARIE HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE 3 - FINAL SUBSTAGES
CONCEPT PLAN

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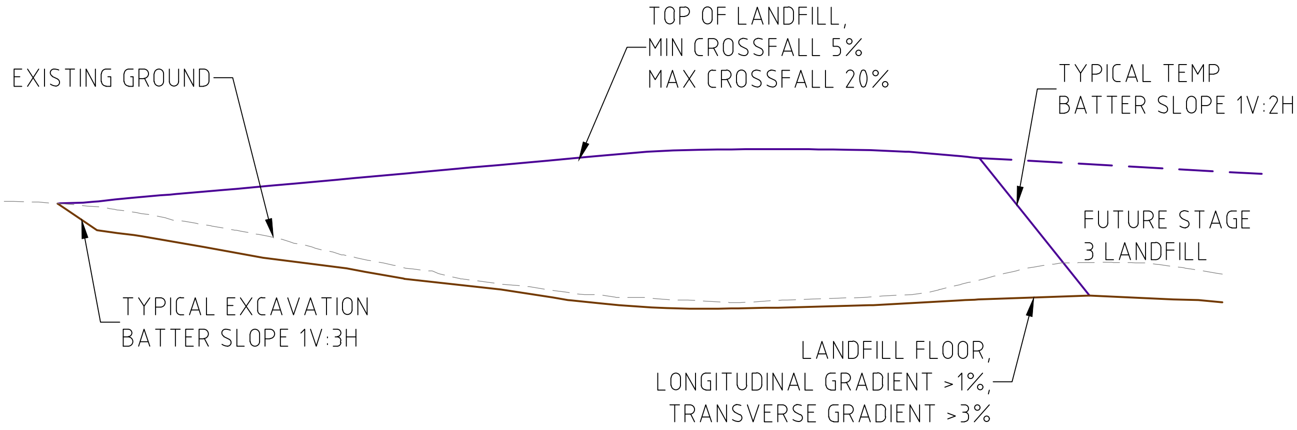
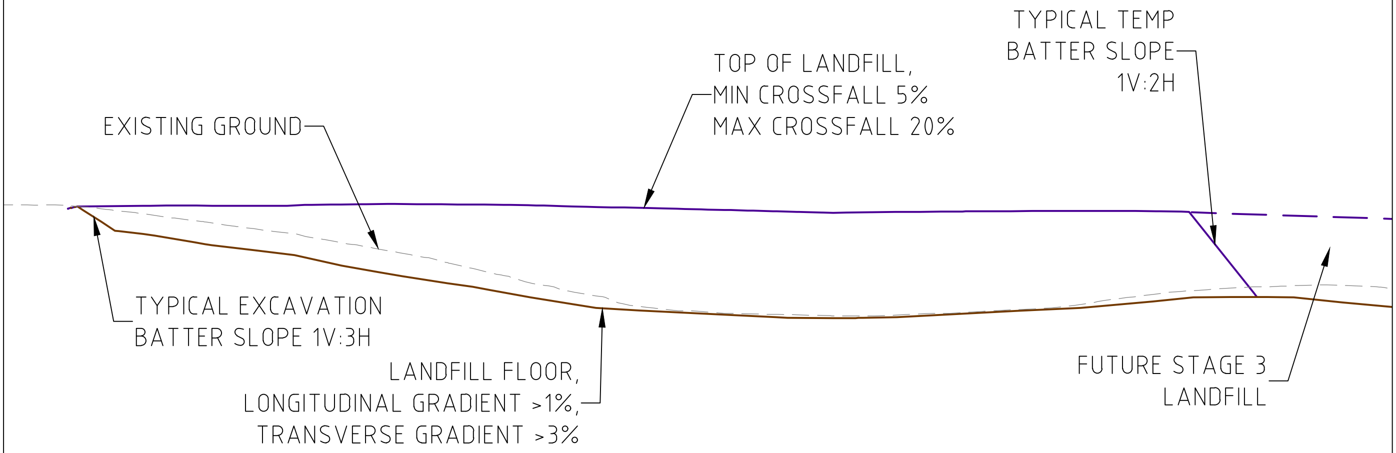
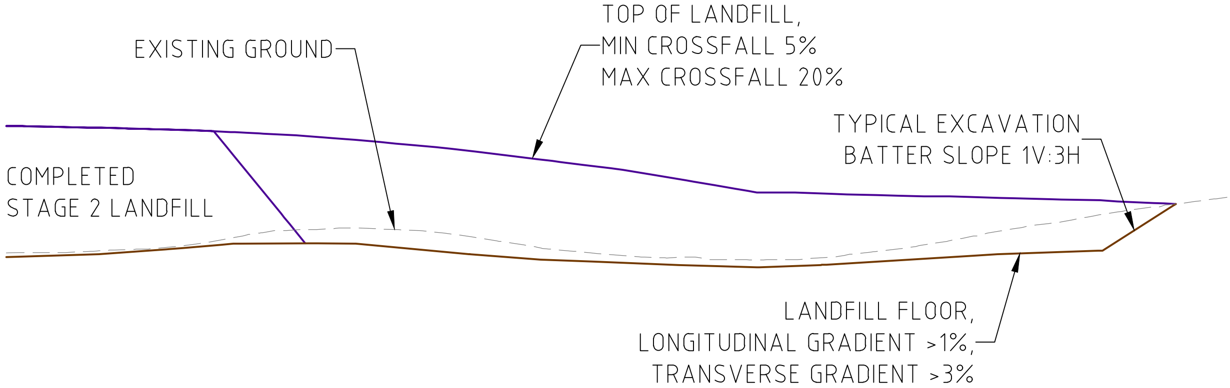
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)



SECTION A (STAGE 1)



SECTION B (STAGE 2)



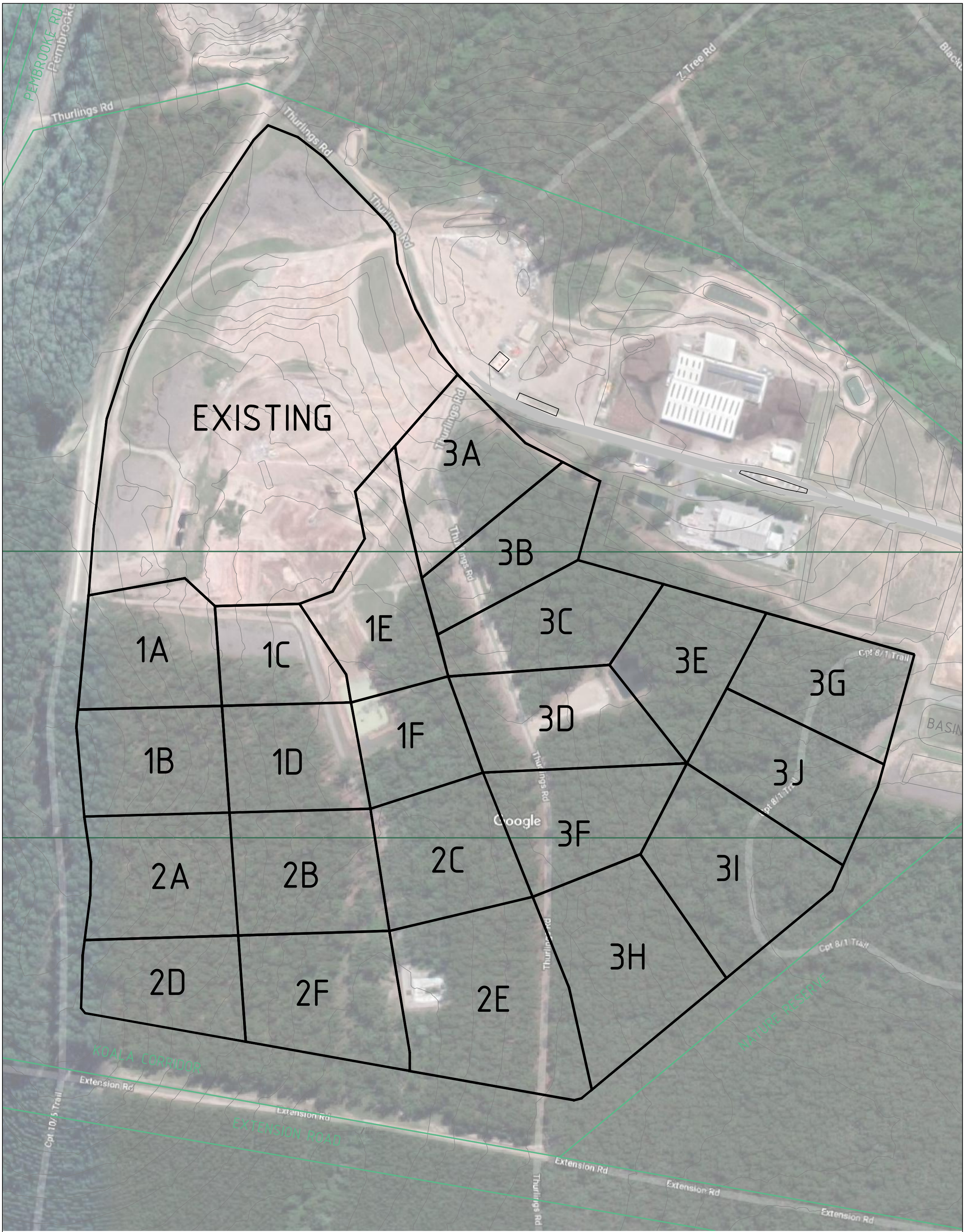
SECTION C (STAGE 3)

NOTE VERTICAL EXAGERATION
2x ON SECTIONS

PORT MACQUARIE
HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY
CONCEPT DESIGN
TYPICAL CROSS SECTIONS

APPENDIX D - FUTURE STAGE CONCEPT PLANS - SUB STAGES

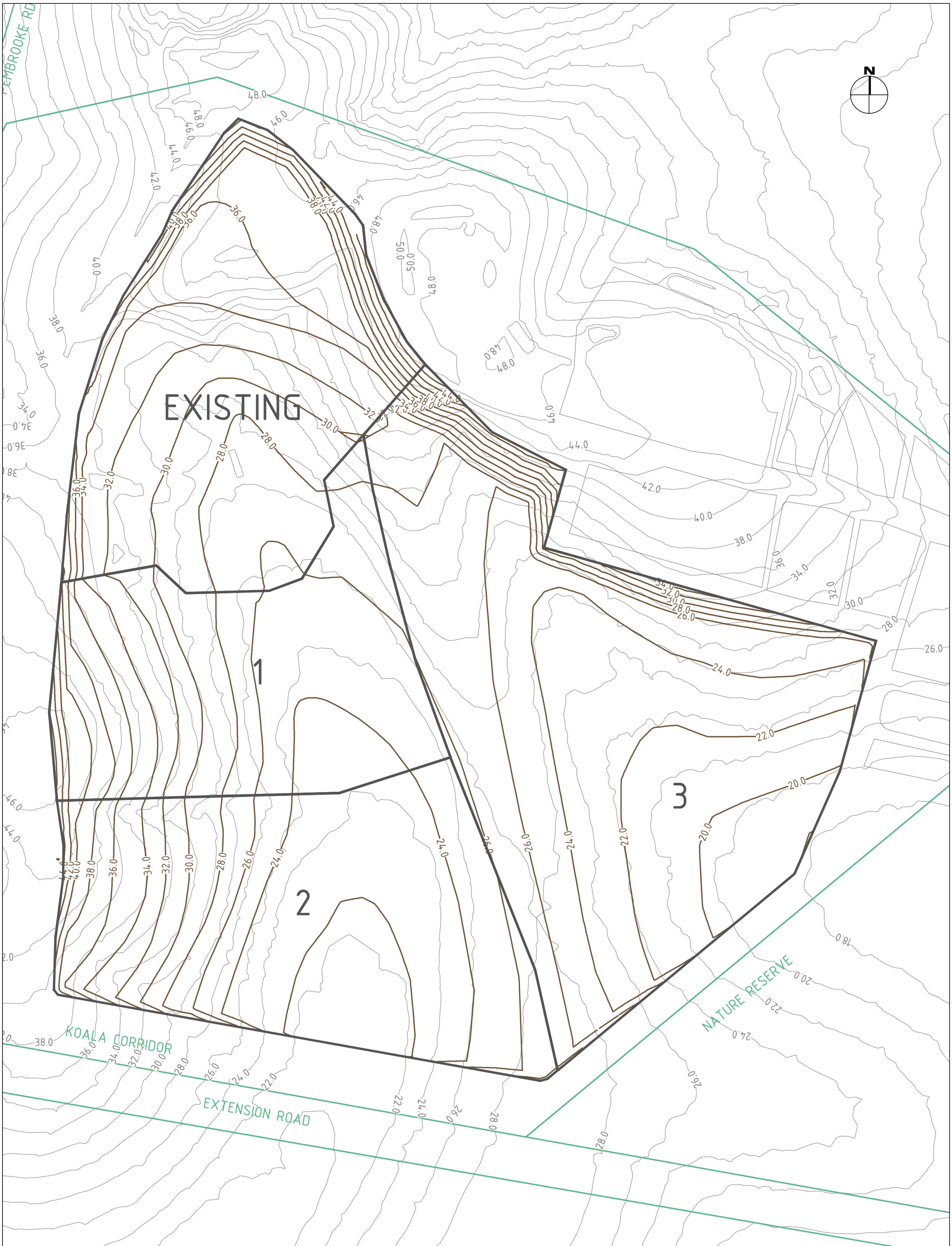


CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGING PLAN
SUB-STAGES

0 50 100 200 300
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)

PORT MACQUARIE HASTINGS

APPENDIX E - LANDFILL FLOOR EXCAVATION LEVELS



CAIRNCROSS WASTE MANAGEMENT FACILITY
LANDFILL FLOOR EXCAVATION LEVELS

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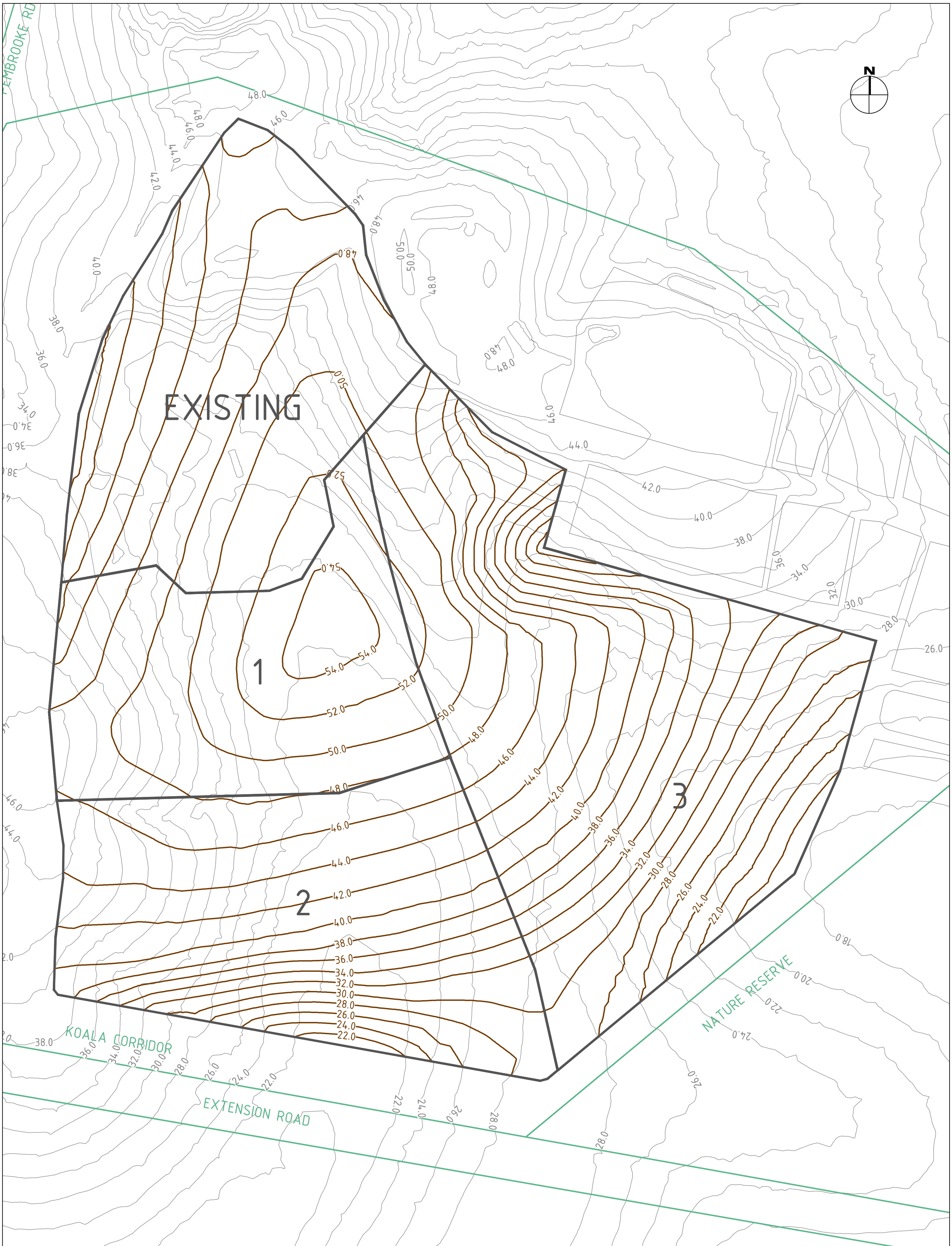
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)

PORT MACQUARIE HASTINGS

APPENDIX F - LANDFILL FINAL LANDFORM LEVELS



PORT MACQUARIE HASTINGS

CAIRNCROSS WASTE MANAGEMENT FACILITY
FINAL LANDFORM LEVELS

0 50 100 200 300
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)

APPENDIX G - BLUE BOOK SPREADSHEET CALCULATIONS

Note: These "Detailed Calculation" spreadsheets relate only to high erosion hazard lands as identified in figure 4.6 or where the designer chooses to use the RUSLE to size sediment basins. The "Standard Calculation" spreadsheets should be used on low erosion hazard lands as identified by figure 4.6 and where the designer chooses not to run the RUSLE in calculations.

1. Site Data Sheet

Site Name: **Cairncross Waste Management Facility**

Site Location:

Precinct:

Description of Site: **Landfill Expansion**

Site area	Site						Remarks
	1	2	3	1north	2final	3final	
Total catchment area (ha)	11.4	17.5	23.2	12.6	5	4.2	
Disturbed catchment area (ha)	6	6	6	1.5	4	4	

Soil analysis

% sand (faction 0.02 to 2.00 mm	10	10	10	10	10	10	Soil texture should be assessed through mechanical dispersion only. Dispersing agents (e.g. Calgon) should not be used
% silt (fraction 0.002 to 0.02 mm)	16	16	16	16	16	16	
% clay (fraction finer than 0.002 mm)	73	73	73	73	73	73	
Dispersion percentage	11.0	11.0	11.0	11.0	11.0	11.0	E.g. enter 10 for dispersion of 10%
% of whole soil dispersible	8.91	8.91	8.91	8.91	8.91	8.91	See Section 6.3.3(e)
Soil Texture Group	F	F	F	F	F	F	See Section 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5	5	5	5	5	5	See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	90	90	95	90	90	95	See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	70	70	106.2	70	70	106.2	See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	14.9	14.9	14.9	14.9	14.9	14.9	See IFD chart for the site

RUSLE Factors

Rainfall erosivity (*R* -factor)	4930	4930	4930	4930	4930	4930	Automatic calculation from above data
Soil erodibility (*K* -factor)	0.042	0.042	0.042	0.042	0.042	0.042	RUSLE data can be obtained from Appendixes A, B and C
Slope length (m)	250	250	250	300	190	180	
Slope gradient (%)	6	6	3	5	3	3	
Length/gradient (*LS* -factor)	2.91	2.91	1.11	2.53	0.97	0.95	
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Calculations

Soil loss (t/ha/yr)	783	783	299	681	261	256	
Soil Loss Class	6	6	3	5	3	3	See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	603	603	230	524	201	197	
Sediment basin storage volume, m^3	615	615	234	134	137	134	See Sections 6.3.4(i) and 6.3.5 (e)

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
1	11.4	20	49	84	96	115	137	155	0.9
2	17.5	24	53	94	107	125	146	166	0.9
3	23.2	26	57	98	112	131	156	176	0.9
1north	12.6	21	54	92	105	122	146	164	0.9
2final	5	15	63	107	122	142	169	190	0.9
3final	4.2	14	65	110	126	146	174	195	0.9

Peak flow calculations, 2

ARI (yrs)	Frequency factor (F_y)	Peak flows						Comment
		1 (m^3/s)	2 (m^3/s)	3 (m^3/s)	1north (m^3/s)	5 (m^3/s)	3final (m3/s)	
1 yr,tc	0.67	0.936	1.555	2.217	1.141	0.528	0.458	
5 yr,tc	0.92	2.204	3.787	5.233	2.668	1.231	1.063	
10 yr,tc	1	2.738	4.685	6.501	3.310	1.526	1.324	
20 yr,tc	1.07	3.510	5.856	8.136	4.115	1.901	1.642	
50 yr,tc	1.11	4.337	7.096	10.051	5.109	2.347	2.030	
100 yr,tc	1.18	5.217	8.577	12.055	6.101	2.805	2.418	

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{x\text{-day, y-\%ile}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

$R_{x\text{-day, y-\%ile}}$ = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	50% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day, y-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
1	0.50	70	11.4	3990	615	4605
2	0.50	70	17.5	6125	615	6740
3	0.50	106.2	23.2	12319.2	234	12553.2
1north	0.50	70	12.6	4410	134	4544
2final	0.50	70	5	1750	137	1887
3final	0.50	106.2	4.2	2230.2	134	2364.2

APPENDIX H - SITE WATER BALANCE

MEMO

ARCADIS Design & Consultancy for natural and built assets

Date	31/08/2016
To	Brad Farr (PMHC)
From	David Stone (Arcadis)
Copy to	Zoe Wood (Arcadis), Bradley Searle (Arcadis), Danielle Haynes (Arcadis), Gordon Cameron (PMHC)
Subject	Cairncross Landfill Expansion - Site Water Balance

Brad

The purpose of this memo is to document the recent site water balance investigations that Arcadis has undertaken to support the concept design prepared by Council for the Cairncross Landfill Expansion.

The aim of the water balance is to estimate the water demands for operational uses and the potential availability of water to meet these demands. The outcome of the investigation will inform the stormwater management strategy for the site.

1.1 Introduction

The proposed stormwater management strategy for the site is documented in the concept staging plans prepared by Port Macquarie Hastings Council (refer **Attachment A**). The proposed landfill expansion involves three Stages and the staging plans include three sediment basins and a firefighting storage dam. A site water balance was prepared to assess the ability of the proposed basins to provide a suitable source of water for the proposed development.

For the purpose of this memo and the attached water balance calculations, the basins are referred to as 'North', 'South', 'West' and 'Fire'. The North and West basins are existing basis and will remain in their current locations for the duration of the landfill operations. The Fire basin is an existing basin and will remain in its current location during Stage 1 and 2, being relocated to the eastern side of Stage 3 prior to commencement of landfilling in the Stage 3 area. The South basin is an existing basin and will be relocated to the southern boundary of the Stage 2 area prior to commencement of landfilling in the Stage 1 area (see figures in **Attachment A**).

1.2 Methodology

A spreadsheet water balance was established using Excel. The key calculations undertaken for each basin are:

(i) *Basin Inflow = Catchment Area x Rainfall Depth x Runoff Coefficient*

(ii) *Basin Inflow – Demand – Pond Evaporation = Water Surplus/Deficit*

The balance was undertaken at a monthly time step for each of the proposed development stages and utilised local climate data, catchment and basin parameters derived from the concept design and predicted water demands.

Climate data included:

- Monthly average and 10 percentile rainfall data from Bureau of Meteorology (BoM) gauge 'Telegraph Point (Farrawells Road)' (Gauge no. 060031) for the 30 year period 1961-1990.
- Monthly average pan evaporation data derived from BoM gridded data.

- Monthly mean number of days with rainfall >= 10 mm for BoM gauge Port Macquarie Airport AWS (Gauge no. 060139).

Catchment and basin parameters included:

- Catchment areas derived from the concept design (refer **Attachment B**).
- Runoff coefficients representative of expected surface conditions.
- Pond evaporation for the proposed basins was estimated by dividing the monthly average pan evaporation data by a factor of 1.3 (a typical factor quoted in most textbooks to account for the extra heat taken in through the sides of a pan).

The only significant water demand for the site is expected to be for dust suppression. Consultation with Council officers suggested that current average daily demand is 25 m^3/day during dry periods and that this is expected to be similar for future operations. In a worst case scenario, the maximum daily demand is expected to be 40 m^3/day. The water balance calculations adopt a demand of 25 m^3/day, however the maximum demand (40 m^3/day or 1,200 m^3/month) has also been considered.

For the purpose of the water balance it was assumed that no watering for dust suppression purposes would be required when rainfall is >=10mm/day.

For all stages, demand was assumed to be supplied from the firefighting storage dam (storage for dust suppression would be provided in addition to firefighting storage requirements of 100 m^3).

1.3 Results

The results of the water balance for each of the proposed stages are included in **Attachment C** and are discussed below in relation to average and 10th percentile rainfall scenarios.

The results show that, in all months with average rainfall conditions, there is a surplus of water available for dust suppression. This applies throughout all stages of the proposed landfill operation. Under average rainfall conditions, the driest month is September, and this corresponds with the minimum surplus of approximately 200 m^3/ month during Stage 1, for the firefighting storage dam on its own. If all four basins are considered, there is a surplus of more than 4,600 m^3 across the site for the same month.

The results also show that under 10th percentile rainfall conditions there is a potential water deficit during July and August in all three stages. A deficit of similar magnitude is also predicted by the water balance for the existing landfill for 10th percentile rainfall conditions. Discussions with Council identified that a water deficit has not previously been experienced at the landfill, even when there have been serious rainfall deficiencies (eg; August and September 2009 were consecutive months of less than 10th percentile rainfall). This is most likely due to the significant water storage provided in the existing basins. The existing firefighting basin alone has a storage volume of approximately 3,000 m^3, which is well in excess of the required firefighting storage requirement of 100 m^3 and also the maximum monthly water demand of 1,200 m^3. The minimum proposed total water storage capacity, including settling zone volume within the sediment basins which could also be used as a water source, is approximately 8,300 m^3 (during Stage 3). Maximum water demands and minimum storage volumes are summarised in Table 1.

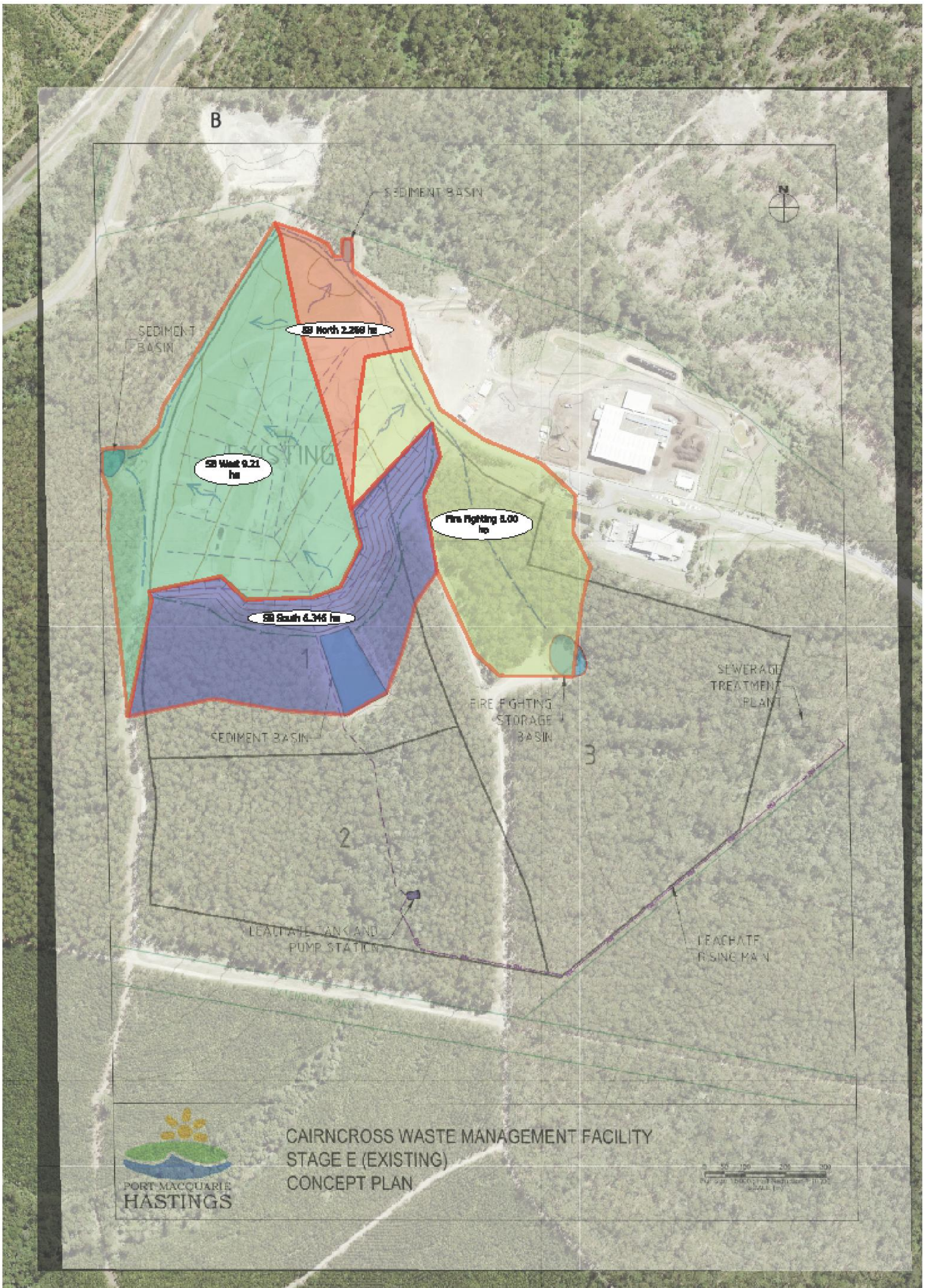
Table 1: Maximum demand and minimum storage volumes

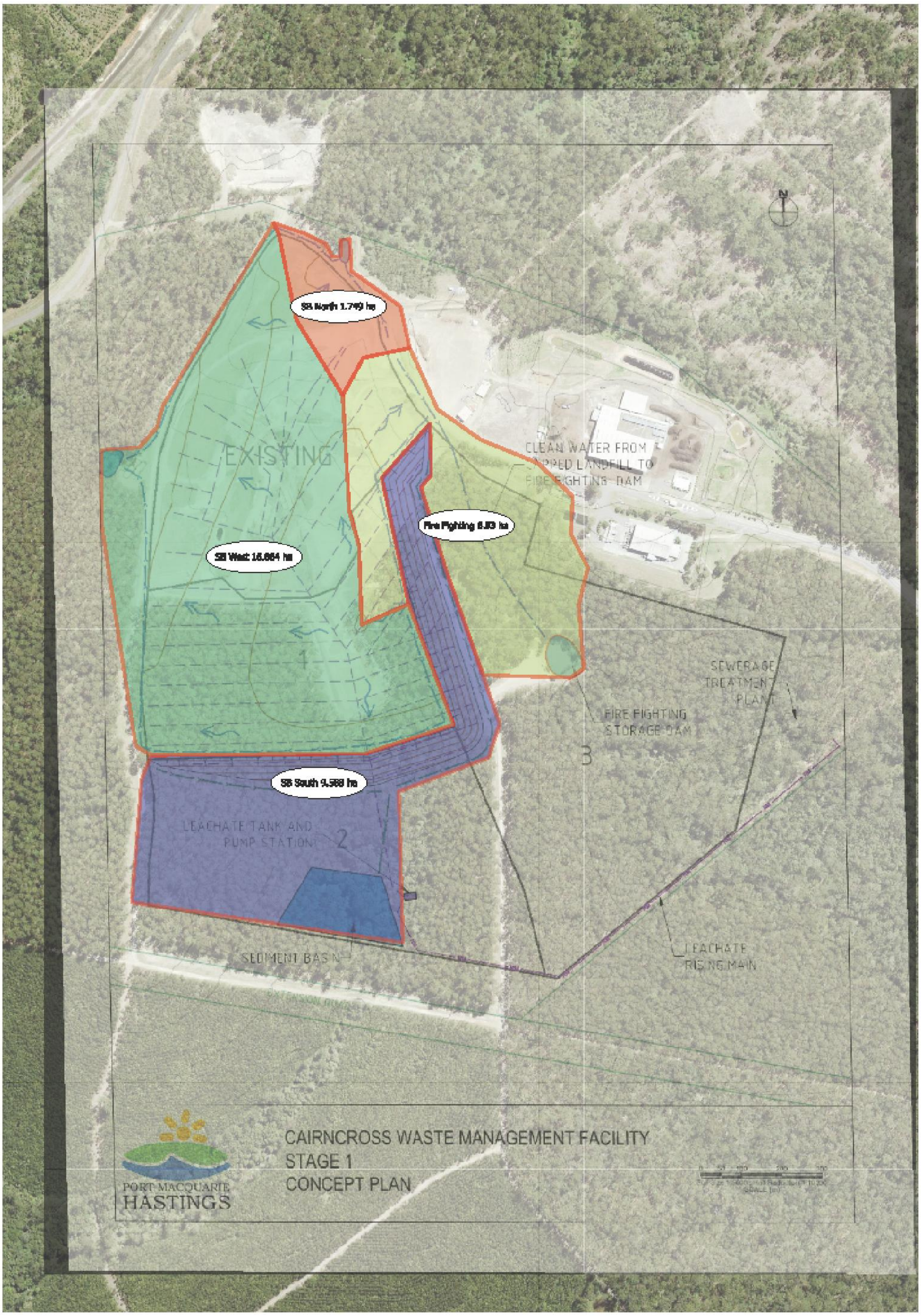
Maximum monthly water demand	Firefighting water storage requirements	Minimum proposed total water storage capacity
1,200 m^3	100 m^3	8,300 m^3

Based on the water balance results and past experience at the landfill, a water deficit is considered unlikely to occur, except in extreme drought conditions. To minimise the risk of experiencing a deficit, which would require water to be imported to the site, it is recommended that the capability to draw water from all basins be continued.

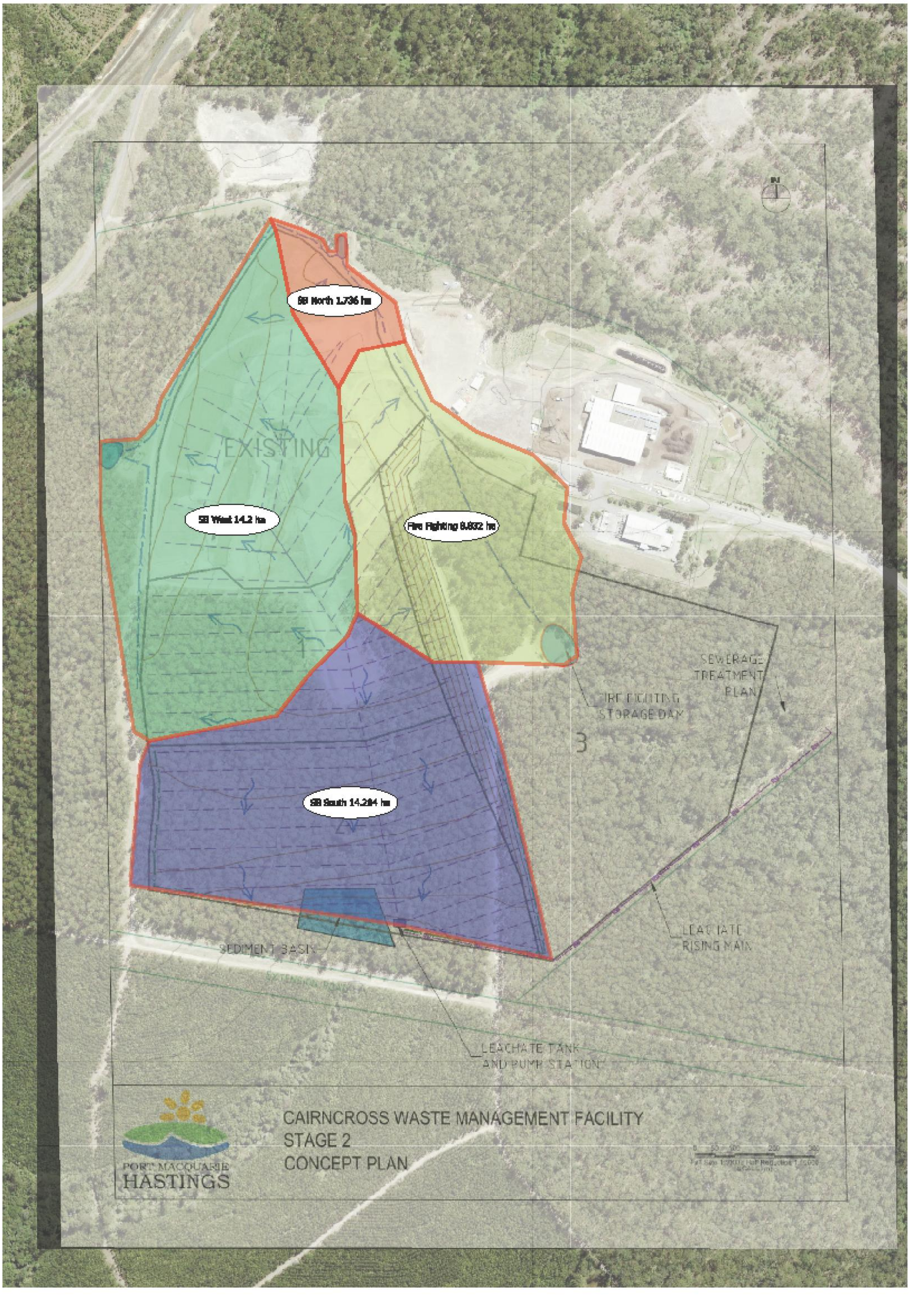
ATTACHMENT A CONCEPT DESIGNS

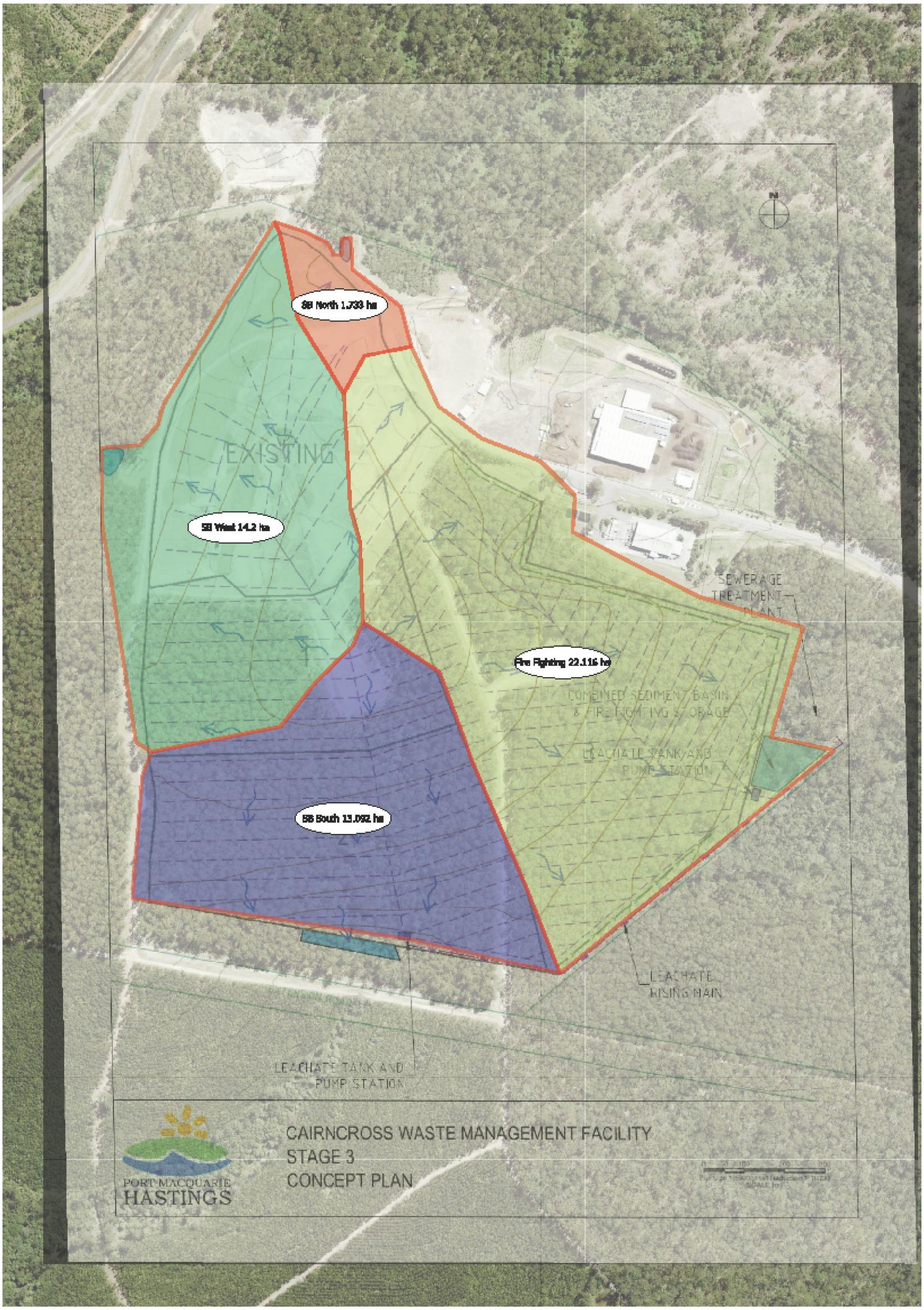
ATTACHMENT B CATCHMENT AREAS


B
SEDIMENT BASIN
SEDIMENT BASIN
SB West 9.21 ha
SB South 6.346 ha
EXISTING
1
2
3
FIRE FIGHTING STORAGE BASIN
SEDIMENT BASIN
SEWERAGE TREATMENT PLANT
LEACHATE TANK AND PUMP STATION
LEACHATE RISING MAIN
PORT MACQUARIE HASTINGS
CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE E (EXISTING)
CONCEPT PLAN



SB North 1.749 ha
EXISTING
SB West 16.664 ha
Fire Fighting 6.93 ha
SB South 9.588 ha
1
2
3
CLEAN WATER FROM CAPPED LANDFILL TO FIRE FIGHTING DAM
SEWERAGE TREATMENT PLANT
FIRE FIGHTING STORAGE DAM
LEACHATE TANK AND PUMP STATION
SEDIMENT BASIN
LEACHATE RISING MAIN
N
CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE 1
CONCEPT PLAN
PORT MACQUARIE HASTINGS
SCALE (m)


SB North 1.736 ha
EXISTING
SB West 14.2 ha
Fire Fighting 8.832 ha
SB South 14.284 ha
FIRE FIGHTING STORAGE DAM
SEWERAGE TREATMENT PLANT
SEDIMENT BASIN
LEACHATE RISING MAIN
LEACHATE TANK AND PUMP STATION
CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE 2
CONCEPT PLAN
PORT MACQUARIE HASTINGS



N
SB North 1.733 ha
EXISTING
SB West 14.2 ha
SEWERAGE
TREATMENT
PLANT
Fire Fighting 22.116 ha
COMBINED SEDIMENT BASIN
& FIRE FIGHTING STORAGE
LEACHATE TANK AND
PUMP STATION
SB South 13.092 ha
LEACHATE
RISING MAIN
LEACHATE TANK AND
PUMP STATION
PORT MACQUARIE
HASTINGS
CAIRNCROSS WASTE MANAGEMENT FACILITY
STAGE 3
CONCEPT PLAN

ATTACHMENT C WATER BALANCE

(

Existing average

Pond and Catchment Details	Fire	South	West	North
Catchment Area (m2)	60,000	63,000	92,000	23,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	1,850	4,900	850	350
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
Mean rainfall (mm)	165	175	204	173	128	121	52	58	51	108	111	127	1473	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	2,970	3,150	3,672	3,114	2,304	2,178	936	1,044	918	1,944	1,998	2,286
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	178	145	135	107	78	73	78	112	148	174	167	192
Surplus (+ve)/Deficit(-ve) (m3)	2,117	2,405	2,887	2,357	1,526	1,455	133	207	70	1,045	1,182	1,394

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	5,198	5,513	6,426	5,450	4,032	3,812	1,638	1,827	1,607	3,402	3,497	4,001
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	471	384	358	283	207	192	207	298	392	460	441	509
Surplus (+ve)/Deficit(-ve) (m3)	4,726	5,128	6,068	5,167	3,825	3,619	1,431	1,529	1,215	2,942	3,056	3,492

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	7,590	5,513	6,426	5,450	4,032	3,812	1,638	1,827	1,607	3,402	3,497	4,001
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	82	67	62	49	36	33	36	52	68	80	77	88
Surplus (+ve)/Deficit(-ve) (m3)	7,508	5,446	6,364	5,400	3,996	3,778	1,602	1,775	1,539	3,322	3,420	3,912

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	1,898	2,013	2,346	1,990	1,472	1,392	598	667	587	1,242	1,277	1,461
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	34	27	26	20	15	14	15	21	28	33	32	36
Surplus (+ve)/Deficit(-ve) (m3)	1,864	1,985	2,320	1,969	1,457	1,378	583	646	559	1,209	1,245	1,424

Total Site Surplus (+ve)/Deficit(-ve) (m3)	16,216	14,964	17,639	14,894	10,804	10,231	3,749	4,157	3,382	8,519	8,902	10,222

Existing 10th percentile

Pond and Catchment Details	Fire	South	West	North
Catchment Area (m2)	60,000	63,000	92,000	23,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	1,850	4,900	850	350
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
10th percentile rainfall (mm)	42	54	33	33	20	14	4	5	19	17	49	32	1015	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	756	972	594	594	360	252	72	90	342	306	882	576
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	178	145	135	107	78	73	78	112	148	174	167	192
Surplus (+ve)/Deficit(-ve) (m3)	-97	227	-191	-163	-418	-471	-731	-747	-506	-593	66	-316

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	1,323	1,701	1,040	1,040	630	441	126	158	599	536	1,544	1,008
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	471	384	358	283	207	192	207	298	392	460	441	509
Surplus (+ve)/Deficit(-ve) (m3)	852	1,317	681	757	423	249	-81	-140	207	76	1,103	499

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	1,932	1,701	1,040	1,040	630	441	126	158	599	536	1,544	1,008
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	82	67	62	49	36	33	36	52	68	80	77	88
Surplus (+ve)/Deficit(-ve) (m3)	1,850	1,634	977	990	594	408	90	106	531	456	1,467	920

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	483	621	380	380	230	161	46	58	219	196	564	368
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	34	27	26	20	15	14	15	21	28	33	32	36
Surplus (+ve)/Deficit(-ve) (m3)	449	594	354	359	215	147	31	36	191	163	532	332

Total Site Surplus (+ve)/Deficit(-ve) (m3)	3,055	3,771	1,822	1,944	814	333	-691	-746	422	101	3,167	1,434

Stage 1 average

Pond and Catchment Details	Fire	South	West	North
Catchment Area (m2)	69,000	96,000	169,000	17,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	2,000	5,000	1,000	500
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
Mean rainfall (mm)	165	175	204	173	128	121	52	58	51	108	111	127	1473	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	3,416	3,623	4,223	3,581	2,650	2,505	1,076	1,201	1,056	2,236	2,298	2,629
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	192	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	2,548	2,866	3,427	2,816	1,865	1,776	267	354	196	1,323	1,468	1,721

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	7,920	8,400	9,792	8,304	6,144	5,808	2,496	2,784	2,448	5,184	5,328	6,096
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	481	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	7,439	8,008	9,427	8,016	5,932	5,612	2,284	2,480	2,048	4,715	4,878	5,577

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	13,943	8,400	9,792	8,304	6,144	5,808	2,496	2,784	2,448	5,184	5,328	6,096
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	96	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	13,846	8,008	9,427	8,016	5,932	5,612	2,284	2,480	2,048	4,715	4,878	5,577

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	1,403	1,488	1,734	1,471	1,088	1,029	442	493	434	918	944	1,080
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	48	39	37	29	21	20	21	30	40	47	45	52
Surplus (+ve)/Deficit(-ve) (m3)	1,354	1,448	1,697	1,442	1,067	1,009	421	463	394	871	899	1,028

Total Site Surplus (+ve)/Deficit(-ve) (m3)	25,188	20,329	23,977	20,288	14,797	14,009	5,257	5,777	4,685	11,624	12,122	13,902

Stage 1 10th percentile

Pond and Catchment Details	Fire	South	West	North
Catchment Area (m2)	69,000	96,000	169,000	17,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	2,000	5,000	1,000	500
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
10th percentile rainfall (mm)	42	54	33	33	20	14	4	5	19	17	49	32	1015	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	869	1,118	683	683	414	290	83	104	393	352	1,014	662
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	192	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	2	361	-113	-82	-371	-439	-727	-743	-467	-561	184	-245

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	2,016	2,592	1,584	1,584	960	672	192	240	912	816	2,352	1,536
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	481	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	1,535	2,200	1,219	1,296	748	476	-20	-64	512	347	1,902	1,017

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	3,549	2,592	1,584	1,584	960	672	192	240	912	816	2,352	1,536
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	96	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	3,453	2,200	1,219	1,296	748	476	-20	-64	512	347	1,902	1,017

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	357	459	281	281	170	119	34	43	162	145	417	272
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	48	39	37	29	21	20	21	30	40	47	45	52
Surplus (+ve)/Deficit(-ve) (m3)	309	420	244	252	149	99	13	12	122	98	372	220
Total Site Surplus (+ve)/Deficit(-ve) (m3)	5,299	5,180	2,568	2,760	1,275	612	-753	-859	679	230	4,360	2,008

Stage 2 average

Pond ID/Catchment	Fire	South	West	North
Catchment Area (m2)	88,000	143,000	142,000	17,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	2,000	5,000	1,000	500
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
Mean rainfall (mm)	165	175	204	173	128	121	52	58	51	108	111	127	1473	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	4,356	4,620	5,386	4,567	3,379	3,194	1,373	1,531	1,346	2,851	2,930	3,353
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	192	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	3,489	3,863	4,589	3,802	2,595	2,466	563	685	486	1,939	2,100	2,445

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	11,798	12,513	14,586	12,370	9,152	8,652	3,718	4,147	3,647	7,722	7,937	9,081
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	481	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	11,317	12,120	14,221	12,081	8,940	8,455	3,506	3,843	3,247	7,253	7,487	8,561

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	11,715	12,513	14,586	12,370	9,152	8,652	3,718	4,147	3,647	7,722	7,937	9,081
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	96	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	11,619	12,120	14,221	12,081	8,940	8,455	3,506	3,843	3,247	7,253	7,487	8,561

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	1,403	1,488	1,734	1,471	1,088	1,029	442	493	434	918	944	1,080
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	48	39	37	29	21	20	21	30	40	47	45	52
Surplus (+ve)/Deficit(-ve) (m3)	1,354	1,448	1,697	1,442	1,067	1,009	421	463	394	871	899	1,028

Total Site Surplus (+ve)/Deficit(-ve) (m3)	27,779	29,552	34,728	29,406	21,542	20,386	7,997	8,834	7,373	17,315	17,972	20,595

Stage 2 10th percentile

Pond ID/Catchment	Fire	South	West	North
Catchment Area (m2)	88,000	143,000	142,000	17,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	2,000	5,000	1,000	500
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
10th percentile rainfall (mm)	42	54	33	33	20	14	4	5	19	17	49	32	1015	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	1,109	1,426	871	871	528	370	106	132	502	449	1,294	845
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	192	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	241	669	75	106	-257	-359	-704	-715	-358	-464	464	-63

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	3,003	3,861	2,360	2,360	1,430	1,001	286	358	1,359	1,216	3,504	2,288
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	481	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	2,522	3,469	1,994	2,071	1,218	805	74	54	959	746	3,054	1,769

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	2,982	3,861	2,360	2,360	1,430	1,001	286	358	1,359	1,216	3,504	2,288
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	96	392	365	288	212	196	212	304	400	469	450	519
Surplus (+ve)/Deficit(-ve) (m3)	2,886	3,469	1,994	2,071	1,218	805	74	54	959	746	3,054	1,769

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	357	459	281	281	170	119	34	43	162	145	417	272
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	48	39	37	29	21	20	21	30	40	47	45	52
Surplus (+ve)/Deficit(-ve) (m3)	309	420	244	252	149	99	13	12	122	98	372	220

Total Site Surplus (+ve)/Deficit(-ve) (m3)	5,958	8,026	4,307	4,500	2,329	1,350	-542	-595	1,680	1,126	6,942	3,695

Stage 3 average

Pond ID/Catchment	Fire	South	West	North
Catchment Area (m2)	221,000	131,000	142,000	17,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	3,500	2,000	1,000	500
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
Mean rainfall (mm)	165	175	204	173	128	121	52	58	51	108	111	127	1473	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	10,940	11,603	13,525	11,470	8,486	8,022	3,448	3,845	3,381	7,160	7,359	8,420
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	337	275	256	202	148	137	148	213	280	328	315	363
Surplus (+ve)/Deficit(-ve) (m3)	9,928	10,728	12,619	10,618	7,638	7,235	2,575	2,908	2,401	6,107	6,394	7,357

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	10,808	11,463	13,362	11,332	8,384	7,926	3,406	3,799	3,341	7,074	7,271	8,319
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	192	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	10,615	11,306	13,216	11,216	8,299	7,847	3,321	3,677	3,181	6,886	7,091	8,111

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	11,715	11,463	13,362	11,332	8,384	7,926	3,406	3,799	3,341	7,074	7,271	8,319
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	96	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	11,619	11,306	13,216	11,216	8,299	7,847	3,321	3,677	3,181	6,886	7,091	8,111

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	1,403	1,488	1,734	1,471	1,088	1,029	442	493	434	918	944	1,080
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	48	39	37	29	21	20	21	30	40	47	45	52
Surplus (+ve)/Deficit(-ve) (m3)	1,354	1,448	1,697	1,442	1,067	1,009	421	463	394	871	899	1,028

Total Site Surplus (+ve)/Deficit(-ve) (m3)	33,516	34,787	40,749	34,492	25,304	23,938	9,638	10,725	9,156	20,751	21,474	24,606

Stage 3 10th percentile

Pond ID/Catchment	Fire	South	West	North
Catchment Area (m2)	221,000	131,000	142,000	17,000
Runoff Coefficient	0.3	0.5	0.5	0.5
Pond Area (m2)	3,500	2,000	1,000	500
Dust Suppression Demand (m3/day)	25	0	0	0

Climate Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Source
10th percentile rainfall (mm)	42	54	33	33	20	14	4	5	19	17	49	32	1015	TELEGRAPH POINT (FARRAWELLS ROAD)
Mean Pan Evaporation (mm)	125	102	95	75	55	51	55	79	104	122	117	135	1115	BoM Map Grid
Mean Pond Evaporation (mm)	96	78	73	58	42	39	42	61	80	94	90	104	858	Derived from pan evaporation
Days in month	31	28	31	30	31	30	31	31	30	31	30	31		
Rainfall Days >= 10mm	4	4	5	4	3	4	2	2	2	2	4	3		Port Macquarie Airport AWS
Rainfall Days < 10mm	27	24	26	26	28	26	29	29	28	29	26	28		Port Macquarie Airport AWS

Fire	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	2,785	3,580	2,188	2,188	1,326	928	265	332	1,260	1,127	3,249	2,122
Dust Suppression Demand (m3/mth)	675	600	650	650	700	650	725	725	700	725	650	700
Pond Evaporation (m3)	337	275	256	202	148	137	148	213	280	328	315	363
Surplus (+ve)/Deficit(-ve) (m3)	1,773	2,706	1,282	1,336	478	141	-608	-606	280	74	2,284	1,058

South	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	2,751	3,537	2,162	2,162	1,310	917	262	328	1,245	1,114	3,210	2,096
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	192	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	2,559	3,380	2,015	2,046	1,225	839	177	206	1,085	926	3,030	1,888

West	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	2,982	3,537	2,162	2,162	1,310	917	262	328	1,245	1,114	3,210	2,096
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	96	157	146	115	85	78	85	122	160	188	180	208
Surplus (+ve)/Deficit(-ve) (m3)	2,886	3,380	2,015	2,046	1,225	839	177	206	1,085	926	3,030	1,888

North	January	February	March	April	May	June	July	August	September	October	November	December
Inflow (m3)	357	459	281	281	170	119	34	43	162	145	417	272
Dust Suppression Demand (m3/mth)	0	0	0	0	0	0	0	0	0	0	0	0
Pond Evaporation (m3)	48	39	37	29	21	20	21	30	40	47	45	52
Surplus (+ve)/Deficit(-ve) (m3)	309	420	244	252	149	99	13	12	122	98	372	220

Total Site Surplus (+ve)/Deficit(-ve) (m3)	7,527	9,886	5,557	5,680	3,078	1,917	-240	-182	2,570	2,023	8,714	5,055