



Environmental Management
Plan
Shoal Bay Waste Management
Facility
City of Darwin

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Appendices

Appendix A	City of Darwin Environmental Policy
Appendix B	Water Quality Monitoring Plan

ACRONYMS

ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Average Recurrence Interval
AS	Australian Standard
BoM	Bureau of Meteorology
CoD	City of Darwin
CoPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
DoD	Department of Defence
EMP	Environmental Management Plan
EPA	Environmental Protection Approval
EPL	Environmental Protection Licence
LFG	Landfill Gas
LDP	Landfill Development Plan
LTP	Leachate Treatment Plant
NT EPA	Northern Territory Environmental Protection Authority
SBWMF	Shoal Bay Waste Management Facility
UXO	Unexploded Ordinance
WMPC Act	<i>Waste Management and Pollution Control Act</i>

1 INTRODUCTION

1.1 Background

The Shoal Bay Waste Management Facility (SBWMF) is a municipal waste resource recovery and disposal site operated by the City of Darwin (CoD). The SBWMF services both domestic and commercial customers in the Darwin area.

The SBWMF is located 13 km north-east of Darwin City within Lot 3952, Town of Sanderson, in the suburb of Holmes (see Figure 1-1). CoD lease the entire property area from the Commonwealth Department of Defence (DoD). Under the terms and conditions of the lease, only a portion of the property is designated as a Waste Management Project Area in which CoD is authorised to conduct waste management and ancillary activities. The remainder of the site consists of an uncleared unexploded ordinance (UXO) area (Figure 1-2).

The operational area of the SBWMF is located within the southern part of the property and is bound to the north and east by floodplains, wetlands and mangroves of Leanyer Swamp, to the south by Holmes Jungle Nature Reserve and to the west by bushland. The nearest residential area to the SBWMF is the suburb of Karama, about 800 m to the south-west with a bushland buffer in between.

1.2 Objective of the EMP

This Environmental Management Plan (EMP) has been developed to detail the environmental management measures undertaken at SBWMF to minimise the potential for impacts to the surrounding environment.

Specifically, it identifies the risks to the environment associated with the activities at SBWMF, and details the environmental management measures, controls and monitoring that will be implemented by all staff and contractors operating within the site.

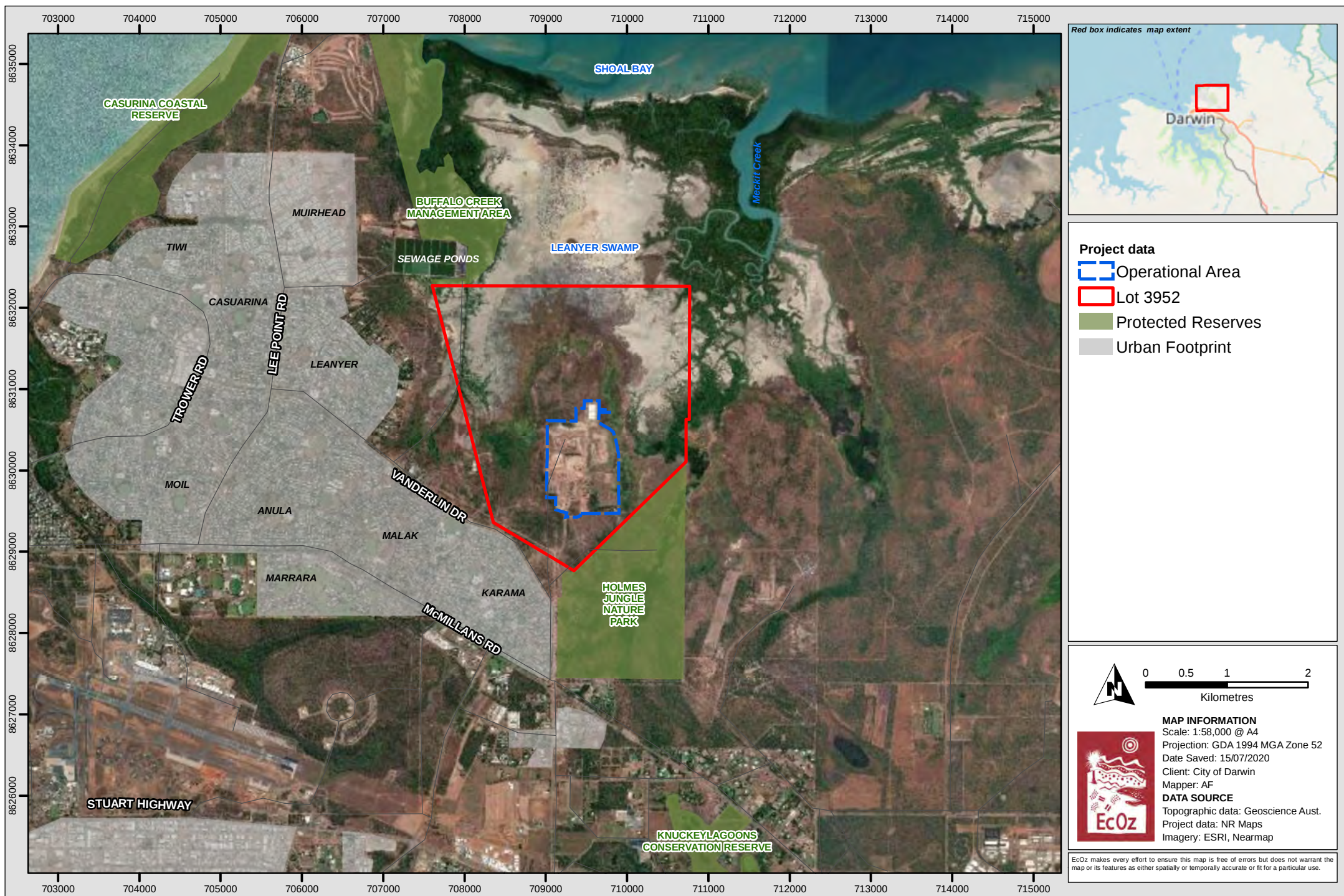
This EMP has been developed to comply with the relevant environmental legislation; and to adhere to conditions of any applicable licence approval and permit.

1.3 Responsibilities

The responsibilities for implementing and monitoring site activities against this EMP are as provided in Table 1-1.

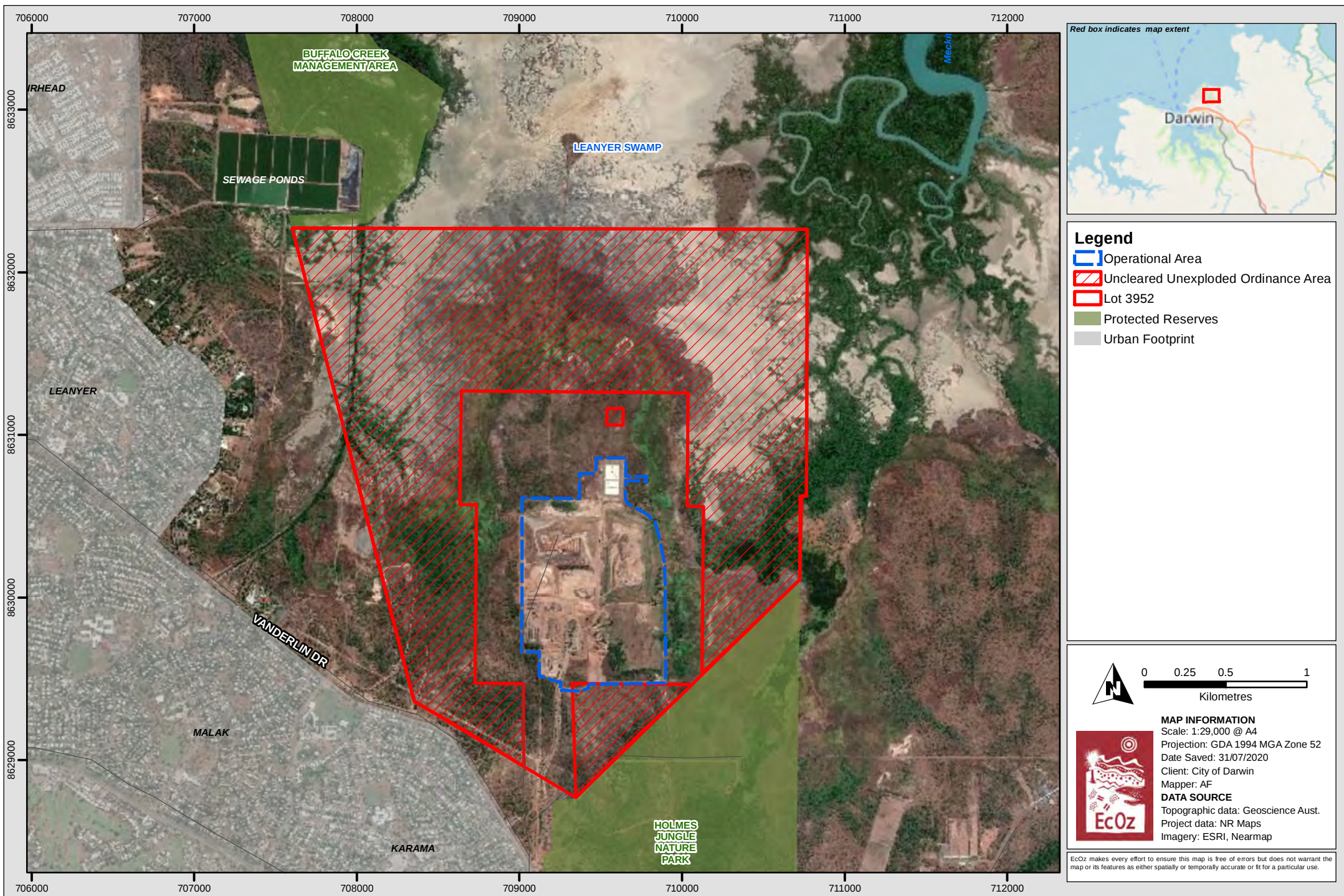
Table 1-1. Responsibilities and contact details

Responsibility	Responsible personnel	Contact details
Develop EMP	- City of Darwin - Environmental Consultant	General Manager Engineering and City Services City of Darwin Ph: 08 8930 0300 E: darwin@darwin.nt.gov.au
Develop and maintain environmental procedures	- City of Darwin - Environmental Consultant	
Implement management measures	- City of Darwin - SBWMF Operating Contractor	
Assure EMP compliance and reporting	- City of Darwin - SBWMF Operating Contractor	Environmental Consultant EcOz Environmental Consultants Ph: 08 8981 1100 E: eco@eco.com.au



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ20089 - SBWMF EMP\01 Project Files\Fig 1-1. SBWMF location.mxd

Figure 1-1. SBWMF location



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\IE220089 - SBWMF EMP\01 Project Files\Fig 1-2. Uncleared Unexploded ordinance Area.mxd

Figure 1-2. Uncleared UXO Area

1.4 Relevant legislation

The key Commonwealth and Northern Territory legislation applicable to the operation of SBWMF is outlined in Table 1-2.

Table 1-2. Applicable legislation

Environmental aspect	Applicable legislation
Air quality	• <i>Ozone Protection Act 1989 (Cwlth)</i> • <i>Waste Management and Pollution Control Act (NT) (WMPC Act)</i> • <i>National Environment Protection Council. 2003 National Environment Protection (Ambient Air Quality) Measure (NEPM)</i> • <i>National Environment Protection Council. 2011 National Environment Protection (Air Toxics) Measure (NEPM)</i> • <i>National Environment Protection Council. 1998 National Environment Protection (National Pollutant Inventory) Measure (NEPM)</i>
Bushfire	• <i>Bushfires Act (NT)</i> • <i>Fire and Emergency Act (NT)</i>
Dangerous goods	• <i>Dangerous Goods Act (NT)</i> • <i>Road Transport (Dangerous Goods) Act 1995 (NT)</i> • <i>Dangerous Goods (Storage and Handling) Regulations 2000 (NT)</i> • <i>Road Transport Reform (Dangerous Goods) Act 1995 (Cwlth)</i>
Flora and Fauna (including weeds and pests)	• <i>Animal Welfare Act (NT)</i> • <i>Bushfires Act (NT)</i> • <i>Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)</i> • <i>Fisheries Act (NT)</i> • <i>National Environmental Protection Council (Northern Territory) Act (NT)</i> • <i>Plant Health Act (NT)</i> • <i>Public and Environmental Health Act (NT)</i> • <i>Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations (NT)</i> • <i>Soil Conservation and Land Utilisation Act (NT)</i> • <i>Territory Parks and Wildlife Conservation Act (NT)</i> • <i>Weeds Management Act (NT)</i>
Heritage	• <i>Australian Heritage Commission Act 1975 (Cwlth)</i> • <i>Heritage Act (NT)</i> • <i>National Heritage Trust of Australia Act 1997 (Cwlth)</i>
Noise	• <i>Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)</i> • <i>Waste Management and Pollution Control Act (NT)</i>
Waste and Hazardous Waste	• <i>Environmental Offences and Penalties Act (NT)</i> • <i>Work Health and Safety (National Uniform Legislation) Act (NT)</i> • <i>Hazardous Waste (Regulation of Exports and Imports) Act 1989 (Cwlth)</i> • <i>Litter Act (NT)</i> • <i>National Environment Protection Council. 2011. National Environment Protection (Used Packaging Materials) Measure as varied 16 September 2011</i> • <i>Public and Environmental Health Act (NT)</i> • <i>Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations (NT)</i> • <i>Waste Management and Pollution Control Act (NT)</i>
Water (surface and groundwater)	• <i>Water Act (NT)</i> • <i>Waste Management and Pollution Control Act (NT)</i>

Environmental aspect	Applicable legislation
Future Development	- Environment Protection Act (NT) - Waste Management and Pollution Control Act (NT)

1.5 Approvals and licences

Conditions of the SBWMF lease agreement between the CoD and DoD include the compliance with all applicable environmental legislation, and that the placement of waste is only to be within the allocated area.

As an operational landfill, the SBWMF requires an Environmental Protection Licence (EPL) under Schedule 2 of the *Waste Management and Pollution Control Act (WMPC Act)*. An EPL has been attained for SBWMF through the Northern Territory Environmental Protection Authority (NT EPA), EPL188. The EPL regulates the operations of the landfill, transfer station, resource recovery centre, leachate ponds and landfill gas. The EPL outlines a number of conditions the SBWMF must meet in order to remain licenced and compliant.

This EMP also serves the purpose of declaring the listed waste that the SBWMF transfer station will accept, as required under Part 2, Schedule 2 of the *WMPC Act*, requiring the activity of collecting, transporting, storing, recycling, treating or disposing of listed waste and operating facilities associated with the activities to be licenced. SBWMF is licenced to collect, store, treat, recycle and dispose of the listed wastes outlined in Table 1-3.

Table 1-3. Listed wastes authorised for handling under EPL188

Listed Waste	Collection	Transport	Storage	Treatment	Recycling	Disposal
Acidic solutions or acids in solid form	x	x	✓	x	x	x
Animal effluent and residues	x	x	x	x	x	✓
Asbestos	x	x	x	x	x	✓
Clinical and related wastes	x	x	x	x	x	✓
Lead, lead compounds	x	x	✓	x	x	x
Sewerage sludge and residues including nightsoil and septic tank sludge	x	x	x	x	x	✓
Soils contaminated with a listed waste	x	x	x	x	x	✓
Tyres	x	x	x	x	x	✓
Waste from the production, formulation and use of inks, dyes, pigments, paints, lacquers and varnish	x	x	✓	x	x	x
Waste mineral oils unfit for their original intended use	x	x	✓	x	x	x

Any future proposed works associated with the landfill or management of listed wastes also require an Environmental Protection Approval (EPA) under Schedule 2 of the *WMPC Act*. Any works not covered by the current EPL shall not be undertaken without a current approval from the NT EPA. Upon closure of any Approval, the operational activities must be included in the current EPL for the SBWMF.

1.6 Environmental policy

CoD will ensure that the requirements of this EMP, the CoD environmental policy and all operational procedures are understood, implemented and maintained by all employees, contractors and subcontractors, at all levels involved in the operations of SBWMF. A copy of CoD's Environmental Policy is provided as Appendix A.

1.7 Related plans

In addition to and to support this EMP, CoD has prepared the following plans to assist with the planning, operation and monitoring of waste management at SBWMF:

- General Waste Landfill Development Plan
 - o Encompasses current and future stages of lined waste disposal cells for the disposal of general waste until 2034
 - o Proposed stage layouts, order of construction, airspace capacity, final landform and final capping
- Inert Waste Landfill Development Plan
 - o Proposed filling plan, airspace capacity and final landform for Stage 2
- Water Balance, Leachate and Stormwater Management Strategies
 - o Includes a site-wide water balance model and assessment of appropriate leachate and stormwater management strategies to cover current and proposed future operations
 - o Details the separation of clean and dirty water around the site and appropriate erosion and sediment controls required to minimise the risk of sediment-laden runoff
- SBWMF Master Development Plan
 - o Identifies key site constraints and future development plans for the SBWMF site
- Disaster Waste Management Plan
 - o Details the responsibilities and procedures to be followed in preparation for and in response to waste generated as a result of a disaster (i.e. cyclone, flood, earthquake etc.) that impacts the wider municipality
 - o Includes procedures and processes specific to SBWMF to assist in disaster waste management
- Environmental Management Plan Leachate Treatment and Irrigation
 - o Incorporates the treatment methodology, treated leachate quality targets, monitoring and maintenance requirements to facilitate leachate treatment and disposal.

2 FACILITY OVERVIEW

2.1 Waste types and volumes

The SBWMF site is currently used for disposal of both commercial and domestic waste generated within Darwin and surrounding areas.

The SBWMF accepts materials for landfill or subsequent resources recovery and disposal by contractors at external facilities, including:

- Putrescible waste
- Construction and demolition waste
- Green waste
- Metal
- Plastic containers
- Paper and cardboard
- Domestic waste oil
- Empty domestic gas bottles
- Domestic paint and chemical containers
- Other authorised listed wastes.

The site manages a total waste throughput of approximately 180,000 tonnes per annum including all listed wastes handled and recyclables salvaged.

2.2 Operational hours

SBWMF standard operating hours are seven days a week from 7:00 am to 6:00 pm, with the exception of Christmas Day.

2.3 Facilities, access and layout

The SBWMF consists of the facilities outlined in Table 2-1, to support waste management activities.

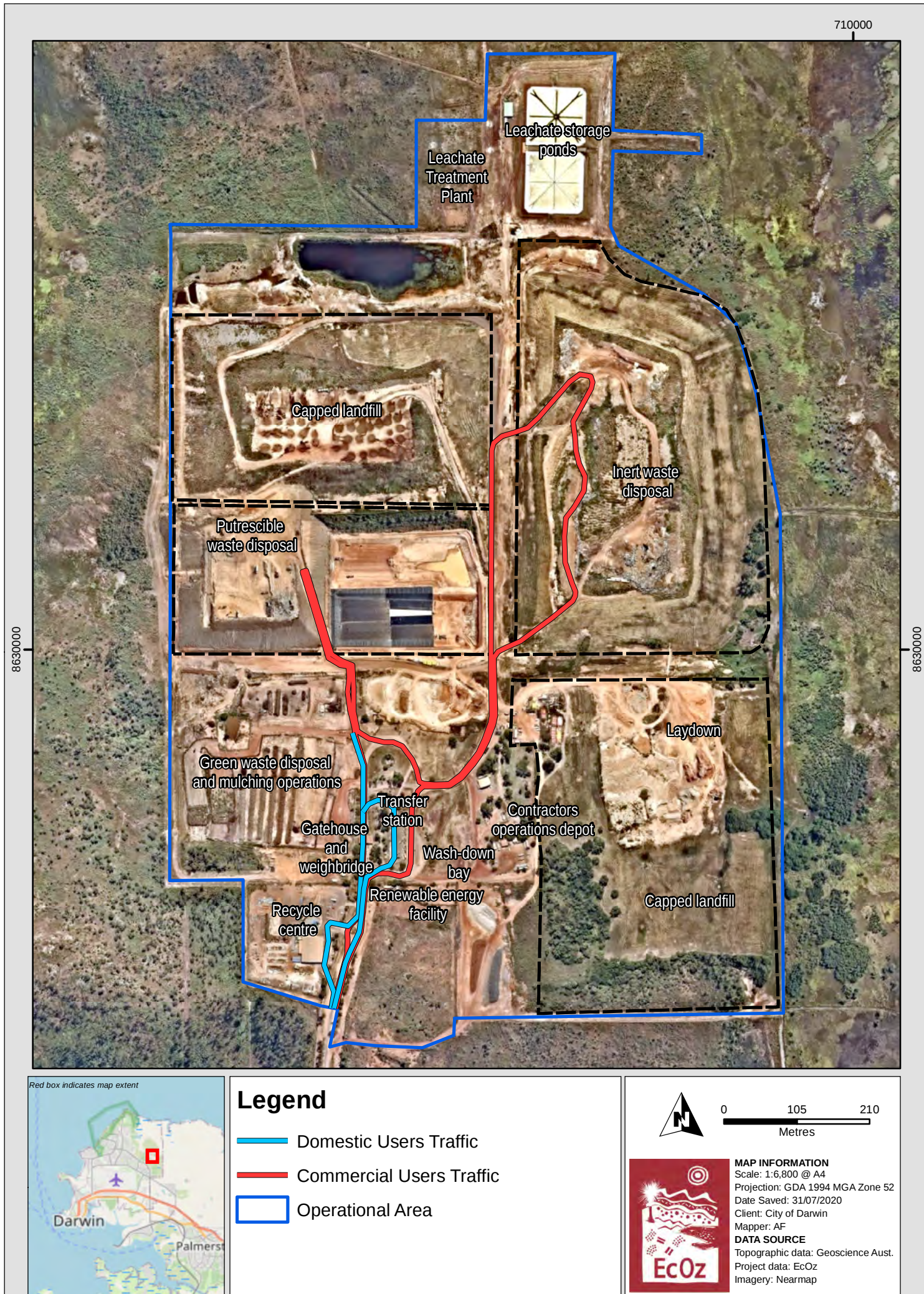
Table 2-1. SBWMF facilities

Facility	Description
Recycle centre	A facility where users can drop off unwanted goods to be recycled, repurposed or resold to other users. The facility accepts a wide range of goods, including building materials, furniture, electronics and bric-a-brac.
Gatehouse and weighbridge	Located at the entrance to the site, the gatehouse includes office space and amenities for staff and a dual weighbridge system to allow for tracking of incoming and outgoing materials.
Transfer station	The transfer station is primarily for domestic users to drop off household waste for recycling, landfill or disposal off-site to a licenced facility. The transfer station allows for segregation of general, recyclable and domestic quantities of listed wastes. Users access the facility directly with their vehicles to unload.
Inert waste disposal	All inert waste loads are directed to the inert waste disposal cell. Where possible, recyclable materials such as steel and concrete are salvaged from the tip face prior to burial. The inert cell also caters for the disposal of asbestos products and asbestos containing material.

Facility	Description
Putrescible waste disposal	All putrescible waste loads and listed wastes licenced for burial are directed to the active lined landfill cell for disposal.
Green waste disposal and mulching operations	All green waste loads are directed to the green waste disposal area for stockpiling. The green waste is then processed into mulch products for reuse on site or resold as a commercial product.
Renewable energy facility	Landfill gas is harvested from the landfill by a third-party contractor and directed to an on-site gas processing facility. The facility consists of a 1.1 MW engine which converts the gas to electrical power for supply back into the grid.
Leachate storage ponds and treatment area	Located at the northern end of the site, the leachate storage ponds are 2 x 15 ML lined and covered ponds that store leachate extracted from the putrescible waste cells. Directly to the east of the storage ponds is the nominated site for the leachate treatment plant.
Wash-down bay	A wash-down bay is located near the site exit for use by commercial users after disposing of waste to landfill. The wash-down water is collected in a sump, processed through an oily-water separator and then irrigated as required over an existing landfill area.
Contractors operations depot	A hardstand compound located at the southern end of site adjacent to Stage 1. The compound area is comprised of a series of demountable buildings and sheds and a workshop area for minor servicing of plant and equipment.

Access to the SBWMF (with exception to the recycle centre) is via the gatehouse. Domestic users can enter the facility through a pre-approved access boom-gate or via the gatehouse operator. Domestic users can only access the green waste area or transfer station to dispose of waste. Commercial users accessing the facility, must use the weighbridge for assessment of waste type and to complete payment. Commercial users are then directed to correct disposal area within the facility, depending on waste type (i.e. putrescible waste, inert waste, green waste, etc.). All users have access to the recycle centre without having to pass through the gatehouse.

The facilities and access routes described above are shown on Figure 2-1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ20089 - SBWMF EMPI01 Project Files\Figure 2-1. SBWMF site facilities and access routes.mxd

Figure 2-1. SBWMF site facilities and access routes

2.4 Landfill operations

2.4.1 Waste disposal method

SBWMF utilises the area method of landfilling whereby waste is disposed of at an active tip face and is then compacted in a mound above ground (as opposed to trench filling below ground), as depicted in Figure 2-2.

Each day the waste is covered with a heavy duty tarp using a deployment system attached to standard landfill machinery. The tarp system is a widely accepted form of landfill daily cover and can be quickly deployed over the tip face. Other alternative methods of daily cover accepted at the site include mulch (during dry periods only) or clean fill (year round). Material for cover is sourced from clean fill material accepted at the facility or imported as required. Daily cover is applied at a minimum thickness of 150 mm most of which can be retrieved on the following day prior to new waste disposal.

As the active tip area moves progressively along the length of the cell (building up the height), the waste disposal areas are covered with a 300 mm intermediate layer of cover material to minimise rainfall infiltration. Intermediate layers are sloped and graded to prevent ponding of water. As the landform progresses in height, intermediate cover is removed or penetrated as much as possible prior to waste placement to prevent impermeable layers potentially leading to perched leachate.

2.4.2 Additional cover for special wastes

Waste products brought to SBWMF as special wastes are to be disposed on a pre-prepared deep burial pit. Deep burial pits are excavated within the active landfill to the required depth for the volume of waste to be disposed. Once the waste has been off-loaded into the pit, the waste is immediately covered with 150 mm of cover material. Each deep burial pit is filled in at the end of each shift.

Asbestos waste is disposed of in the dedicated asbestos disposal area. Deposited asbestos waste at the asbestos area must immediately be covered by suitable material to prevent the release of fibres into the air. Final cover of the asbestos shall be to a minimum thickness of 3 m in the case of asbestos fibre and dust wastes, and 1 m in the case of stabilised asbestos wastes in a bonded matrix. Final cover of the asbestos is to incorporate orange marker mesh identifying that asbestos is buried below to the depth required as above.

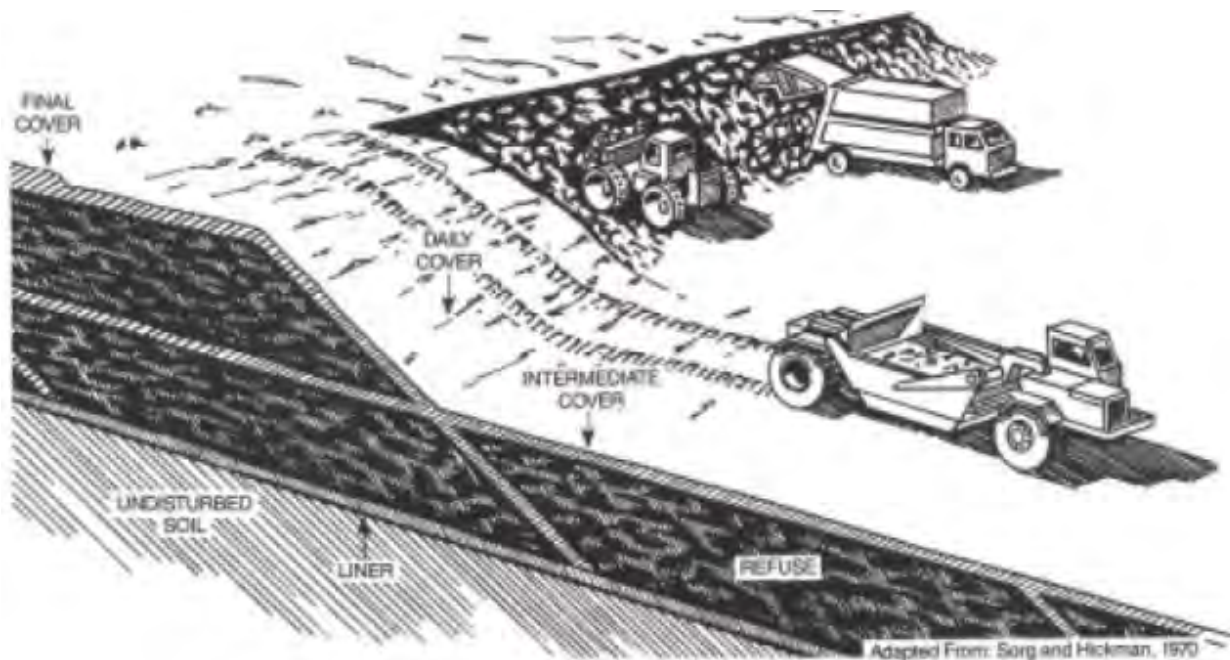


Figure 2-2. Area method of landfilling (NT EPA 2013)

2.4.3 Performance criteria

To preserve landfill airspace and ensure appropriate placement and compaction of waste, the performance criteria detailed in Table 2-2 have been adopted by SBWMF.

Table 2-2. SBWMF waste disposal performance criteria

Parameter	Performance Criteria	Notes
Waste layer thickness	Max 0.6 m	Waste layers shall be placed at approximately 600 mm uncompacted thickness
Total lift height	Min 2.0 m	- Minimum daily lift height 2.0 m after being compacted in layers - Maximum height to be governed by placement methodology on site and the safety of exceeding 2 m
Waste disposal area (daily cell/tip face)	Max 900 m ² (e.g. Approx. 30 m (L) x 30 (W))	- Disposal area shall be managed to ensure safety at all times and to minimise the extent of exposed waste and usage of soil daily cover material - The tip face shall be clearly identified with high visibility markers and signage to promote safety to staff and users
Final batter slope construction	Slope 3 (W): 1 (H)	The final batters slope around the edge of the extent of waste and forming the final landform shall be a maximum of 3 (wide): 1 (high)
Target Waste Density	Min 850 kg/m ³	Confirmed by comparison of survey and weighbridge data
Daily cover	Active tip face covered daily	Tarp system deployed at the end of each shift
Alternative daily cover	Min 150 mm – clean fill or mulch	- Applied daily and cut back for reuse at next day - Mulch only to be applied during dry periods

Parameter	Performance Criteria	Notes
Intermediate cover	Min 300 mm	Cut back and reused prior to placing additional waste
Final capping	Min 1.0 m (estimated)	Minimum 1.0 m (0.3 intermediate cover, 0.6m low permeability subsoil and 0.1m topsoil) – but dependent on final capping design

2.5 Landform & site development

Waste disposal and landfilling activities have been occurring at the site since the 1980's. The initial Stages 1 & 2 are located on the eastern side of the operational area and are unlined cells that previously accepted all waste types. Stage 3 was constructed between 2001 and 2007 with a geo-membrane liner and was progressively filled with general waste during this time. In 2013, Stage 4 was constructed on the north-west corner of Stage 3 by tying in the new geomembrane liner with existing infrastructure. Filling activities in Stage 3 & 4 ceased in 2018.

Stage 5 and all future landfill cells consist of a composite liner system built to best-practice standards, including leachate collection systems. All new cells and liner designs are subject to an Environment Protection Approval regulated by the NT EPA.

CoD have developed a landfill filling plan that shows the sequence and timing for Stages 5 to 10 to be constructed south of Stage 3. Figure 2-3 shows the current and future staged landfill cells, which is estimated to manage average waste disposal volumes over the next 15 to 20 years. Landfill cell development (including the current Stage 5) volumes and associated lifespan estimates are included in Table 2-3 below.

Table 2-3. Summary of landfill stage lifespans

Stage	Estimated airspace (m ³)	Lower range filling rate lifespan	Upper range filling rate lifespan
Stage 5	510,000	35 months	27 months
Stage 6	950,000	65 months	50 months
Stage 7	450,000	31 months	23 months
Stage 8	1,220,000	83 months	64 months
Stage 9	525,000	36 months	28 months
Stage 10	1,180,000	81 months	62 months
Totals	4,835,000	331 months	254 months

As the landform progresses the current site layout of the SBWMF is required to change in order to accommodate the new cells whilst ensuring continuation of ancillary site activities. The site Master Development Plan details the future development plans for the facility. The plan identifies 13 future development precinct areas and three stormwater management areas which are summarised in Table 2-4 and shown in Figure 2-4. These precincts have been identified as a part of a master-planning exercise, therefore it is recognised that many of the future proposed land uses are still subject to the appropriate design and approvals prior to implementation.

Table 2-4. Summary of future development precincts

Precinct	Area (ha)	Current use/constraints	Future proposed land use
1	12.2	Stage 1/vacant laydown	Green waste management
2	18.1	Stage 2/inert landfill	Unchanged
2A	5.7	Stage 2/inert landfill	Unchanged, concrete/steel management
3	20.2	Stages 3 to 6/landfill	Unchanged
4	14.1	Green waste and transfer station	Stages 7 to 10 putrescible landfill
5	3.0	Leachate storage ponds	Unchanged
6	2.5	Recycle shop/vacant	Unchanged, commercial waste operation
7	1.0	Renewable energy facility/vacant	Transfer Station
8	0.5	Vacant	Renewable energy facility
9	1.0	Landfill operations	Unchanged
10	2.6	Vacant	Alternative waste processing facility
11	16.6	Vacant/UXO	Disaster waste management, commercial waste operation
12	31.1	Vacant/UXO	Disaster waste management, commercial waste operation
13	26.4	Vacant	Future landfill, leachate treatment
Stormwater Area A	6.6	Vacant/stormwater	Stage 2 inert landfill stormwater management
Stormwater Area B	7.0	Vacant/UXO	Future green waste stormwater management
Stormwater Area C	31.1	Vacant/UXO	Landfill, waste processing stormwater management

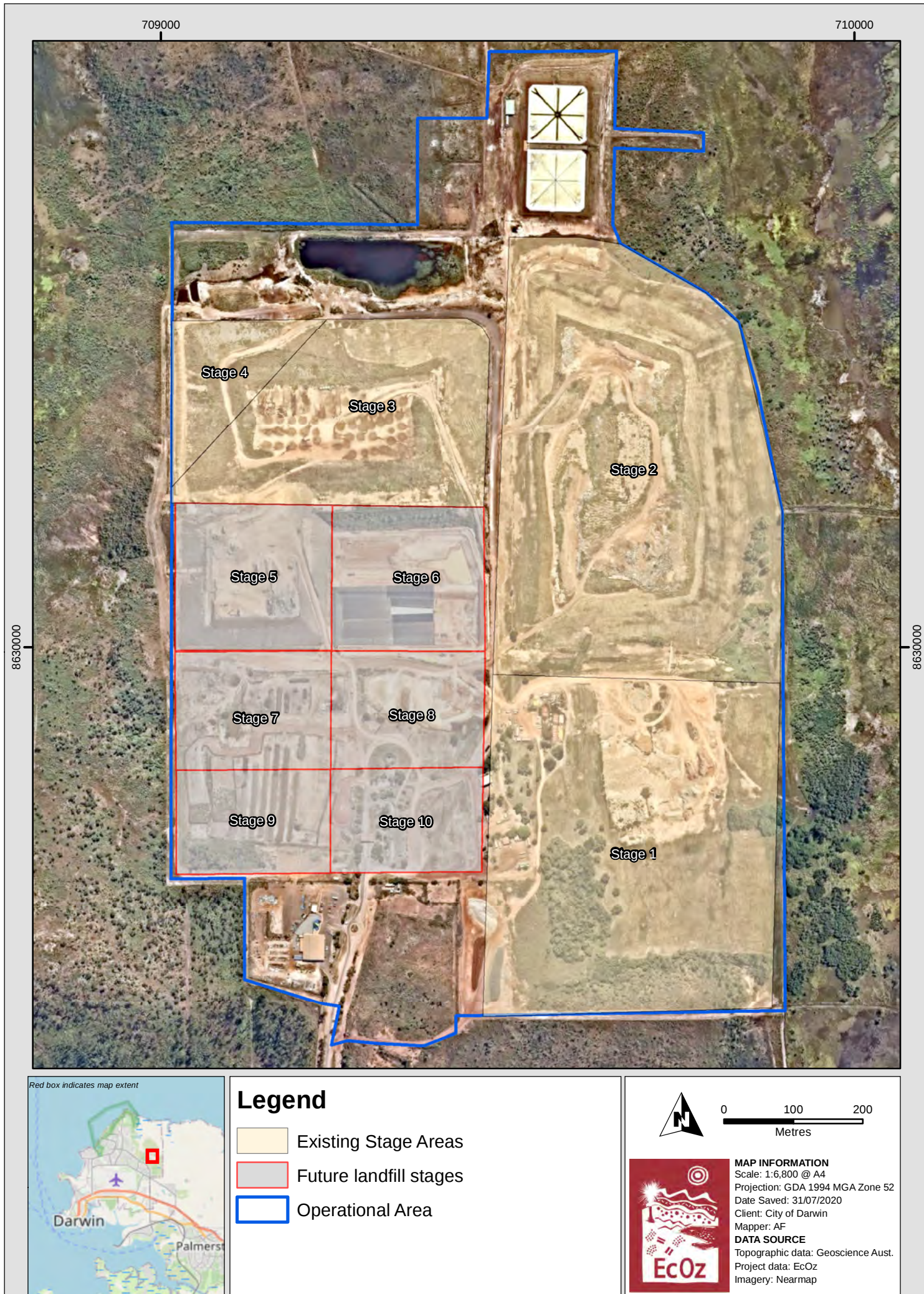


Figure 2-3. Landfill cell staging



Figure 2-4. Future development precincts

3 CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) is required to assess the interconnections between the Contaminants of Potential Concern (CoPC), exposure pathways and potential receptors (source > pathway > receptor model). A CSM describes the possible pathways by which exposure to potential contamination may occur. For exposure to occur, a complete pathway must exist between the source of contamination and the receptor (source > pathway > receptor), i.e. the person or ecosystem components potentially affected or harmed by the contamination.

A risk may only exist where a plausible source > pathway > receptor linkage is present, and where the quantity or concentration of a contaminant is sufficient to pose harm.

An exposure pathway will typically consist of the following elements:

- A source of contamination (i.e. a spill or leak, particulates)
- A release mechanism (i.e. migration in soil, leaching to water, emission to air)
- Retention in the transport medium (i.e. soil, groundwater, surface water or air)
- An exposure point (i.e. where a person(s) come into contact with contaminated soil, air, dust, groundwater, surface water)
- An exposure route (i.e. inhalation, ingestion, absorption).

3.1 Environmental setting

This section provides an overview of the existing environmental values, and how these values inform the CSM assessment.

3.1.1 Surrounding landscape

The land surrounding the SBWMF to the north and the east consists of floodplains, wetlands and mangroves of the Leanyer Swamp including Meckitt Creek. Immediately to the west of the SBWMF is undeveloped bushland with remnant dirt tracks from previous public access, and to the south is the Homes Jungle Nature Reserve.

The Buffalo Creek Management Area is located to the north-west of the SBWMF and includes the Leanyer Sanderson Waste Stabilisation Ponds. The residential suburb of Karama is to the south-west of SBWMF, and the suburb of Muirhead is further to the west of the site.

The SBWMF site is zoned as No Planning Scheme Controls (CA) under the *NT Planning Scheme (NTPS)*. Leanyer Swamp to the north and east is zoned Conservation (CN) under the *NTPS*. The undeveloped bushland to the west of the site is zoned a combination of CA and Community Purpose (CP), and the nearest residential area of Karama is zoned Single Dwelling (SD).

3.1.2 Sensitive receptors

Nearby sensitive receptors include the floodplains, wetlands and mangroves of Leanyer Swamp to the north and east of the site and the Homes Jungle Nature Reserve to the south. The Homes Jungle Nature Reserve is a listed NT reserve for the purpose of protecting large numbers of birds, mammals and reptiles that depend on cool monsoon vine thicket and rainforest habitat. Palm Creek flows directly through the Homes Jungle Nature Park, and to the east of the site, then joins with Meckitt Creek to the north-east of the SBWMF.

The nearest residential area to the SBWMF is the suburb of Karama which is approximately 800 m from the south-west boundary.

3.1.3 Site land use

Landfilling activities have been undertaken at the site since the 1980's. Prior to this, the Department of Defence utilised the site for military training exercises. A large proportion of the site (outside of the approved Waste Management Project Area and current operational area) remains un-cleared for unexploded ordinances.

3.1.4 Climate

The SBWMF is classified within a monsoonal tropical climate, with a distinct Dry season (approximately April to October) and Wet season (November to March). Typically, for this region, humidity, maximum and minimum temperatures are highest in the Wet season, and annual evaporation far exceeds annual rainfall.

The Darwin International Airport station (Station no. 014015) is the closest Bureau of Meteorology (BoM) weather station to the proposal area, located approximately 2 km away. The annual rainfall data of the station is 1722.8 mm (BoM 2020). The variation in temperature and rainfall across the seasons is shown in Figure 3-1.

Climate variation throughout the year directly influences the management of surface water at SBWMF, including the potential for leachate generation and contamination of surface waters within the site. Surface water drainage and quality are further discussed in the following sections.

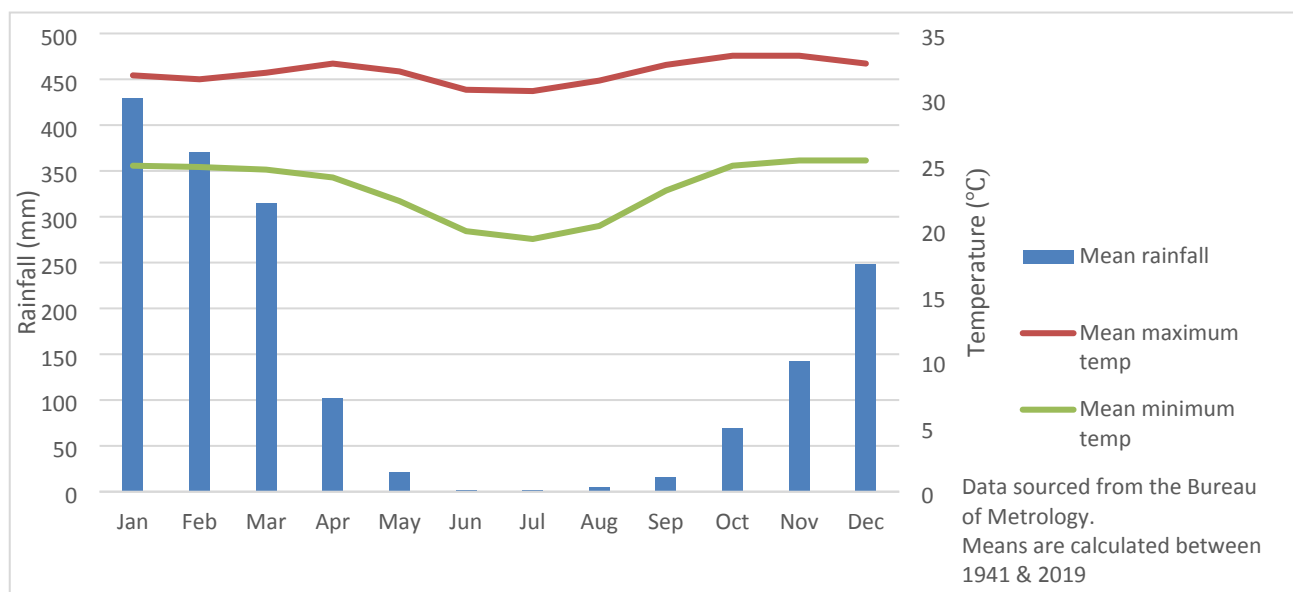


Figure 3-1. Graph of mean temperature and rainfall at Darwin Airport (Station no. 014015)

3.1.5 Land units and soils

Land unit mapping by Fogarty *et al.* (1984) indicates that the area comprises three different land units, 1c, 3d and 4c, as described in Table 3-1 and shown in Figure 3-2. The majority of the site is covered by land unit 3d, with a small section of 1c to the west and small section of 4c to the east.

Directly west of the site there is a drainage system-based landform (land unit 6b), and to the north-east is a swamp system-based landform (land unit 8c).

There are two recognised landform types within the SBWMF site, rises and plains, with most of the site classified as plains, with two small area of rises on the western side and the south-eastern section of the site.

Drainage associated with the identified landforms and land units tends to be rapid draining for the majority of the site (i.e. land units 1c and 3d), with the area to the west classified as prone to Wet season waterlogging.

Table 3-1. Land units within the SBWMF site

Land unit	Landform Class	Landform Description	Soil	Vegetation description	Slope	Drainage
1c	Rises	Rises and short steep slopes	Organosols / rudosols	Woodland of <i>Eucalyptus tetradonta</i> , <i>E. miniata</i> , over <i>S. intrans</i> and <i>H. triticeus</i> .	5 - 15%	Rapid draining, nil to low level of seasonal soil waterlogging
3d	Plains	Gently undulating upland surface	Rudosols	Open woodland of <i>Eucalyptus miniata</i> , <i>E. tetradonta</i> over <i>Sorghum</i> spp.	1 – 3%	Rapid draining, low level of seasonal waterlogging
4c		Gentle lower slopes	Hydrosols	Open forest <i>Eucalyptus tetradonta</i> , <i>E. papuana</i> over mixed grasses.	0.5 – 1.5%	Slow drainage, Wet season waterlogging soil with often dry season seepage

3.1.6 Surface water drainage

Within the SBWMF there are no defined surface water drainage lines. Palm Creek flows directly through the Homes Jungle Nature Park, and to the east of the site, then joins with Meckitt Creek to the north-east of the SBWMF.

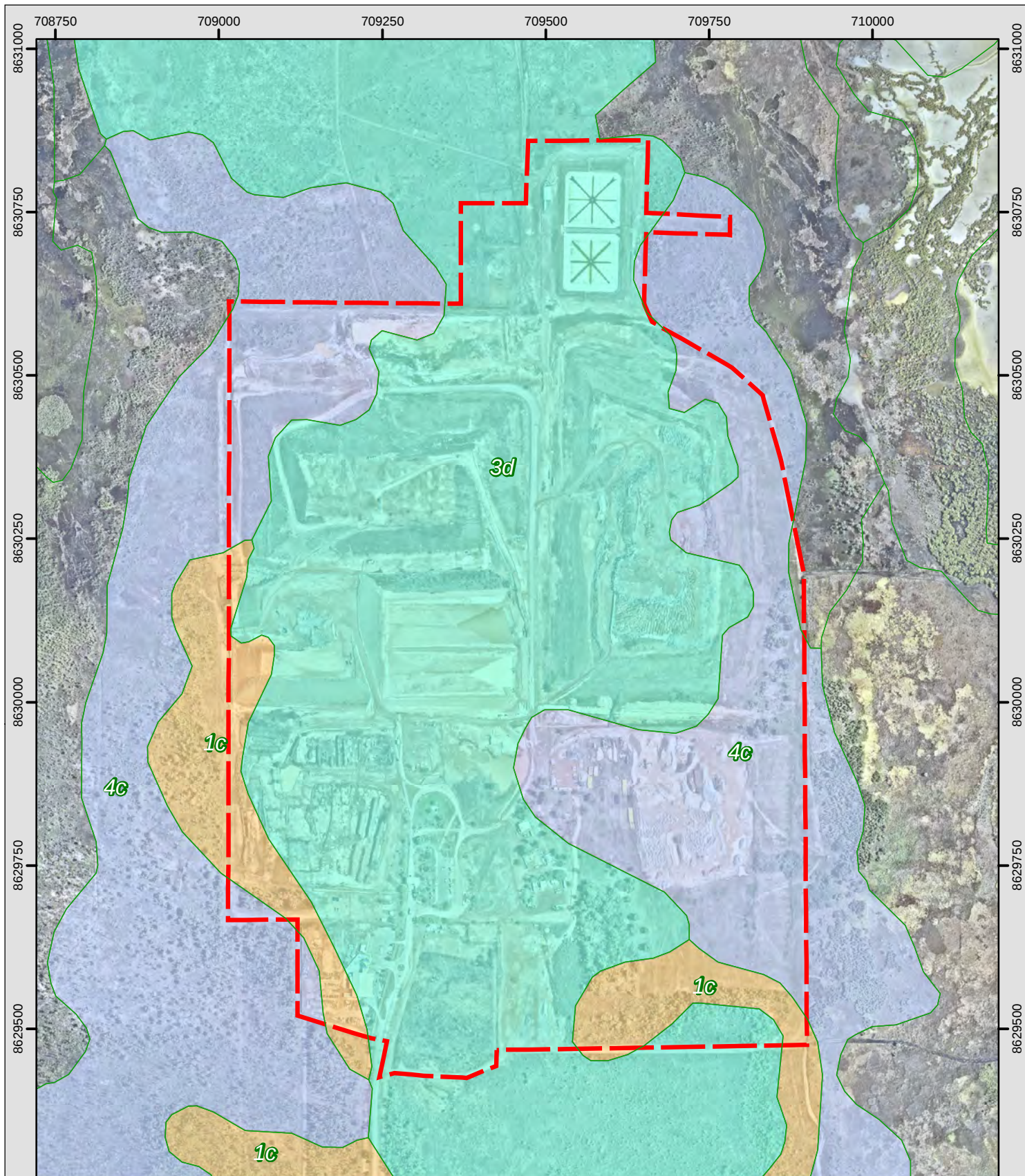
Surface water from the eastern portions of the SBWMF flows north towards the Meckitt Creek floodplain (CDM Smith 2019). Flows from the western portion of the site are towards the Leanyer Swamp and Buffalo Creek. Both Meckitt Creek and Buffalo Creek are mangrove-lined tidal inlets of Shoal Bay; a coastal embayment with extensive sand and mud flats.

The site is mainly characterised by rapid drainage landforms (see Table 3-1), therefore localised flow is managed through the onsite surface water drainage system, which consists of stormwater structures and open drains. Surface water is diverted away from the landfill cells that have the possibility of contaminating surface waters and towards water management infrastructure (CDM Smith 2019).

SBWMF is not within a Water Control District or within a Water Plan Management Zone, however it is within the Darwin Harbour Region for Water Beneficial Uses and has been identified for four beneficial uses including:

- Aquaculture
- Environment
- Cultural
- Rural stock and domestic.

The operational area sits outside the estimated highest astronomical tide zone and the 1 in 100-year Average Recurrence Interval (ARI) primary storm surge impact zone, however may experience some impacts from a 1 in 1,000 or 10,000 ARI storm surge around the perimeter of the operations (GHD 2014).



Project data

Operational Area

Land unit

- 1c
- 3d
- 4c



0 125 250
Metres



MAP INFORMATION

Scale: 1:8,000 @ A4
Projection: GDA 1994 MGA Zone 52
Date Saved: 21/08/2020
Client: City of Darwin
Mapper: DC
DATA SOURCE
Topographic data: Geoscience Aust.
Project data: EcOz
Imagery: Shaded relief, Landsat

Figure 3-2. Mapped land units at SBWMF

3.1.7 Geology and hydrogeology

The site is located within the Money Shoal Basin, which is of sedimentary succession composition. The 2013 Northern Territory Geological Survey describes the basin as a tilted passive margin basin with no specific depocentre (Ahmad & Munson 2013). The basin generally consists of formations that are monoclonal and relatively under formed. The Money Shoal Basin overlies the Arafura Basin, the Pine Creek Orogen and the McArthur Basin.

Groundwater aquifers beneath the site are described in detail in the *Shoal Bay Waste Disposal Site, Hydrogeological Investigation* (URS 2015). Lithology encountered during groundwater bore drilling for the investigation comprised top soils (silts and clays), generally underlain by weathered (lateritised) siltstone over most of the site, and claystone east of Stage 1. Beneath this, sandstone was encountered at depths of 9 to 20 m below the surface across most of the site. Groundwater exists within the unconsolidated overlying sediments, and fractured and weathered underlying bedrock. Bore yields are generally very poor; less than 5 L/sec.

The shallow (water table) aquifer is recharged by the direct infiltration of rainfall and runoff, and groundwater levels vary seasonally in accordance with rainfall totals. Seasonal groundwater standing water levels (SWLs), measured as part of the SBWMF water quality monitoring program since 2016, are greater than 12 m below ground level at the end of the Dry season, and usually less than 2 m from the ground surface during the peak of the wet season.

Higher yielding weathered and fractured carbonate rock aquifers occur in the wider region, with yields commonly greater than 5 L/sec. The *Groundwater Supply Prospects and Hydrogeology of the Cox Peninsula Region* map identifies a high yielding carbonate aquifer south-east of the SBWMF, trending in a northerly direction (NRETAS 2008). Groundwater from this aquifer discharges to the surface within the Holmes Jungle Nature Park and maintains streamflow through the Dry season. This spring and associated shallow groundwater support the Holmes Jungle Nature Park. Further to the south-east around the Knuckey Lagoon area, a large number of bores draw groundwater from this carbonate aquifer for domestic and agricultural purposes.

There are no groundwater bores or groundwater users down gradient of the SBWMF; although an important environmental consideration is the supply of groundwater seepage into wetlands and tidal inlets during the dry season.

The carbonate rock aquifer and associated springs, Holmes Jungle Nature Park and groundwater users are all located up gradient of the SBWMF. No significant areas of carbonate rock aquifer are located down gradient of the SBWMF and no carbonate rocks were encountered when drilling the 32 groundwater bores, to depths of up to 30 m below ground level, across the site for the hydrogeological investigation (URS 2015).

As part of the environmental monitoring program for SBWMF a total of 39 groundwater bores have been drilled. The bores drill depth varies between 3 to 30 m.

3.1.8 Surface water and groundwater quality

Water quality within the SBWMF has been monitored through the Shoal Bay Waste Disposal Site Water Monitoring Plan (URS 2016), and as per the Environmental Protection Licence (EPL188), issued by the NT EPA. This monitoring plan includes the monitoring of five surface water sites, 39 groundwater bores and three leachate sites, for leachates generated within SBWMF.

Water quality parameters measured through the monitoring plan include physical parameters (pH, electrical conductivity, dissolved oxygen), major cations and anions, nutrients, metals, and total recoverable hydrocarbons.

Surface water typically records elevated ammonia and lead concentrations above guideline values, with the majority of other parameters measured within guideline limits. Groundwater and leachate water frequently

record elevated ammonia, copper, lead and zinc concentrations above guideline values. The migration of leachate water into the surface and groundwater is known to be causing the transportation of some contaminants.

Groundwater quality is highly variable in terms of salinity, pH, metals and nutrients (CDM Smith 2019). Groundwater down gradient of the SBWMF is saline due to its close proximity to the coast and tidal saline intrusion; see the Groundwater Resources of the Darwin Area map (DIPE 2003). There are no groundwater bores or groundwater uses down gradient of SBWMF other than that potentially associated with environmental supply of groundwater seepage into wetlands and tidal inlets.

The carbonate rock aquifer and associated springs, Holmes Jungle Nature Park and groundwater users are all located up gradient of the SBWMF. No significant areas of carbonate rock aquifer are located down gradient of the SBWMF and no carbonate rocks were encountered when drilling the 39 groundwater bores, to depths of up to 30 m below ground level, across the site for the hydrogeological investigation (URS 2016).

3.1.9 Acid sulfate soil

Aforementioned the SBWMF is bound by floodplains, wetlands and mangroves of Leanyer Swamp to the north and the east of the site boundaries. Acid Sulfate Soils (ASS) are associated with these types of ecosystems. ASS risk modelling for the Darwin Region (50 k) models that there is a high probability of ASS occurrence on the eastern, north-eastern and north-western boundaries of the SBWMF. This modelling suggests that potential ASS would be present generally below three meters, however, in some high probability areas, potential ASS could be present within the upper one meter when within the tidal zone.

3.2 Potential contaminants and receptors

This section provides an overview of the potential contaminants and receptors associated with the SBWMF.

3.2.1 Potential sources of contamination

Known on-site sources of potential contamination

Known on-site sources of potential contamination include:

- Landfill leachate occurs in the landfill due to the decomposition/degradation of the waste
- Landfill gas occurs in the landfill due to the decomposition/degradation of the waste
- Stormwater that may come into contact with waste and become contaminated.
- Wheel wash water that may come into contact with waste or oil and grease from vehicles and become contaminated.

Other possible on-site sources of potential contamination

Other possible on-site sources of potential contamination include:

- Chemical and container storage areas have the potential for spills and/or leaks of stored chemicals
- Recycling areas have the potential for spills and/or leaks from the storage of oil, batteries and gas bottles
- Workshop/compound areas which contain stores of oil, grease, fuel and other chemicals used on operations at SBWMF have the potential for spills and/or leaks.

Potential off-site sources of contamination

Surrounding land uses may potentially be responsible for sources of contamination to the hydrogeological environment, including:

- The adjacent unexploded ordinance (UXO) area and military training ground
- Urban stormwater runoff
- The former Leanyer landfill (pre-dating SBWMF)
- Potential use of herbicides, pesticides or nitrogen based fertilisers at properties located up-hydraulic gradient of the site.

3.2.2 Contaminants of potential concern

Contaminants of potential concern (CoPC) at the SBWMF include:

- Nitrogen compounds (ammonia and nitrate)
- Metals
- Phenolic compounds
- Benzene, Toluene, Xylene and Napthalene (BTEXN)
- Total organic carbon (TOC)
- Volatile fatty acids (VFAs)
- Total recoverable hydrocarbon (TRH)
- Per- and polyfluoroalkyl substances (PFAS)
- Chloride
- Sodium
- Salinity
- Methane.

3.2.3 Potential receptors

Potential receptors for contamination resulting from activities at SBWMF include (but are not limited to):

- Nearby groundwater users (although no bores down-gradient of SBWMF are currently registered)
- Holmes Jungle Nature Park and Leanyer Swamp and their ecosystems
- Surrounding land/ecosystems (e.g. floodplains, wetlands and mangrove communities)
- Any staff or users of the SBWMF.

3.2.4 Potential exposure pathways

The possible exposure pathways are identified as natural and/or manmade pathways for the preferential migration of contaminants in the liquid and/or gaseous state. Potential contaminant migration pathways for contaminants resulting from activities at SBWMF include (but are not limited to):

- Leachate migration from the landfill to soil and groundwater
- Leachate impacted surface water runoff from the landfill
- Contaminated surface water runoff from chemical and container storage areas, recycling area, green waste area and workshop/compound areas
- Direct emission of landfill gas (methane) to atmosphere.

Exposure to human receptors can occur through three routes; dermal contact, ingestion and inhalation. Ecosystem exposure occurs through leaching, migration, ingestion, dermal contact and inhalation. Potential exposure routes to potential receptors include (but are not limited to):

- Infiltration of leachate, leachate impacted or otherwise impacted water to the groundwater system
- Overland flow of leachate, leachate impacted or otherwise impacted water to the surface water system
- Direct or in-direct exposure to water users of both groundwater and surface water
- Direct exposure of leachate, leachate impacted or otherwise impacted water or soil leading to dermal contact, inhalation or accidental ingestion by on-site staff or users of the SBWMF
- Direct exposure to landfill gas through inhalation by on-site staff or users of SBWMF or surrounding environment users.

These potential contamination sources and exposure pathways require management measures, and monitoring, to minimise risks to receptors. The risk assessment (Section 4) and environmental management plans (Section 5) assess these risks and put in place appropriate management measures and monitoring.

4 RISK ASSESSMENT

4.1 Methodology

The risk assessment process involves identification of environmental aspects and impacts, and is systematic and consistent with the following international best practice standard methodologies:

- AS/NZS ISO 31000:2009: Risk management - Principles and Guidelines (Standard).
- HB 203:2006: Environmental risk management - Principles and Process (Guide).
- HB 158:2010: Delivering assurance based on ISO 31000:2009 - Risk management - Principles and Guidelines (Guide).

Environmental aspects are defined as the elements of an organisations activities, products or services that can interact with the environment (e.g. use of machinery, storage of wastes). Environmental impacts are any change to the environment, whether adverse or beneficial, wholly or partially resulting from the organisations environmental aspects.

Identifying the environmental aspects and impacts relevant to the works undertaken at SBWMF allows an assessment of the environmental risk to be completed, using a standard consequence and likelihood matrix. Management or mitigation measures can be assigned to each aspect, with a residual risk calculated based on the resulting potential impacts. Environmental management activities can then be prioritised according to risk. Risks have only been assessed for activities related to the operations undertaken at SBWMF.

4.1.1 Risk ranking

The ranking for event consequence is shown in Table 4-1. The likelihood of an event occurring provides a measure of the known or anticipated frequency of occurrences (Table 4-2). Combining likelihood with consequence provides guidance on risk levels of each aspect and enables key risks to be identified and management strategies to be prioritised (Table 4-3). The risk assessment for the activities associated with SBWMF is provided in Table 4-4.

Table 4-1. Consequence ranking

Consequence		
1	Insignificant	No/low measurable impact on the environment.
2	Minor	Some minor, temporary environmental impact.
3	Moderate	Contained temporary or permanent minor, localised environmental damage.
4	Major	Severe environmental damage.
5	Catastrophic	Environmental disaster.

Table 4-2. Qualitative measures of likelihood

Probability/Likelihood			Likelihood criteria
A	Rare	May occur only in exceptional circumstances.	0-1%
B	Unlikely	Could occur at some time.	2-10%
C	Moderate	Might possibly occur at some time.	11-50%
D	Likely	Will probably occur in most circumstances.	51-90%
E	Almost certain	Expected to occur in most circumstances.	91-100%

Table 4-3. Risk rankings from combined consequences and likelihood

Consequence						
Likelihood		1	2	3	4	5
	A	1	3	6	10	15
	B	2	5	9	14	19
	C	4	8	13	18	22
	D	7	12	17	21	24
	E	11	16	20	23	25

Where;

Red = extreme risk intolerable
Orange = high risk intolerable or tolerable
Yellow = medium risk tolerable or acceptable
Green = low risk acceptable

4.2 Risk assessment

Table 4-4. Environmental aspects and impacts register

Environmental concern	Operational Aspect	Potential Impact	Initial Risk			Management Measure / Controls	Residual Risk		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
Water quality	On site water management i.e. stormwater diversion, leachate generation, wash down water generation	Contamination of water quality including: - Infiltration of leachate into groundwater due to seepage from landfill - Overland drainage of leachate to receiving surface waters via stormwater - Failure of leachate ponds or leachate treatment system - Overflow of leachate ponds	C	3	H (13)	- Waste acceptance and segregation procedures are adhered to, to ensure waste is accepted into lined cells and only inert waste is placed in unlined cells - Regular inspections are conducted of landfill operations to ensure compliance of procedures - Waste is covered as required i.e. daily covers, temporary covers and/or capping - Stormwater diversions are installed and maintained to divert clean stormwater away from operational areas - Leachate collection systems are installed, maintained and regularly inspected to ensure their effectiveness - Installation and maintenance of a leachate treatment system - Leachate ponds are lined to prevent seepage to groundwater, and covered to prevent surface water infiltration - Emergency backflow infrastructure is installed and working effectively to return leachate from ponds to landfill - All wash down bay water is captured and contained - Water quality monitoring program is undertaken according to procedures, and any impacts are detected in a timely manner to be addressed by contingency management measures	B	3	M (9)
	Spills of chemicals, hydrocarbons or hazardous substances when handling wastes	Contamination of receiving surface waters via stormwater drainage	C	2	M (8)	- Hazardous substances to be stored in appropriately bunded containers or within impervious areas - Regular removal of hazardous substances from storage containers at the Transfer Station - Spill response plans are developed, and all personnel and contractors have been trained in spill response procedures - Spill kits are located throughout the site and are adequately stocked and sized for potential spills - Approvals are required and obtained prior to receipt of any unidentified/unnamed chemicals - Waste oil tanks are regularly inspected, maintained and decanted when required	B	2	L (5)

Environmental concern	Operational Aspect	Potential Impact	Initial Risk			Management Measure / Controls	Residual Risk		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
						All bulk fuel or oil tanks are to meet all AS1940 requirements i.e. double bunded			
	On site operations leading to erosion of sediments from disturbed areas, generation of sediment laden runoff	Contamination of receiving surface waters, through uncontrolled water release	C	2	M (8)	- Installation of erosion and sediment controls - Implementation of a regular inspection and maintenance program for erosion and sediment controls - Stormwater infrastructure designed to direct clean runoff from disturbed areas - Stormwater infrastructure designed to capture runoff within operation/disturbed areas - Leachate system effectively capturing leachate volumes generated on site - Rehabilitation and revegetation for exposed slopes and disturbed areas to be implemented in accordance with the closure and post closure plans	B	2	L (5)
Waste management	On site waste management i.e. cross contamination of wastes, asbestos handling, windblown litter	- Reduced recycling ability due to cross contamination - Human health risk due to inappropriate management of asbestos - Reduced visual amenity leading to community complaints	C	3	H (13)	- Waste acceptance and segregation procedures are adhered to, to ensure waste is accepted into lined cells and only inert waste is placed in unlined cells - Waste segregation requirements are clearly labelled with signage at the Transfer Station - An asbestos disposal cell is appropriately constructed and signed - Waste is covered as required i.e. daily covers, temporary covers and/or capping - Recyclable materials that are incorrectly deposited are salvaged following regular inspections - Approvals are required and obtained prior to receipt of any Special Wastes - Litter fences are installed, regularly inspected and maintained as required - Regular inspections and clean-up operations are undertaken to prevent wind-blown litter leaving site boundaries	B	3	M (9)
Environmental and Public Nuisance (Noise, Dust, Odours and Greenhouse Gas Emissions)	On site operations generating excessive noise, dust, offensive odours and/or excessive greenhouse gases	- Off-site dust deposition resulting in community complaints - Excessive noise causing community disturbance and resulting in community complaints - Offensive odours causing	C	2	M (8)	- Water trucks are in regular use and static dust suppression techniques i.e. stockpile sprinklers, are implemented when dust is being generated on site - Operations are confined to site opening hours, afterhours works will only occur through prior arrangement with appropriate notification and controls implemented - A vegetation buffer is maintained between the site and the nearest	B	2	L (5)

Environmental concern	Operational Aspect	Potential Impact	Initial Risk			Management Measure / Controls	Residual Risk		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
		community disturbance resulting in community complaints • Fugitive methane gas emission release resulting in an increased in net greenhouse gases emitting to the atmosphere.				sensitive receptors • Waste is covered as required i.e. daily covers, temporary covers and/or capping • All community complaints are recorded, responded to, and any corrective actions and/or community follow up is recorded • The landfill gas management system is installed, regularly inspected and maintained to capture methane in the waste cells • All plant and equipment is regularly inspected and maintained i.e. pre-start inspections and routine maintenance schedules are implemented			
	Vehicle movements to and from the site resulting in mud tracked on public roads	• Reduced visual amenity leading to community complaints	C	2	M (8)	• A wheel wash is located at the site exit point and is regularly inspected and maintained • Access roads to and from the site are regularly inspected and maintained when required	B	2	L (5)
Flora and Fauna	Vehicle movements resulting in harm to fauna via vehicle strike or unapproved clearing	• Injury or death to native fauna resulting from on-site operations	C	2	M (8)	• Only authorised access tracks are utilised in site operations • Installation and maintenance of a boundary fence	B	2	L (5)
	Uncontrolled release of contaminated water in areas of native vegetation and habitat	• Flora stress or die back resulting from exposure to contaminated water and soils	C	2	M (8)	• Leachate collection systems are installed, maintained and regularly inspected to ensure their effectiveness • Installation and maintenance of a leachate treatment system • Leachate ponds are lined to prevent seepage to groundwater, and covered to prevent surface water infiltration • Emergency backflow infrastructure is installed and working effectively to return leachate from ponds to landfill	B	2	L (5)
Weeds and Pests	On site operations leading to the introduction and/or spread of weeds	• Introduction of new weeds, and/or the spread of existing weeds within the site • Spread of weeds to surrounding land	C	2	M (8)	• Develop and implement a regular vegetation/weed management program that details control measures i.e. seasonal weed spraying, slashing • Develop and implement a rehabilitation and revegetation plan for exposed slopes and disturbed areas	B	2	L (5)
	On site operations providing a habitat for pests i.e. vermin, biting insects	• Introduction and/or spread of pests within the site and to the surrounding land	C	2	M (8)	• Waste is covered as required i.e. daily covers, temporary covers and/or capping • Regular inspections and clean-up operations are undertaken to prevent wind-blown litter leaving site boundaries • Regular inspections across the site to minimise ponding of water at any area of operations • Installation and maintenance of a boundary fence to prevent access	B	2	L (5)

Environmental concern	Operational Aspect	Potential Impact	Initial Risk			Management Measure / Controls	Residual Risk		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
						by larger animals			
Fire	On site handling of flammable and combustible wastes i.e. mulch, hot load	Uncontrolled fire within the site and/or into the surrounding land resulting in damage to infrastructure and impacts to the community	C	4	H (18)	- An Emergency Response Plan has been developed and all personnel and contractors have received training into Emergency Response Procedures - Fire breaks and fuel reduced areas are maintained regularly - NT fire authorities are engaged and involved in any prescribed burning activities - Appropriate firefighting equipment is located throughout the site - Hazardous substances to be stored in appropriately bunded containers or within impervious areas - Waste is covered as required i.e. daily covers, temporary covers and/or capping - Implement a procedure to reduce green waste storage volumes into rows Mulch stockpile heights are limited to prevent excessive piling of mulch materials - Develop and implement a regular vegetation/weed management program that details control measures i.e. seasonal weed spraying, slashing - Implementation and maintenance of 1 m wide path around the edge of any geomembrane	A	4	M (10)
	Undertaking hot works i.e. welding		C	4	H (18)	Implementation of a hot works permit procedure and regular inspections of hot works	A	4	M (10)
Heritage Values	On site excavations, earthworks or vehicle movements disturbing a heritage site or artefact	Damage or disturbance to an unknown heritage site of Aboriginal or European significance	C	3	H (13)	- AAPA Certificates have been obtained and all conditions have been adhered to i.e. excluding areas identified in AAPA Certificates from operational works - Develop and implement a Heritage Discovery Procedure, and all personnel and contractors have received training for heritage site identification and protection - Only authorised access tracks are utilised in site operations - Installation and maintenance of a boundary fence to prevent access from the general public	A	3	L (6)
Public Safety	On site operations resulting in potential public safety hazards i.e. trip hazards, unauthorised access to hazardous areas	Injuries to personnel, contractors and/or the general public	C	3	H (13)	- Safety and awareness signage is installed throughout the site - Traffic control signage and devices i.e. boom gates, are installed - All personnel and contractors are to be inducted to the site and provided with clear instructions for each waste disposal area - Personnel and contractors to manage and maintain the Transfer Station i.e. clearing loose rubbish, placing chemicals in hazardous	A	3	L (6)

Environmental concern	Operational Aspect	Potential Impact	Initial Risk			Management Measure / Controls	Residual Risk		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
						storage cupboards - Waste disposal bays will be closed to the general public when hook bins are full and require emptying - Maintain clear access and sufficient working pad space for vehicles depositing waste at tip face			

5 ENVIRONMENTAL MANAGEMENT

5.1 Overview

The following sections provide specific environmental management tables related to identified potentially significant environmental aspects (see Section 4). An environmental aspect is an element of the landfill operation activity that can interact with the environment.

Each environmental management table forms the basis of an environmental inspection and audit to verify compliance with the EMP. Each of the tables shown in the relevant sections below include the following components:

- Environmental objectives – describes the key environmental objectives or goals that the EMP aims to influence for this aspect.
- Mitigation measures – measures that will be implemented with the aim to eliminate, reduce, or control potential adverse environmental impacts and risks resulting from site activities.
- Performance criteria - measureable control indicator that is used to quantify, or evaluate, so as to determine if the performance standard is met.
- Monitoring and Reporting – actions to measure and report compliance against the objectives and performance standards.
- Corrective Action – measure to ensure a non-conformance or non-compliance is corrected.
- Responsibility – overall responsibility to ensure the mitigation measure is implemented and is an effective control. If the task is delegated, the person is still responsible for ensuring implementation.

5.2 General environmental management

The following environmental compliance measures (Table 5-1) to be implemented at the SBWMF are based on EPL conditions and outcomes of the environmental impact and risk assessment (Table 4-4).

Table 5-1. General environmental management

Objective / outcome	To minimise the risk and likelihood of causing harm to the environment
Mitigation / Control	• Ensure the implementation and compliance of this EMP • Annual environmental audit of EPL conditions and EMP • Ensure all personnel working at SBWMF are given an induction detailing environmental risks and mitigation measures in this EMP, as well as emergency response procedures
Target / performance criteria	Impacts/risks to environment are reduced to acceptable levels
Monitoring	• Daily visual site inspection (general parameters) • Monthly environmental inspection against EPL conditions and this EMP, as per site inspection checklist
Corrective actions and contingencies	Non-compliance of the EPL and this EMP must have suitable corrective actions with assigned responsibility and date for completion
Responsibility	Site Manager

5.3 Waste acceptance and disposal

Table 5-2 details how environmental aspects related to general and recyclable waste are managed at SBWMF. All listed waste management measures are detailed in Section 6.

Table 5-2. General and recyclable waste management

Objective / outcome	- To accept only approved waste for disposal and/or recycling at SBWMF - To ensure no harm is done to the environment as a result of waste disposal at SBWMF - To prevent ground water and surface water contamination - To prevent fires at SBWMF
Mitigation / Control	- Relevant staff are to be trained on the types of waste accepted and pre-approvals required – this will be done through inductions and toolbox talks/staff meetings - Clear signage and communication to make landfill users aware of the types of waste accepted at SBWMF - At the weighbridge – conduct visual inspections of waste loads and question driver regarding types of wastes within the load - If not general waste, seek compliance documentation to verify type of wastes and prior approval if applicable - Any waste not listed in the EPL can only be accepted after special approval from NT EPA - Only clean fill can be accepted for disposal. Soil being brought to SBWMF from potentially contaminated sites will require validation sampling results to be assessed against relevant guidelines as per Section 6 - Provide assistance and clear directions on correct waste disposal areas - Clearly labelled signs at transfer stations - Salvage of recyclable materials incorrectly disposed of - Regular clean-up of scattered and inappropriately disposed waste - Apply daily cover, intermediate cover and capping as required - Only domestic users are permitted to use the transfer station unless directed by the weighbridge operator - Accepted wastes are only to be stored within approved areas and storage vessels - All liquid waste (toilets, ablutions etc.) will be disposed of directly into site septic tanks, which will be managed as required - All drivers will be instructed to remain on alert for evidence of hot loads (smoke/fire) and to alert SBWMF staff
Target / performance criteria	- No acceptance of unapproved wastes - No significant impacts or environmental harm - No breach of EPL conditions - All wastes disposed of in accordance with EPL and industry standards
Monitoring	- Visual monitoring of loads to ensure appropriate acceptance of wastes - Water quality monitoring as per EPL - Visual inspections of waste transfer stations and active tip face shall occur at least daily in the dry season and at least twice daily in the wet season
Corrective actions and contingencies	- Ongoing training for relevant staff regarding acceptance of waste procedures - Clearly marked signs stating waste types accepted and not accepted at the entry points to SBWMF for all users to see - Further assistance and instructions from SBWMF staff for users of SBWMF to ensure appropriate disposal of wastes - If waste is found to be incorrectly disposed of, correct if possible - If hazardous waste or unidentified waste is found, identify a licenced specialist for possible disposal and report non-compliance to the NT EPA

Responsibility	Site Manager
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5.4 Storage and use of hazardous substances

The storage and use of chemicals, oils and fuels is managed as per Table 5-3, which describes the mitigation measures to be implemented to reduce negative impacts and the risk of causing environmental harm from spills leading to the contamination of surface and groundwater. It also details the performance criteria and monitoring measures in place.

Table 5-3. Storage and use of chemicals, oils and fuels

Objective / outcome	- To prevent spills of hazardous substances - To ensure correct use, handling and storage of hazardous chemicals - To prevent contamination to surface water, ground water and surrounding environment
Mitigation / Control	- Any spills or leaks of hazardous materials will be treated in accordance with the emergency response plan – spill response procedure - All chemicals, oils and fuels will be stored appropriately in locked areas that are bunded, impervious areas in accordance with their SDS - SDS will be available in a folder where the chemicals, oils and fuels are stored - Storage of oils and fuels must be in accordance with Australian Standards (AS1940 – The storage and handling of flammable and combustible liquids) - Chemical use will be in accordance with the appropriate SDS - Volumes of stored chemicals, oils and fuels will be kept to a minimum where possible - Spill response kits to be stored and maintained in all storage areas - Site staff to be trained in spill response as part of the induction process
Target / performance criteria	- No spills or leaks of hazardous substances - No breach of EPL - Reporting of spills/leaks to NT EPA
Monitoring	- Daily visual inspections of waste disposal areas to identify any hazards or spills - Monthly site inspection to check correct use and storage of hazardous materials and for signs of any spills or leaks
Corrective actions and contingencies	- Review storage and handling of hazardous materials and provide training where required - Raise concerns at toolbox talks / staff meetings - Ensure staff are trained in spill response procedures
Responsibility	Site Manager

5.5 Water quality

Management of water quality throughout the SBWMF is based on the following objectives in order of preference:

- 1) No measurable impact on surface water and groundwater quality within the SBWMF operations area:
 - o Recognising the historic legacy of water management issues with staged infrastructure upgrades to improve performance.
- 2) No measurable impacts on aquatic ecosystems and groundwater between the lease area and the SBWMF operations area:

- o Providing a buffer or attenuation zone for the protection of the surrounding environment from the historic legacy related to contamination within the SBWMF.
- 3) No measurable impacts on aquatic ecosystems and groundwater quality at the edge of the lease area:
- o Reflects the basis for conditions within the EPL.

Water present within the SBWMF is defined into five categories for management purposes which are described in Table 5-4.

Table 5-4. Water categories for management

Water Type	Description	Management Objectives
Clean water	Stormwater runoff that is not impacted by landfilling operations. This may include: • Catchments upstream/outside the operational area • Undisturbed catchments within the operational area • Rehabilitated landfill areas	• Diversion around or away from operational areas and other water types. • Suitable quality for direct release to the environment without active management.
Sediment water	Sediment laden stormwater runoff from erosion of exposed materials within operational areas such as: • Un-vegetated waste cell bunds • Stockpiles of material • Unsealed access tracks and cleared areas	• Minimise the size of disturbed areas. • Progressive rehabilitation of waste cells. • Capture of sediment prior to release of water into the environment.
First flush	Potentially impacted stormwater runoff from lower risk stockpiled resource recovery material such as: • Green waste (tannins & nutrients) • Steel (metals and hydrocarbons) • Concrete (sediment)	• Minimise the size of resource recovery hardstand areas. • Capture first flush water containing contaminants for management through water quality testing and/or treatment prior to release.
Leachate	Water that has been in direct contact with putrescible waste. This can occur through: • Release of stored water from buried waste material. • Surface water infiltration through cover materials into underlying buried waste. • Stormwater runoff contacting uncovered waste.	• Minimising leachate generation through maximising stormwater runoff away from buried waste through small active disposal faces, placement of daily cover and well-shaped landforms. • Progressive rehabilitation of waste cells. • Active collection and management of leachate generation within buried waste materials.
Groundwater	Water flowing through subsurface soils and rock. Groundwater is generally recharged in higher elevation catchment areas and discharges into waterways within lower catchment areas.	• Containment of buried wastes and leachate and separation from underlying groundwater.

5.5.1 Treatment concepts and principles

As per the adopted stormwater management strategy for SBWMF, a “treatment train” approach has been adopted to manage sediment and first flush water. The train of controls is designed to target capture or attenuation of approximately 80% of the contaminant load in run-off from disturbed or active operational areas (Golder 2020).

Inert waste landfill (Stage 2)

The stormwater management concept design for Stage 2 is comprised of the following elements:

- Two contour banks surrounding the active waste area at the top of the landform that will convey impacted runoff to a chute in the north-west corner
- Runoff from the chute will be conveyed via culverts under the leachate pond access road towards a grassed drain
- Sediment impacted water will be discharged into a sediment basin located within the existing disturbed area north of Stage 3/4 general waste landfill.

General waste landfill (Stage 3 onwards and green waste)

The stormwater concept design for the general waste landfill and green waste areas will be implemented through a staged approach as the landform progresses. Given the larger catchment areas, high rainfall conditions and available land areas, it is proposed to utilise a combination of sediment containment infrastructure as an alternative to large scale sediment basins. This approach is also designed to facilitate nutrient attenuation from the first flush waster. The stormwater management concept for these areas is comprised of the following elements:

- Contour banks surrounding the active waste and along the batters of the landform that will convey impacted runoff to rock-lined chutes down the batters
- Runoff from the chute will be conveyed via toe drains to causeways under the eastern access tracks towards primary coarse sediment traps
- The coarse sediment traps will be designed to slow concentrated flows and settled coarse suspended sediment with rock-lined outlets
- High-flow bypass drains are to be built alongside the sediment traps to convey peak flows
- Design flows from the coarse sediment traps will be conveyed along a bunded, grassed approach drain to a concrete outlet sill level spreader, releasing the concentrated flow as sheet flow onto a stable vegetated area downslope (see Figure 5-1).

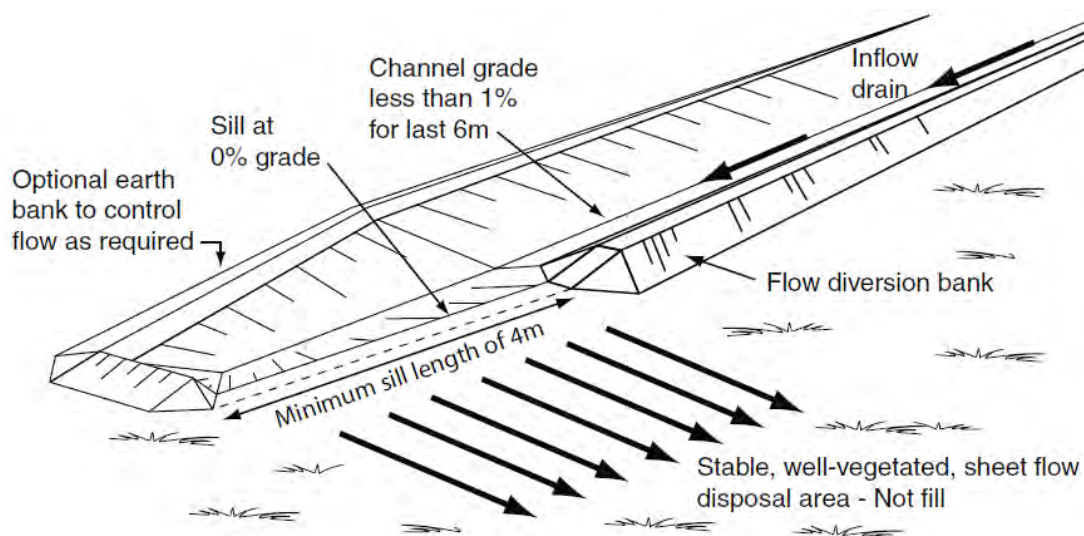


Figure 5-1. Typical layout of a level spreader

The stormwater management concepts outlined above are shown on Figure 5-2 to Figure 5-4 and the nominated controls are summarised in Table 5-5 along with their maintenance triggers and action requirements.

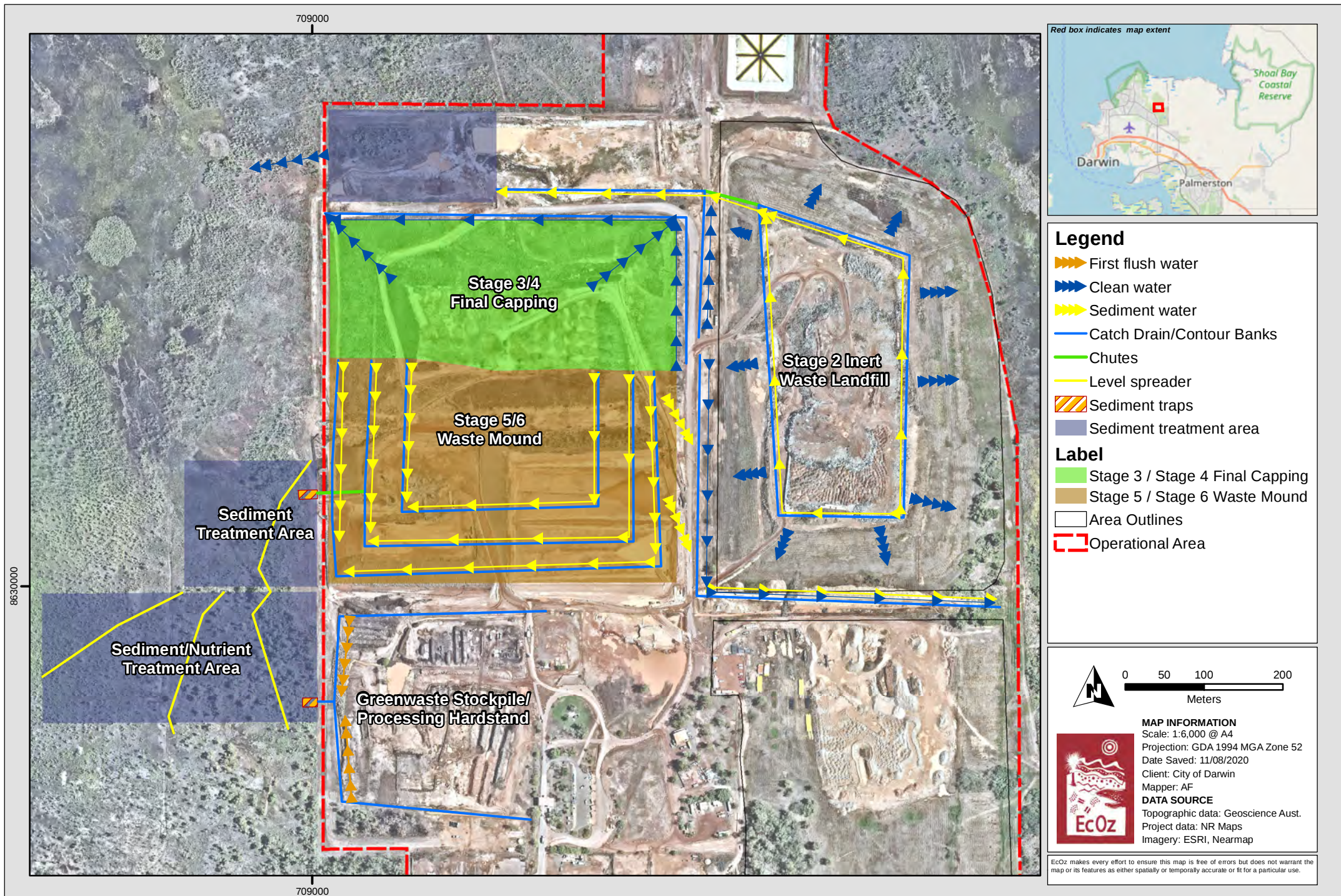
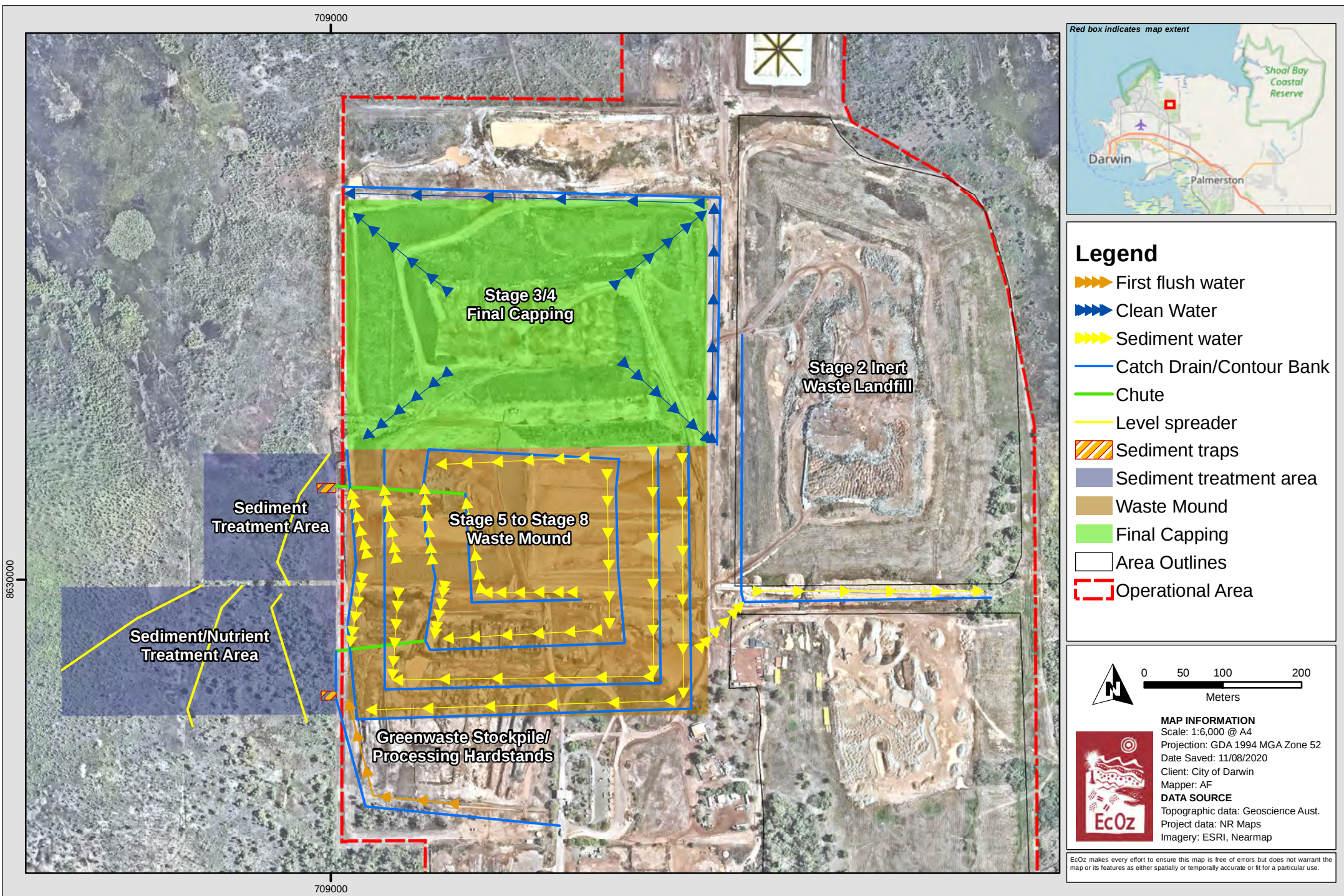
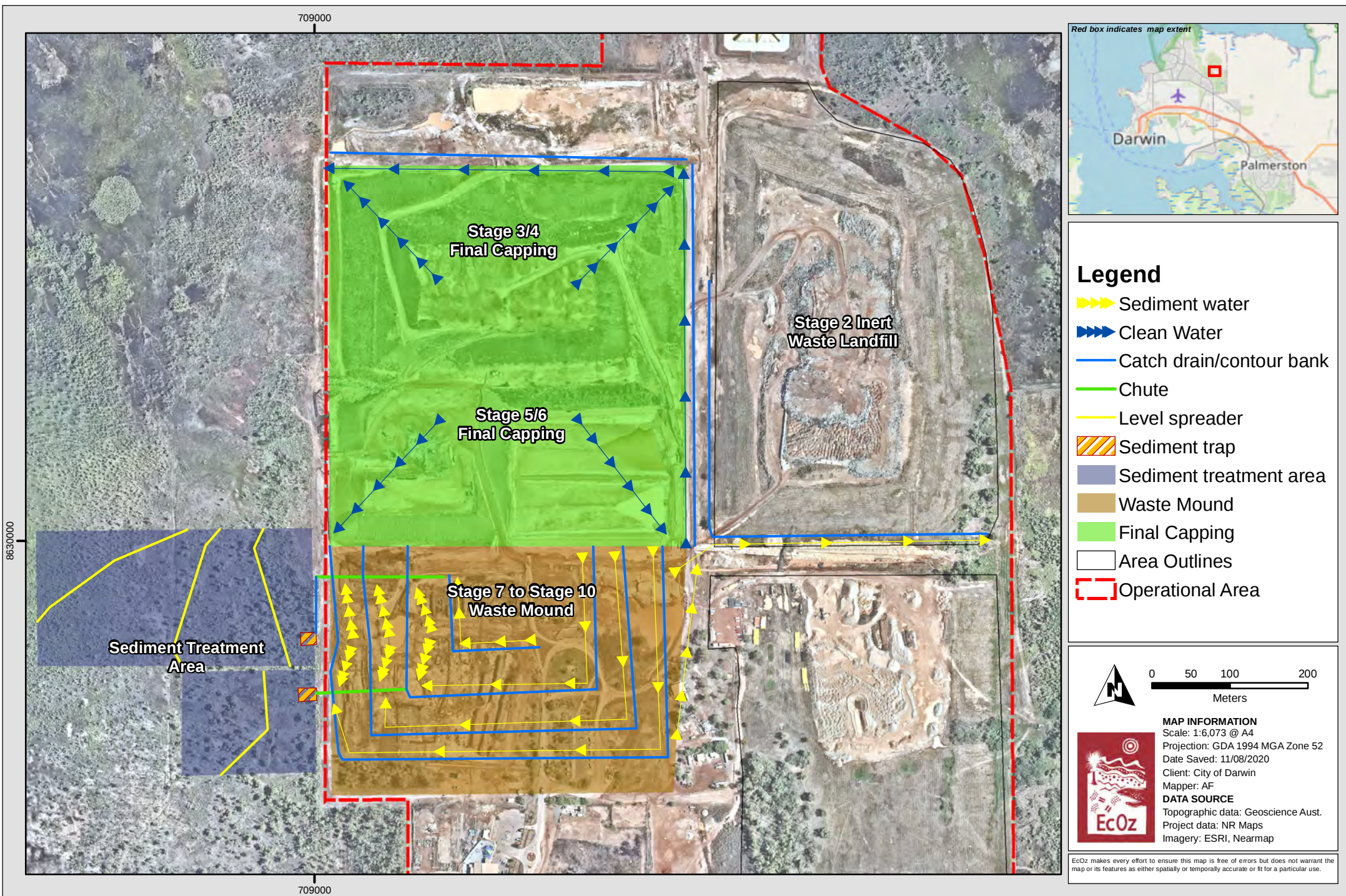


Figure 5-2. Stormwater management for Stages 2 to 6 and greenwaste



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Figure 5-3. Stormwater management for Stages 7 to 8 and greenwaste



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Figure 5-4. Stormwater management for Stages 9 to 10

Table 5-5. Proposed controls, maintenance triggers and actions

Control	Description	Maintenance trigger	Maintenance action
Grass-lined contour banks/catch drains	Used to control and direct flows on slopes (i.e. landfill batters) to toe drains or chutes	Evidence of erosion or slumping	Repair/reinstate. Investigate need for additional controls or replace with more effective controls
		Sediment, debris or vegetation blockage	Remove accumulated sediment or debris
		Changes in design slope	Re-profile drain
Rock-lined chutes	Used to convey impacted runoff from the elevated areas of the landfill directly down the batters to toe drains	Displacement of rock or scour	Move rock to original location and consider local placement of larger rock
		Exposed base and/or geotextile	Ensure integrity of base/geotextile and reinstate locally
		Erosion on bunds	Repair/reinstate
Grass-lined drains	Used to convey runoff to treatment areas or to surrounding environment	Vegetation is longer than 250 mm	Grass to be maintained to approximately 100 mm
		Poor vegetation growth	Water if applicable. Consider secured turf or plant tubestock of native grasses/sedges/vetiver
		Evidence of erosion	Repair/reinstate. Consider localised additional controls
Check dams	Rock dams or fibre logs in catch drains used to slow flow velocities and facilitate sediment capture	Damage to dam structure	Reinstate
		Sediment accumulation	Remove any accumulated sediment
		Signs of overtopping/scour	Reduce central height or increase rock armour around edges
		Significant erosion between dams	Install additional dams or install channel liner
Causeway/culvert	Conveys flows across roads/access tracks and maintain trafficability	Evidence of overtopping	Place more rock protection or increase depth
		Evidence of erosion or damage to headwalls or channels	Repair/reinstate. Install extra scour protection
		Blockage, sediment build up	Unblock and/or desilt immediately
Coarse sediment trap	Used to settle out and capture sediment from most flows	Evidence of erosion or damage to structures	Repair/reinstate. Place more rock protection
		Sediment build-up of 30%	Remove sediment and dispose of appropriately
High-flow bypass drain	Grassed trapezoidal drain adjacent to the sediment trap used to convey flows greater than the design event to minimise potential damage to	Vegetation is longer than 250 mm	Grass to be maintained to approximately 100 mm
		Poor vegetation growth	Water if applicable. Consider secured turf or plant tubestock of native grasses/sedges/vetiver

Control	Description	Maintenance trigger	Maintenance action
	downstream controls	Evidence of erosion	Repair/reinstate. Consider localised additional controls
Level spreader	Grassed and bunded structure to spread and direct flow from the coarse sediment trap to a well vegetated area	Evidence of erosion or damage to structures	Repair/reinstate
		Evidence of erosion in vegetation directly below outlet	Consider placing geotextile and rock armour for first 0.5m after outlet or lower inflow level to high-flow bypass
Stiff grass barrier	Vetiver strips (or other suitable vegetation) placed downstream of level spreader discharge or in grassed drains	Evidence of erosion	Repair/reinstate. Consider planting additional strips or alternative species
		Vegetation is longer than 500 mm following wet season	Grass to be cut back to approximately 500 mm
Vegetated extended detention area	Localised bunding in surrounding vegetation to promote increased settling of sediment and uptake of nutrients from green waste area by strategically planted grasses and sedges	Evidence of erosion	Repair/reinstate. Consider planting additional strips or alternative species
Sediment basin	Optional large scale engineered structure (Type C) to capture, treat and store sediment water.	Evidence of erosion or damage to structures	Repair/reinstate. Place more rock protection
		Sediment build-up of 30%	Remove sediment and dispose of appropriately

5.5.2 Water monitoring

Monitoring of groundwater, surface waters and leachate quality is undertaken regularly. Details of the monitoring program, including locations, frequency, parameters measured, analysis and reporting are included in the Water Quality Monitoring Plan (WQMP) in Appendix B.

As the general waste landform progresses, some of the existing monitoring sites may become redundant. Additional surface water monitoring will be required to determine the effectiveness of the sediment controls and nutrient attenuation within the sediment treatment areas. Monitoring sites shall be established at outfalls from the proposed sediment basin and coarse sediment traps, and within any clean water drains that discharge into the surrounding vegetation. The WQMP will be updated as these changes to the monitoring program occur.

5.6 Leachate

5.6.1 Leachate overview

Leachate is liquid that passes through the waste facility and collects extracted solutes and suspended solids. Leachate has the potential to pollute the surrounding environment and is of particular concern during the wet season.

Stage 1 & 2

Leachate that moves laterally from Stage 1 and 2 waste cells is recovered using interception trenches along the eastern toe of both stages. A gravity drain transfers the leachate to a single sump that is pumped to an irrigation area over the eastern side of Stage 1.

Stage 3

The constructed cell floor leachate collection system in Stage 3 is considered to have failed and is no longer in use. Leachate extraction from Stage 3 comprises the following:

- Overflow drainage into Stage 4
- A leachate collection strip drain below the toe of the southern batter that drains to leachate well DW2
- Six sumps located around the perimeter of the northern and eastern batter slopes
- Landfill gas wells fitted with leachate pumps.

The performance of Stage 3 will be monitored, with additional leachate control infrastructure to be installed if performance issues with existing infrastructure is identified.

Stage 4 & all active and future landfill cells

From Stage 4 and ongoing, waste cells are designed and constructed with liner systems and cell floor leachate collection systems that are compliant with NT EPA landfill guidelines.

Leachate collected from the waste cells is managed as follows:

- Pumped into the leachate storage ponds
- Treated through the site adopted leachate treatment system for on-site disposal
- If the leachate storage ponds reach capacity prior to or during treatment processes, leachate management will comprise:
 - o Irrigation on the top of waste cells prior to final capping
 - o Recirculation with buried waste material within the lined landfill cells as appropriate.

Leachate collection volumes

A leachate water balance was undertaken for the site which predicted the leachate collection volumes over ten years. The water balance calculation included an assessment of current leachate volumes and generation rates, based on rainfall and capping stages. Table 5-6 outlines the estimated leachate collection volumes from the putrescible waste cells over ten years based on two rainfall scenarios. This includes estimates from Stage 3 to the proposed Stage 7 landfill cells. An additional 4 to 8 ML of leachate is estimated to be collected from Stage 1 and 2 over this period.

Table 5-6. Estimated leachate collection volume estimates (ML) (Golder 2020)

Rainfall	2021	2022	2023	2024-27	2028	2029	2030
50 th percentile	25	14	14	16	17	11	13
90 th percentile	33	17	18	21	24	14	16

Leachate storage ponds

Two leachate storage ponds fitted with floating covers and a nominal capacity of 30 ML have been installed at the SBWMF.

Each of the leachate ponds are lined with geosynthetic liners and comprise of an earthen perimeter bund, constructed up to approximately 2.5 m above ground level surrounding an excavation of approximately 2 m to 2.5 m depth.

The ponds and the contained leachate are also covered with a synthetic cover. The covers are designed to allow stormwater runoff to be collected and retained over the cover. Clean water storage on top of the covers assists with mitigating risks of damage to the cover system associated with high wind/cyclone events and bushfire embers.

The leachate storage ponds are also protected by an internal perimeter fence to exclude unauthorised access that may result in exposure to safety risks and protect liner systems from damage by terrestrial fauna.

Leachate treatment system

From the leachate storage ponds, leachate will be pumped to a leachate treatment system designed to treat the leachate to a suitable quality for discharge within the site (i.e. via irrigation, dust suppression or to supplement water requirements for green waste management). Subject to an Environment Protection Approval, the leachate treatment plant (LTP) for SBWMF consists of the following elements:

1. Foam fractionation and extraction process for PFAS removal
2. Biological nutrient removal – Sequence Batch Reactor (SBR) combined with Moving Bed Biological Reactor (MBBR)
3. Dissolved air floatation (DAF) for solids removal
4. Constructed wetlands
5. Storage and irrigation of treated leachate over a vetiver grass operation

The treatment system has been sized to treat flows of up to 140 kL/day however is inherently scalable and flexible in nature to manage the fluctuating leachate generation rates outlined in Table 5-6. The storage of treated leachate will be within one of the existing leachate storage ponds (to be emptied prior to treatment operations).

An Environmental Management Plan for Leachate Treatment and Irrigation (WCG 2020) has been prepared detailing the treatment methodology, outputs and monitoring requirements, and should be read in conjunction with this EMP.

5.6.2 Leachate management

Leachate is managed as per Table 5-7 to reduce to risks of leachate generation and contamination from SBWMF.

Table 5-7. Leachate management

Objective / outcome	To prevent impacts to the surface water, groundwater and surrounding environment due to leachate
Mitigation / Control	<i>General landfill operations:</i> - Ensure appropriate disposal of wastes into landfill cells - Use of appropriate cover and capping for landfill cells and installation of interim and final capping as required - Minimise exposed tip face area to reduce rainfall infiltration - Maintain a free-draining landform at all times - Use of diversion bunds or similar where required to direct stormwater runoff around active tip faces - Inspections and installation of additional controls as required for periods of forecast high rainfall (i.e. cyclones or monsoons) - New landfill cells designed to minimise leachate generation (i.e. sub-cells) with early waste placement scheduled during dry periods - All wash down bay water is captured and contained - Irrigation of raw leachate to occur over lined (uncapped) landfill cells only - Monitor all active waste areas following high rainfall events for signs of discoloured runoff / leachate - Where leachate contamination of surface runoff is visible, construct diversions to direct leachate back into landfill or into leachate management structures - Minimise the surface area and volumes of green waste kept on site <i>Leachate collection and storage:</i> - Leachate collection systems are installed, maintained and regularly inspected to ensure their effectiveness - Maintain leachate sumps, drains, ponds, pumps and other infrastructure and ensure no new leachate springs occur - Leachate ponds are lined to prevent seepage to groundwater, and covered to prevent surface water infiltration - Emergency backflow infrastructure is installed and working effectively to return leachate from ponds to landfill <i>Leachate treatment</i> - Installation and maintenance of a leachate treatment system - Undertake daily checks on treatment infrastructure - Ensure leachate is stored within tanks/ponds specifically designed for leachate - Treat leachate to a quality suitable for on-site discharge (sampling of treated leachate prior to discharge) - Development and implementation of an irrigation management plan - Irrigation will be controlled to avoid surface runoff and irrigation will be limited or stopped during rainfall events - Ground saturation to be monitored and logged to avoid overland flow - Implementation of a monitoring program - Flow and volumes will be monitored and recorded
Target / performance criteria	- No incidents or monitoring results in breach of the EPL - No detectable leachate flowing from SBWMF operations area - No impacts to the surface water or groundwater at SBWMF
Monitoring	Ensure water quality monitoring is undertaken in accordance with the

	monitoring plan • Inspection of waste disposal areas following heavy rainfall events • Conduct site inspections on water quality controls as per the site inspection schedule
Corrective actions and contingencies	• Implement changes to the leachate management system if required • Raise concerns at toolbox talks / staff meetings • Report non compliances of EPL to NT EPA
Responsibility	Site Manager

5.7 Dust and odour

Table 5-8 describes the complaints management system in place at SBWMF for dust and odour management, and details mitigation measures in place to reduce the occurrence of dust, odour and aesthetic nuisances to the surrounding properties and SBWMF users.

Table 5-8. Dust, odour and aesthetics management

Objective / outcome	• To minimise dust and odour nuisance to SBWMF users, employees and surrounding properties • To minimise dust impacts to the surrounding environment
Mitigation / Control	• Dust suppression through the use of a water cart/truck will be undertaken when necessary • Speed limits on site will be enforced to reduce the amount of dust • Progressive revegetation of disturbed areas will be undertaken to reduce generation of dust • Appropriate use of daily cover to minimise odour from the tip face • Immediate cover of odorous wastes, such as animal effluent and residues • Transfer station skip bins will be emptied when full and at least at the close of each working day • Skip bins used at the transfer station are to be cleaned at least monthly to prevent build-up of odours • Wastes that cause odour are to be covered immediately
Target / performance criteria	• No complaints received from SBWMF users, employees and surrounding land owners/users relating to dust or odour.
Monitoring	• Regular inspections of tip face throughout the day to manage odour or windblown waste • Daily site inspection to include visual checks of cleanliness and tidiness • Visual monitoring for excessive dust generation
Corrective actions and contingencies	• Training of staff regarding dust suppression, tidiness and cleanliness • Training staff in complaints handling • Raise concerns at toolbox talks / staff meetings • All complaints received will be logged in a complaints register • All complaints shall be responded to within 48 hours, with documentation added to the complaints register
Responsibility	Site Manager

5.8 Landfill gas

5.8.1 Management

Landfill gas is managed as per Table 5-9 to reduce the risks of landfill gas (LFG) emissions from SBWMF.

Table 5-9. Landfill gas management

Objective / outcome	To minimise the fugitive loss of greenhouse gas (methane) emissions to atmosphere
Mitigation / Control	- A LFG collection system is installed on site - Ensure regular maintenance of gas infrastructure including raising of gas wells in line with current fill plans
Target / performance criteria	No significant loss of greenhouse gas (methane) emissions to atmosphere
Monitoring	- Undertake LFG monitoring as per monitoring schedule - Conduct inspections on gas infrastructure to identify any leaks or defects
Corrective actions and contingencies	- Rectify any leaks or defects in the system immediately - Consider installation of additional wells if there is sufficient capacity
Responsibility	Site Manager

5.8.2 Monitoring

Monitoring of LFG shall occur at both a surface and sub-surface level. Surface monitoring will detect any emissions through the cover/capping material whilst sub-surface monitoring will detect any migration of LFG off-site through monitoring bores. Monitoring for LFG also needs to be undertaken within any pits, enclosed spaces, buildings or structures on-site to detect any potentially harmful accumulation of gas. Table 5-10 details the LFG monitoring schedule, whilst Figure 5-5 shows the location of LFG monitoring sites.

Table 5-10. LFG monitoring schedule

Aspect	Surface LFG	Sub-surface LFG	Pits/Buildings
Parameters measured	- CH₄ - Wind speed - Observations for cracks, odours, stressed vegetation or cap penetrations	- Peak CH₄ and CO₂ - Minimum O₂ - Stabilised CH₄, CO₂ and O₂ - Balance, flow rate, atmosphere pressure, relative pressure - Integrity including signs of corrosion	- CH₄ - Integrity including signs of corrosion
Locations	Two transects at 90° to each other over areas of interim and final capping: 25 m transects for interim cap 50 m transects for final cap	As shown on Figure 5-5	As shown on Figure 5-5
Frequency	Quarterly over interim capped areas Biannually over final capped areas	Quarterly	Quarterly

Aspect	Surface LFG	Sub-surface LFG	Pits/Buildings
	Biannually for Stage 1 & 2 for 2 years, then annually		
Trigger criteria	CH ₄ in air (50 mm above landfill surface) >100 ppm	CH ₄ >1.0 % v/v, or CO ₂ above background >1.5% v/v	Pits and enclosed spaces CH ₄ >10,000 ppm Buildings and structures CH ₄ >5,000 ppm

All gas monitoring will be conducted in accordance with the *Landfill Gas Fugitive Emissions Monitoring Guidelines* (VIC EPA 2018) and will be undertaken by a qualified person. The frequency of monitoring will be reviewed following three years of monitoring and the identification of seasonal trends. In the event that LFG conditions are stable or report a decreasing trend, the frequency may be reduced.



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Figure 5-5. LFG monitoring sites

5.9 Noise

Table 5-11 describes the complaints management system in place at SBWMF for noise management, and details mitigation measures in place to reduce the occurrence of noise nuisances to the surrounding properties and SBWMF users.

Table 5-11. Noise management

Objective / outcome	- To minimise noise nuisance to SBWMF users, employees and surrounding properties - To minimise noise impacts to the surrounding environment
Mitigation / Control	- Maintain all equipment and machinery to manufacturers standards - Conduct all operations during standard work hours
Target / performance criteria	No complaints received from SBWMF users, employees and surrounding land owners/users relating to noise
Monitoring	- If noise outside of what is considered normal operational noise is to occur, notification and details will be given to the public and surrounding land owners via newspapers and letter drops - Noise monitoring will be undertaken in the event of a complaint
Corrective actions and contingencies	- Train staff in complaints handling - Raise concerns at toolbox talks / staff meetings - All complaints received will be logged in a complaints register - All complaints shall be responded to within 48 hours, with documentation added to the complaints register
Responsibility	Site Manager

5.10 Litter

Table 5-12 describes the complaints management system in place at SBWMF for litter management, and details mitigation measures in place to reduce the occurrence of litter nuisances to the surrounding properties.

Table 5-12. Litter management

Objective / outcome	- To ensure no litter nuisance to SBWMF users, employees and surrounding land owners/users - To minimise litter impacts to the surrounding environment
Mitigation / Control	- Litter will be regularly cleaned up and disposed of appropriately by SBWMF staff - The perimeter fence is designed to reduce wind-blown litter leaving the SBWMF. This fence will be maintained. - Additional litter fencing should be installed around active tip faces where required.
Target / performance criteria	No complaints received from SBWMF users, employees and surrounding land owners/users relating to litter
Monitoring	- Daily site inspections to include a visual check for litter - Monthly formal site inspection including inspection of litter and litter controls
Corrective actions and contingencies	- Training staff in complaints handling - Raise concerns at toolbox talks / staff meetings - All complaints received will be logged in a complaints register

	All complaints shall be responded to within 48 hours, with documentation added to the complaints register
Responsibility	Site Manager

5.11 Flora and fauna

Table 5-13 details the management and mitigation measures to reduce the risks to flora and fauna.

Table 5-13. Flora and fauna management

Objective / outcome	To minimise impacts on flora and fauna at SBWMF and in the surrounding environment
Mitigation / Control	- All clearing at SBWMF will have the required approvals undertaken by CoD - Any sightings of threatened fauna species are to be reported to the Site Manager to determine whether the animal is at risk and requires relocation - Report any injured fauna to the Site Manager - No pets / domestic animals allowed to be brought onto SBWMF - Speed limits will be enforced to minimise potential for fauna impact - Disturbed areas will be progressively rehabilitated, and done so with species local to the surrounding environment - Perimeter fencing around the landfill site to prevent large fauna entering the site
Target / performance criteria	- No significant impacts to flora and fauna - No injured fauna as a result of SBWMF activities - Disturbed areas progressively rehabilitated with local native species, and achieving a minimum 80% groundcover within the first year
Monitoring	- Monthly site inspections to check for signs of impacted flora and fauna - Monitoring of rehabilitation areas will be undertaken to ensure it is to an acceptable standard (i.e. a minimum 80% groundcover within the first year)
Corrective actions and contingencies	- Training of staff regarding potentially significant fauna on site - Ensure clear signage of speed limits for users of SBWMF - Raise concerns at toolbox talks or staff meetings - Further rehabilitation works if found to be to in-effective
Responsibility	Site Manager

5.12 Pests and weeds

Table 5-14 details mitigation measures to reduce the likelihood of infestations, introduction and spread of pests and weeds.

Table 5-14. Pest and weed management

Objective / outcome	- To reduce the likelihood of weed infestations at SBWMF - To reduce the spread of weeds at SBWMF - To minimise the numbers of feral / pest species and mosquitos at SBWMF
Mitigation / Control	- Declared weeds are not to be disposed of at SBWMF without prior approval from CoD and the NT EPA - Weed management to be undertaken in accordance with the <i>NT Weed Management Handbook</i> depending on weeds present - Regular pest control activities to be undertaken at SBWMF, including use of

	bait stations etc. - Where an infestation has been identified, a qualified, licensed pest control contractor will be called in to control the infestation - Boundary fence to be regularly inspected and maintained to prevent access to animals - The pooling of water will be prevented where possible, to decrease the breeding grounds for mosquitos
Target / performance criteria	- No declared weeds or introduction of noxious weeds at SBWMF - No spread of weeds from SBWMF to surrounding environment - No introduction of feral / pest species at SBWMF - No feral / pest / vector infestations at SBWMF
Monitoring	- A weed survey is to be undertaken at least annually - Monthly site inspection to check for presence of pests and weeds in operational areas
Corrective actions and contingencies	- Seek advice from the NT Weeds Management Branch if required - Seek advice from the NT Department of Health if mosquito eradication is required - Implement more rigorous monitoring routines for pests and weeds as required - Ensure clear signage for SBWMF users so they know what declared weeds are - Training for staff regarding weed identification and management of weeds at SBWMF - Raise concerns at toolbox talks or staff meetings
Responsibility	Site Manager

5.13 Fire prevention

Fire prevention management is detailed in Table 5-15 which includes mitigation measures relating to risks such as fires within the landfill and bushfires.

Table 5-15. Fire prevention management

Objective / outcome	To minimise the risk of fire from and to the landfill
Mitigation / Control	- Appropriate management of waste disposal into landfill cells to ensure no hot loads or smoking loads - Ensure a clean and tidy operations area to minimise ignition sources - Appropriate hot works procedures – no hot works undertaken during fire bans or near flammable materials - Maintain fire-fighting equipment including extinguishers in date and accessible water cart. - Smoking only to occur in designated smoking areas - Maintain a 4 m wide fire break around the perimeter of the SBWMF, around buildings and operational areas
Target / performance criteria	- Fire risk from and to the SBWMF is reduced - No fires started at SBWMF
Monitoring	- Visual monitoring of loads going to landfill cells for evidence of smoking or hot loads - Site inspections to include checks for firefighting equipment and fire risks such as site tidiness, appropriate hot works permits etc.
Corrective actions and contingencies	- Training for staff regarding fire risks and emergency response plan - Raise concerns at toolbox talks or staff meetings
Responsibility	Site Manager

6 LISTED WASTE MANAGEMENT

6.1 Listed waste objectives and targets

The objectives, targets and performance measures for listed waste management at SBWMF are detailed in Table 6-1.

Table 6-1. Listed waste management objectives, targets and performance measures

Objectives	Targets	Performance Measures
- To ensure no environmental harm occurs as a result of waste disposal - To prevent contamination of surface water and groundwater - To ensure no spills of hazardous substances occur - To foster re-use / recycling of listed wastes, where possible	- No significant impacts or environmental harm has occurred - No incident in breach of the EPL conditions causing environmental harm - Re-use / recycling of listed wastes, where possible	- All wastes disposed of in accordance with the conditions of the EPL and good industry practice - Listed waste handling and spill response undertaken in accordance with relevant procedures - Transfer of listed wastes with potential for re-use / recycling

6.2 Listed waste tracking

Records of all listed waste being stored or disposed of on-site shall be maintained, and include the following details:

- The date of collection
- The source of the listed waste
- The name of the transport company, if not the licensee
- Vehicle registration
- Listed waste type
- Quantity of listed waste
- Whether the listed waste was stored, treated, recycled or disposed of
- Final destination of the listed waste.

Where domestic users are disposing of listed wastes to the transfer station (i.e. batteries, waste oil, tyres), waste volumes will be tracked when removed from site for recycling or disposal. The records will be reconciled and reported on annually through the EPL Annual Return.

6.3 Listed waste management measures

The acceptance criteria, storage, disposal, monitoring, corrective actions and reporting requirements for each listed waste product handled on-site is detailed in Table 6-2 to Table 6-7 below.

Table 6-2. Special waste management

Category	Management measure	Frequency
Special waste acceptance	The following listed wastes for disposal to landfill must be pre-arranged and approved through completion of a <i>Special Waste disposal application</i>:	Per load

	- o Animal effluent and residue (including animal carcasses) - o Clinical and related wastes - o Sewerage sludge and residues including nightsoil and septic tank sludge	
Special waste disposal	• All approved special waste loads are to be disposed of in a pre-prepared pit excavated within the active tip face. • The waste is to be immediately covered with waste material upon disposal.	Per load
Monitoring	• Inspection of the tip face for correct disposal.	As required
	• Inspection of other tip areas to detect any illegal dumping of special wastes.	Daily
Corrective Actions	• Rectification of any incorrect special waste disposal. • Raising community awareness as required.	As required
Reporting	• Listed waste volumes to be reported in the EPL Annual Return. • Incident reports completed and filed, including any necessary incident notification.	As required

Table 6-3. Contaminated soil management

Category	Management measure	Frequency
Contaminated soil acceptance	• Contaminated soil for disposal to landfill must be pre-arranged and approved through completion of a <i>Soil disposal application</i>. • The soil originating location and potential contaminants of concern considered and sampling results requested as required. • Soil results are assessed against relevant guidelines to determine acceptance.	Per load
Contaminated soil disposal	• All soil loads declared as contaminated are to be disposed of in a pre-prepared pit excavated within the active tip face. • The waste is to be immediately covered with waste material upon disposal.	Per load
Monitoring	• Inspection of the tip face for correct disposal.	As required
	• Inspection of other tip areas to detect any illegal dumping of soil material.	Daily
Corrective Actions	• Rectification of any incorrect soil disposal. • Raising community awareness as required.	As required
Reporting	• Listed waste volumes to be reported in the EPL Annual Return. • Incident reports completed and filed, including any necessary incident notification.	As required

Table 6-4. Asbestos and asbestos containing material management

Category	Management measure	Frequency
Asbestos acceptance	• All asbestos loads for disposal must be pre-arranged through completion of an <i>Asbestos disposal application</i>. • Approved loads are given a booking time for disposal in order to adequately prepare the disposal area and coordinate loads for maximum use and efficiency of the asbestos cell. • Check compliance of asbestos loads with the <i>National Occupational Health and Safety Commissions Asbestos Code of Practice and Guidance Notes</i>.	Per load

Asbestos disposal	- Only correctly wrapped asbestos will be accepted at the SBWMF for disposal - in accordance with Section 4.8 of the <i>NT Worksafe and Safe Work Australia How to Safely Remove Asbestos Code of Practice</i>. - Deposited asbestos waste at the asbestos cell area must immediately be covered by suitable material to prevent the release of fibres into the air. - Final cover of the asbestos shall be to a minimum thickness of 3 m in the case of asbestos fibre and dust wastes, and 1 m in the case of stabilised asbestos wastes in a bonded matrix. - Final cover of the asbestos is to incorporate orange marker mesh identifying that asbestos is buried below to the depth required as above. - GPS location and total volume of disposed waste, for each asbestos disposal, will be recorded and maintained in the listed waste tracking register.	Per load
Monitoring	• Inspection of the asbestos cell for correct disposal.	As required
	• Inspection of other tip areas to detect any illegal dumping of asbestos material.	Daily
Corrective Actions	- The licenced waste transporter responsible for any incorrect asbestos disposal is contacted to rectify and place the asbestos in the correct location. - Additional training for staff involved in asbestos acceptance and disposal. - Increased signage	As required
	• Raising community awareness if required.	Regular basis
Reporting	- Listed waste volumes to be reported in the EPL Annual Return. - Incident reports completed and filed, including any necessary incident notification.	As required

Table 6-5. Battery and paint management

Category	Management measure	Frequency
Battery & paint acceptance	• Batteries and paint products only accepted from residential users (i.e. no commercial quantities)	Per load
Battery & paint storage	• Batteries and paint products are to be stored on bunded pallets at the transfer station and protected from rainfall ingress	Per load
Battery & paint disposal	- Batteries and paint products to be removed from site by a licenced waste transporter, for recycling/disposal at an appropriately licenced facility. - Empty, dry and clean paint tins may be disposed of in the scrap metal skip after inspection.	As required
Monitoring	• Inspection of transfer station disposal area for correct disposal.	Daily
Corrective Actions	- Rectification of any incorrect waste disposal. - Increased signage or community awareness if required.	As required
Reporting	- Listed waste volumes to be reported in the EPL Annual Return - Incident reports completed and filed, including any necessary incident notification.	As required

Table 6-6. Waste tyre management

Category	Management measure	Frequency
Tyre acceptance	- SBWMF accepts both whole and shredded tyres - All tyres for disposal are presented to the weighbridge and relevant charges applied for both domestic and commercial users.	Per load
Tyre disposal	When landfilling tyres, tyres shall be spread amongst the tip face to minimise movement.	Per load
Monitoring	Visual inspection of the tyre storage area to identify any ponding water, appropriate fire breaks, appropriate stacking of tyres, etc.	As required
Corrective Actions	- Rectification of any incorrect tyre disposal. - Increased signage or community awareness if required.	Per event
Reporting	- Listed waste volumes to be reported in the EPL Annual Return. - Incident reports completed and filed, including any necessary incident notification.	As required

Table 6-7. Waste oil management

Category	Management measure	Frequency
Waste oil acceptance	Domestic volumes of waste mineral oil or cooking oil accepted only.	Per load
Waste oil storage	- Storage of fuels and oils must be to Australian Standard 1940-2004 The storage and handling of flammable and combustible liquids (AS 1940), including within a bunded and impervious area. - Any leaks of hazardous materials or chemicals will be treated in accordance with emergency response procedures. - In the event of an oil / fuel spill, the Site Manager will be notified and all persons directed away from the spill area. If safe to do so, contain the spill to prevent further spill from occurring. - If the spill is too large or hazardous to control safely, the fire brigade will be notified by the Supervisor and the appropriate safety precautions taken as deemed necessary (i.e. evacuation). When the fire brigade arrives, the Supervisor will surrender control of the site to the officer on duty. - Disposing of absorbent material used in any clean up shall be done in an appropriate manner with consideration given to any hazardous substances or dangerous goods. - Spill kits and response equipment will be available near the storage areas.	As required
Waste oil disposal	Waste oil to be removed from site by a licenced waste transporter, for recycling/disposal at an appropriately licenced facility.	As required
Monitoring	Inspection of waste oil tank and disposal area for correct disposal, and signs of any leaks or spills.	Daily
Corrective Actions	- Rectification of any incorrect waste oil disposal. - Implement appropriate spill clean-up measures. - Increased signage or community awareness if required.	As required
Reporting	- Listed waste volumes to be reported in the EPL Annual Return. - Incident reports completed and filed, including any necessary incident notification.	As required

7 COMMUNICATION AND CONSULTATION

7.1 Inductions and training

All project personnel, subcontractors and consultants will be required to undertake a site induction which will, as a minimum, address the following environmental topics:

- Details of the EPL and conditions and consequences of non-compliance with the EPL;
- The significant environmental risks and details of this EMP;
- Location of significant environmental sensitive areas; and
- Incident management procedures (e.g. the action to be taken in emergencies, communication lines and contact details for emergency services and site representatives).

Personnel performing tasks that can cause significant environmental impacts shall be competent on the basis of appropriate education, training and/or experience. Training related to emergency response is outlined in Section 9.5.

7.2 Stakeholders

The key stakeholders of the landfill facility include:

- Commonwealth Department of Defence;
- Northern Territory Environmental Protection Agency;
- Northern Territory Government agencies / departments;
- SBWMF operations contractor;
- Adjacent properties to landfill site;
- Local environmental / conservation groups;
- Local community organisations;
- Local indigenous parties / groups;
- Domestic and commercial users; and
- Darwin community / public.

7.3 Communication and consultation

Communication and consultation will be undertaken in accordance with the SBWMF Communication and Consultation Procedure and this EMP.

7.3.1 Internal communication

Activities, changes or incidents relevant to SBWMF will be communicated to staff through different means such as meetings, toolbox talks, emails and flyers. Site specific environmental information and lessons learnt will be disseminated through to site based teams through the use of pre-start messages and toolbox talks to ensure all parties are kept informed.

7.3.2 Awareness

Ongoing environmental awareness will be maintained through the use of visual aids and signage so as to be visible to the general public and users of SBWMF. The CoD website will be maintained with current and relevant information on the facility. Information may also be disseminated through CoD social media pages and media releases.

7.3.3 Community consultation

In accordance with the CoD's Community Consultation Policy (Policy No 025), CoD has a standing commitment to effectively consult with the community through communication, awareness, participation and inclusion. CoD is committed to open, accountable and responsive decision making, which is informed by effective communication and consultation between CoD and the community. The Community Consultation Policy specifies three levels designated to suit all consultation requirements, ranging from the most basic public notification, to seeking input on an issue or communitywide significance.

Should a change arise at the SBWMF that involves community consultation, prescribed statutory requirements and the Community Consultation Policy will be followed. The Community Consultation Policy is available for public viewing on the CoD website or in hard copy at the Civic Centre customer service desk.

7.3.4 External stakeholders

Where a site activity or issue is of concern or interest to any external stakeholders such as regulatory authorities or the land owner, the respective parties will be notified by verbal or written communication as deemed appropriate by CoD or as detailed in the EPL. Any communications with external stakeholders will be documented and recorded in a communication / consultation register detailing contact details, time / date, location, any issues raised, responses given and actions (who, what, when and how), each issue will be addressed.

7.4 Complaint management

Complaints handling will be undertaken in accordance with the CoD's Complaints Handling and Review of Decisions Policy (Policy No 026). Complaints may be made in person, in writing, by telephone, by facsimile transmission or by email. Complaints may be lodged directly to CoD, to an Elected Member, or through the Ombudsman, Commissioner for Public Disclosure or other external agency.

A complaints and enquiry handling system will be implemented and managed through CoD's electronic document register. This will require the following records to be kept:

- Date, time and nature of the complaint or inquiry;
- Type of communication (telephone, letter, meeting etc.);
- Name, address, contact number;
- Nature of complaint; and
- Response details.

All complaints shall be treated as an environmental incident and logged in a complaints register including details of the complaint, issue and time / date. Verification of the incident shall be reviewed and if justified an action to address the issue assigned. All complaints shall be responded to within 48 hours, with documentation added to the register.

Following a complaint, ensure all employees and sub-contractors are aware of the potential environmental nuisance issues and controls through inductions, toolbox and pre-start meetings

8 AUDITS AND REPORTING

8.1 Audits

CoD will commission an audit to be conducted by an independent and suitably qualified person on an annual basis to evaluate the extent to which compliance has been achieved with this EMP, the EPL, the *WMPC Act* and the *Water Act*. A written report must be prepared and signed by the qualified person who conducted the audit. The written report must be provided in full to the NT EPA within five business days of being signed.

8.2 Non-conformance and corrective actions

Any non-conformance, corrective or preventative actions identified during an inspection or audit will be recorded in an action register and issued to the relevant party for rectification. The action register will detail the non-conformance, identified actions, responsible persons and due date for completion.

Any non-compliance with the EPL will be managed as an incident and any corrective or preventative actions will be detailed in the action register.

8.3 Incident management

All environmental incidents, near-misses or EPL non-compliances must be reported to CoD as soon as practicable. Reports can be made verbally but must be followed up in writing using the approved Incident Reporting Form.

Incident reports must have the following information, including the:

- Date, time and circumstance under which the incident became known;
- Known or estimated dates and times at which the incident commenced and ended;
- Details of the person initially reporting the incident;
- Actual and potential causes and contributing factors to the incident;
- Risk of environmental harm arising from the incident;
- Action(s) that have or will be undertaken to mitigate any environmental harm;
- Corrective actions that have or will be undertaken to prevent a reoccurrence; and
- If no action was taken, why no action was taken.

A record of all environmental incidents, near-misses and EPL non-compliances will be maintained in an environmental incident register.

8.4 Reporting

CoD will ensure all non-compliances with the EPL are reported to the NT EPA, as soon as practicable after (and in any case within 24 hours after) first becoming aware of the non-compliance.

CoD will prepare and submit an Annual Return to the NT EPA, outlining compliance with the EPL conditions in the preceding 12-month period. The Annual Return will be submitted within 10 business days after the EPL commencement date anniversary each year.

CoD will prepare and submit an annual Monitoring Report to the NT EPA, outlining the results of monitoring over the preceding 12-month period and will be submitted within 20 business days after the EPL commencement date anniversary each year. In accordance with the EPL, the Monitoring Report must include a data analysis and interpretation as well an assessment of environmental impact.

8.5 Reviews

The EMP will be reviewed every 12-months to ensure that it adequately addresses the identified issues and the activities being undertaken during the operation of SBWMF.

The review will consider as a minimum of:

- NT EPA comments or recommendations;
- Audit findings;
- Environmental monitoring outcomes;
- Incidents and non-conformances;
- Changes in organisational structure and responsibilities; and
- Changes in standards and legislation.

8.6 Document control

CoD is required by the *Information Act* to ensure that complete and accurate records of the business of CoD are created and managed for as long as required to support business, accountability and legislative requirements until their disposal in accordance with an authorised retention and disposal schedule. This requirement is outlined in CoD's Record and Information Management Policy (Policy No 057), which applies to all CoD staff and to records of all business activities performed by or on behalf of CoD.

All environmental documentation, plans, procedures, reports, data and records will be uploaded onto the CoD electronic document and records management system. Records of quantities and source of waste, including listed waste, received at SBWMF will be maintained through CoD's electronic weighbridge reporting system.

All records will be held for at least 10-years and will be accessible to the regulatory authorities as required.

9 EMERGENCY RESPONSE PLAN

Emergency response planning includes responses to environmental emergencies, and operational actions that cause an environmental incident. This Emergency Response Plan (ERP) outlines the environmental emergency risks, emergency preparedness, mitigation and reporting requirements specifically relating to environmental incidents for SBWMF.

9.1 Emergency incidents

Emergency incidents that may occur at SBWMF include:

- **Extreme weather event** (i.e. cyclone) resulting in damage to facilities, and/or flooding that leads to uncontrolled discharges to the surrounding properties
- **Lightning strike** that may disrupt power sources and impact on operations
- **Fuel, chemical or leachate spill** that may contaminate water or soils
- **Fire** as a result of bushfire or accidental fire as a result of operations.

9.2 Emergency contacts

The Site Manager is the contact person for all emergencies and environmental incidents. All incidents which cause or have the potential to cause material or serious environmental harm, will be reported to NT EPA as soon as the Site Manager becomes aware of the incident, or in any case within 24 hours as required under Section 14 of the *NT Waste Management and Pollution Control Act*.

The details of the designated contact persons responsible for on-site environmental management are included in Table 9-1. Also included are emergency contacts for reporting pollution incidents (including non-urgent problems such as dust/noise) and contacts for provision of advice.

Table 9-1. Emergency contact details

Contact	Details
Team Leader Waste	City of Darwin Ph: 08 8930 0300 E: darwin@darwin.nt.gov.au
Site Manager SBWMF	Nick Walker Veolia Ph: 08 8947 8947
NT EPA Pollution Hotline / Pollution Reporting	GPO Box 3675, Darwin NT, 0801 Pollution Hotline: 1800 064 567 pollution@nt.gov.au
Emergency Services (police, fire, ambulance)	000
NT Police (non-emergency)	131 444

Environmental conditions are monitored by the Site Manager through the Bureau of Meteorology website, NT Police, Fire and Emergency Services announcements, media and local radio emergency.

9.3 Objectives, targets and indicators of the ERP

The objectives, targets and indicators of this ERP are summarised in Table 9-2.

Table 9-2. Emergency objectives, targets and indicators summary

Objectives	Targets	Indicators
Protect people, property and the environment	No incidents of harm to people, property or the environment from activities associated with an environmental emergency	Number of incidents recorded
Identify potential environmental emergency risks	All risks identified and management controls are in place	Audits and inspection findings
Identify and implement management and mitigation controls to reduce the residual risk		
Ensure emergency response equipment requirements are able to be identified and are available	- All risks are identified and management controls are in place. - Emergency response scenarios have been identified	Audits and inspection findings
Ensure a high level of preparedness is maintained		
Facilitate efficient response to emergencies to limit the impacts to the environment		
Ensure emergency response training is relevant for the types of emergencies that SBWMF may experience	Training for all employees	Training records

9.4 Emergency response procedures

9.4.1 General emergency preparedness

SBWMF commit to continuous emergency preparedness through the following actions:

- Ensure that all personnel, including management, have received a site induction that specifically covers emergency response procedures
- The Site Manager will regularly liaise with staff to ensure that they are competent in responding to emergencies
- Conduct regular inspections on all emergency response equipment and ensure that all equipment is in good working order
- Following an emergency event, undertake an incident debrief and provide all staff with training into improved emergency response procedures or actions.

When advice is issued by authorities (e.g. cyclone watch, cyclone warning, evacuation order), the Site Manager will ensure that the following steps will be undertaken:

- All employees and contractors will report to the designated evacuation point (front gate), and receive further instructions regarding preparations for the emergency or evacuation.
- Where there is sufficient preparation time (i.e. in the event of a cyclone watch issued by the Bureau of Meteorology),
 - o All essential vehicles will be fuelled, if required to evacuate employees, and non-essential vehicles will be parked and secured.
 - o All potentially mobile items will be secured, tied down and/or stored and locked in the site buildings.

9.4.2 Fire

There are many different situations on-site where fire may result, such as landfill fire, fire in a waste haulage vehicle, office/building fire, transfer station fire, plant and equipment fire or bushfire.

In response to discovery of a fire, the following general steps must be undertaken:

- Notify the Site Manager immediately, with the location, type of fire, and details of any potential injuries or hazards. If necessary, the Site Manager will notify emergency services.
- Any plant or equipment in the vicinity of the fire should be moved to a suitable location or shutdown if safe to do so
- If evacuation of the site is necessary, all employees and contractors will report to the designated evacuation point, and receive further instructions regarding the emergency or evacuation.
- The affected area is not to be re-entered until the Site Manager deems the area safe
- All fire-fighting water is to be treated as leachate and must be managed accordingly.

Landfill fire

- Landfill fires can be managed by attempting to smother the fire with inert soil or similar material, or using a water cart
- Power supply and gas lines should be switched off only if there is ensuing risk.

Fire in waste haulage vehicle

- In the event of fire within a waste haulage vehicle, the vehicle must stop on a hardstand, vegetation free area (where possible and safe to do so) where the load can be extinguished (i.e. wash-down bay).
- If possible, the driver should exit the vehicle and remain at a safe distance whilst the fire is being extinguished by water or smothering

9.4.3 Spills

In the case of any spills the following procedure is to be implemented:

- Locate the source to identify volume and type of spill
- Assess the risk to workers and environment to ensure appropriate PPE and measures to be implemented
- Control and contain the spill by isolating or removing source
- Clean the spill using spill kit and absorbent material or installing bunds

- Appropriate disposal of any material that was used to control and clean up the spill
- Repair any damaged plant or infrastructure associated with the spill
- Report significant spills or spills that have entered stormwater to NT EPA Pollution Hotline (1800 064 567).

Spill containment equipment kits will be available in works areas. All personnel on site will be trained in how to use these spill kits.

9.4.4 Leachate breakouts

In the event of a leachate breakout from the landfill, storage or treatment area the following measures are to be undertaken:

- Undertake measures to protect downstream receiving waters (e.g. block drainage lines)
- Isolate the area with appropriate bunding and remove excess leachate i.e. pump to storage ponds, recirculate through lined landfill cell or pump to an emergency leachate storage
- Excavate the breakout area (if within landfill) to remove any obstructions and encourage downward flow of leachate towards liner
- Re-compact waste layer and apply intermediate cover or capping as required
- Excavate any contaminated material from surface as a result of breakout and dispose of within the landfill cell.

9.4.5 Storm surge or flooding

In the event of a storm surge or forecast high rainfall event that may lead to some localised flooding, the following response measures shall be implemented:

- Move machinery, equipment and any fuel or chemical stores to high ground
- Ensure instruments or equipment that are to remain in-situ are well secured
- Switch off electric power to any low-lying appliances
- Empty any stormwater or sediment ponds to ensure sufficient capacity to attenuate stormwater flows
- Check all flow paths including open drains, ponds and culverts
- Confirm availability of pumping equipment for any potential dewatering
- Ensure appropriate cover over active waste management areas.

Following a flooding event, the following clean-up measures shall be undertaken:

- Inspect the landfill for instability and leachate breakouts
- Isolate any water that could be contaminated
- Inspect the site for any breaches of ponds or drains
- Clear any debris from drainage lines or structures that may have collected.

9.4.6 Environmental incidents

In accordance with the conditions of the EPL, the NT EPA will be notified in the event of an incident causing or with the potential to cause environmental harm, including but not limited to the following:

- Fire
- Spills involving waste/leachate which can result in environmental harm
- Release of potentially contaminated leachate or stormwater to receiving environment

- Exceedance of monitoring parameters
- Incidents which may have public health consequences or cause nuisance.

Environmental incidents can also occur as a result of illegal waste being delivered to the landfill. This can occur where the illegal waste is not discovered at the weighbridge because it is mixed in with other waste material. Where an employee becomes aware of such an incident, the Site Manager must be notified and the waste identified.

The Site Manager will be responsible for seeking advice on how to manage the situation.

9.4.7 Medical emergencies

In the event of a medical emergency, where possible the First Aid Officer will administer assistance to their level of training and competence. Where required, emergency services will be contacted immediately.

9.5 Emergency Training

All employees must be trained in the contents of this ERP, including the location of the designated evacuation point, emergency contact details and incident notification during the induction process.

Specific training will be provided for appropriate persons in the following:

- First Aid
- Spill response
- Evacuation drill
- Fire extinguishers
- Any other training identified for the purposes of emergency response.

An annual emergency drill shall be undertaken to evaluate compliance with this ERP and identify areas for further training or updates to the ERP as required.

9.6 Equipment

All emergency response equipment will be serviced and maintained in accordance with relevant Australian Standards and/or manufacturer's instructions.

Regular training will be carried out to ensure that designated/appropriate employees can operate the equipment as required.

The equipment will include as a minimum:

- Fire extinguishers, appropriate to materials on site
- Fire hose, pump and water tank
- Operational machinery such as loader and water cart
- Appropriate spill kits and clean-up material.

10 CLOSURE

10.1 Closure objectives

The main closure and rehabilitation objectives for SBWMF include:

- Final landform designed and rehabilitated to ensure structural stability, revegetation success and containment of wastes
- Final landform is maintained in a manner that minimises leachate generation
- Final landform is safe and non-polluting
- Rehabilitation aspects are conducive to post-closure land use and are compatible with surrounding and future land uses.

10.2 Closure considerations

Prior to closure of the SBWMF, appropriate environmental management strategies are required to be established and operational in order to manage any potential environmental risks once operations cease. Such management strategies include:

- An established and functioning leachate collection and treatment system with the capacity to manage the predicted volumes of leachate to be generated during the post-closure period
- Stormwater management infrastructure with erosion and sediment considerations to appropriately manage site runoff water
- A groundwater monitoring network to identify any potential risks to groundwater during the post-closure period
- A landfill gas extraction and management system capable of managing the predicted gas generation during the post-closure period
- Designated site access points to allow for ongoing maintenance and monitoring throughout the post-closure period
- The removal of redundant facilities and infrastructure i.e. buildings, laydowns, storage areas.

10.3 Final landform

The final landform will reach a maximum elevation of 70 m AHD with external batter gradients of 3W:1H pre-settlement (see Figure 10-1). Post-closure, waste settlement can result in a reduction of total waste thickness of up to 25%. The final landform post settlement is expected to result in a final elevation of 54.90 m AHD and batter slopes closer to 4W:1H (see Figure 10-2).

10.4 Capping

A final capping layer is required over the landfill to ensure the final surface provides an appropriate barrier to water infiltration, controls emissions to water and air, promotes sound land management and conservation, prevents hazards and protects amenity (NT EPA, 2013). Progressive capping of the final landform is to occur as per the LDP, whilst the facility remains operational (see Figure 10-3). This staged approach is recommended to reduce long-term leachate generation rates.

A detailed capping design is being undertaken; however, the final capping system proposed for SBWMF includes the following layers (Golder 2016b):

- Revegetation layer (approximately 1 m thick) including top soil to suit root depths of proposed revegetation species.
- Geocomposite drainage layer – this is a geosynthetic drainage layer encased in a filtration geotextile, with typical thickness in the order of 30 mm. This is thinner than the 0.3 m thick drainage layer of sandy soil or gravel indicated in the NT EPA Guidelines. Detailed design will need to consider anticipated flow rates for selection of an appropriately sized geocomposite drainage material.
- Liner low density polyethylene (LLDPE) geomembrane – LLDPE materials have higher strain tolerance compared to high density polyethylene (HDPE) geomembrane materials; LLDPE materials are considered favourable for geomembrane liners in landfill caps due to their capacity to withstand differential settlement of the underlying waste. The NT EPA Guidelines also include a geomembrane layer.
- Geosynthetic clay liner (GCL). Detailed design should consider whether a GCL is required underneath the geomembrane to achieve the NT EPA Guideline requirement that final capping be designed such that infiltration through the cap does not exceed the calculated seepage rate through the landfill liner. If a GCL is required, there may be value in considering a combined coated product to replace the geomembrane that provides protection against wetting and drying cycles and root penetration.
- Gas collection system. Detailed design should consider inclusion of a gas collection system incorporating passive gas relief strips (e.g. geocomposite drainage material) underneath the geosynthetic liner elements, connected to gas vents. This system would be intended to provide a means of passive gas management to be used when active gas collection is no longer commercially viable.
- Intermediate cover layer (300 mm).

10.5 Revegetation

Revegetation will be undertaken progressively as the final capping layer is completed for each cell. The purpose of the vegetation is to establish quickly and provide a long-term vegetative cover to improve resistance to erosion. The vegetation must be shallow rooted to maintain the cover system.

Prior to direct seeding, weed control will be undertaken (if necessary) and the topsoil will be ripped along contours to a depth of at least 500mm to reduce erosion and improve vegetation recruitment. Native vegetation will then be established via hydroseeding. The seed mix will comprise of native grass species that occur in region. However, because the end landform is steeply sloped – in contrast to the surrounding landforms – further investigation is required to identify suitable native grasses which can grow on a slope and are compatible with the characteristics of the topsoil that is being used. Use of supplementary tubestock may be required. Active, ongoing management of the landfill site will necessary to ensure adequate groundcover and to avoid colonisation by native or introduced plant species with deep roots.

Where the final capped cell has alternative uses identified (i.e. treated leachate irrigation), revegetation will include tubestock planting of specific plants for the intended use – e.g. vetiver grass. In other areas of rehabilitation (i.e. decommissioned and removed facilities), a combination of seeding, planting and natural regeneration will be used to reflect the surrounding undisturbed vegetation areas.

10.6 Final land use

There is currently no proposed future land use for the SBWMF site. The site will be rehabilitated and revegetated to a condition reflective of the surrounding areas. As the site is leased, the land will be returned to the Commonwealth Government in an acceptable condition agreed by all parties.

10.7 Landfill gas

During operations, landfill gas collection and treatment infrastructure is managed by a third-party contractor. Following closure, it is anticipated that gas extraction for the renewable energy facility will continue until such time where insufficient gas is being generated to operate the facility.

10.8 Leachate

The generation of leachate within the landfill cells will continue for some time after closure of the facility. The leachate collection system will continue to extract leachate from the cells and direct it to the LTP for treatment. These operations will continue until monitoring of the leachate indicates that the generation of leachate has reached a sustainable level and the quality of the leachate is no longer considered a contamination risk.

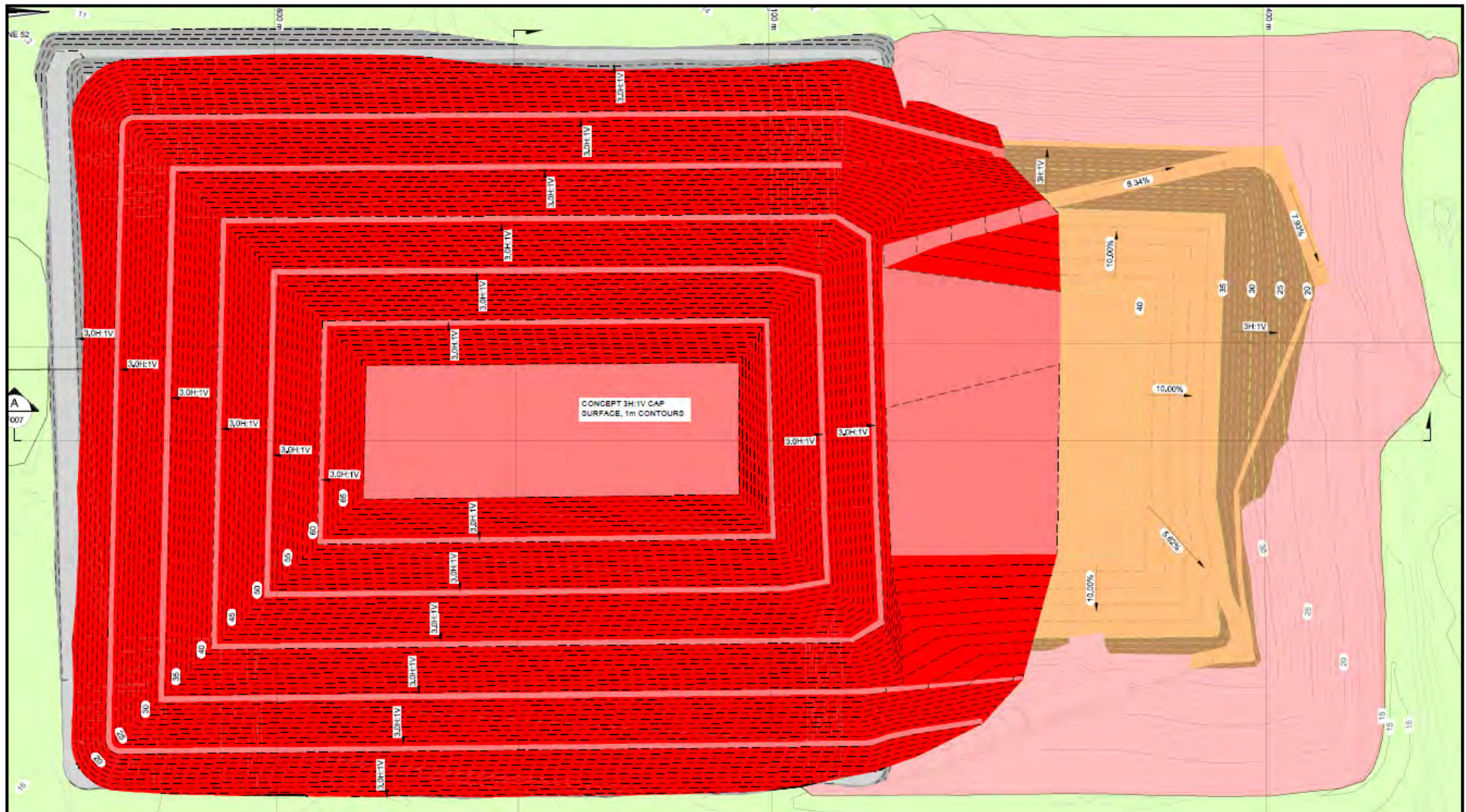


Figure 10-1. Pre-settlement landform (Golder 2016a)

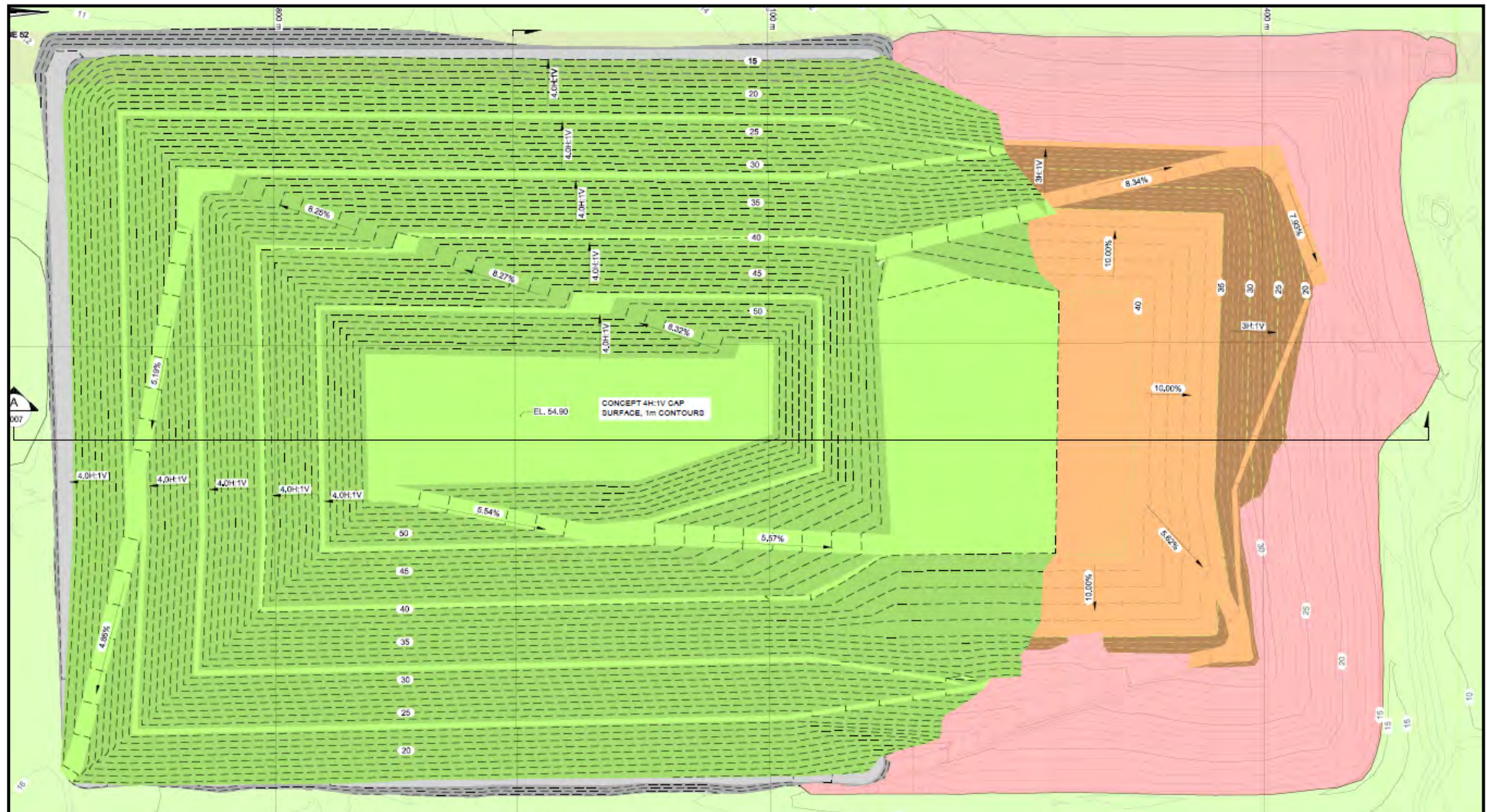


Figure 10-2. Post-settlement landform (Golder 2016a)

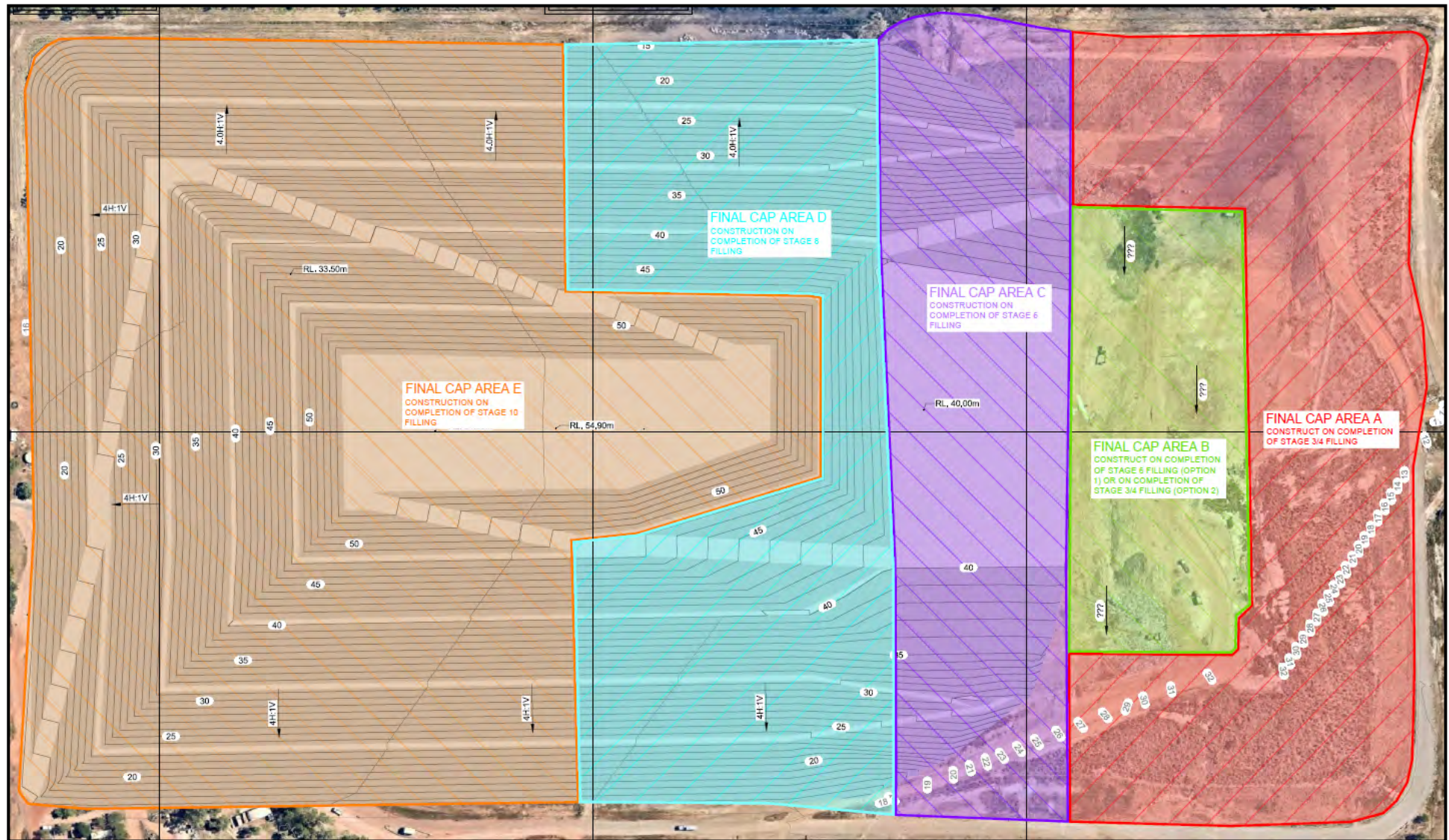


Figure 10-3. Final capping plan (Golder 2016b)

11 POST CLOSURE

Closed landfills require extensive monitoring and maintenance for up to 30 years' post-closure to ensure there are no ongoing environmental impacts on receiving environments.

11.1 Monitoring

An environmental monitoring program is required to assess potential impacts of the landfill on the receiving environment as it matures. The monitoring program should include any elements potentially at risk or posing a risk to the environment, including groundwater, surface water, landfill gas and leachate. The post-closure monitoring program is detailed in Table 11-1.

Table 11-1. Post-closure environmental monitoring program

Aspect	Parameters measured	Locations	Frequency	Duration
Groundwater	Analytes listed in WQMP at the time of closure	All active bores	Quarterly	First 2 years
			Biannually	Following 3 years (provided existing data supports a reduced frequency)
			Annually	Following 25 years
Surface water	Analytes listed in WQMP at the time of closure	All surface water discharge points	Biannually (during wet season)	5 years
Leachate	Analytes listed in LTP at the time of closure	Leachate treatment outputs	As per LTP at time of closure	Whilst leachate treatment plant is in operation
	Levels	Landfill cells	Quarterly	First 2 years
			Annually	Following 28 years
Landfill gas	Concentrations	Monitoring risers	As required by gas management operations	Whilst gas management system is in operation
		Gas monitoring bores and final cap areas	Annually	30 years

11.2 Settlement

Following capping and rehabilitation works on each cell, site walkovers to inspect the integrity of the cap should be conducted twice annually and following severe weather events (i.e. cyclones or monsoons) for a 15 year period.

Topographical surveys to measure the settlement should be undertaken annually in the first two years and then reduced to every two years for the following 13 years unless the settlement rate indicates that more

frequent surveys are required. Following this it is anticipated that settlement will be very minor, therefore surveys should be reduced to every five years or until settlement has stabilised.

11.3 Maintenance

Maintenance planning shall take into consideration maintenance aspects associated with the landfill cap, leachate collection and treatment systems and landfill gas management system. Maintenance requirements for the facility may also include:

- Maintenance and repairs of site infrastructure such as fencing, buildings, security features etc.
- Mowing schedules or other landscaping requirements
- Weed and pest management
- Stormwater control and collection infrastructure.

Leachate collection and treatment systems

Maintenance and operation of leachate collection and treatment system shall continue as per the operational stage to prevent potential leachate contamination and allow effective extraction of landfill gas. Regular inspections of the leachate collection and treatment infrastructure is required and maintenance undertaken as per manufacturers recommendations or as identified by the operator.

Landfill gas management system

Maintenance and operation of landfill gas extraction system are required to ensure effective gas extraction and reduce the risk of fugitive emissions. Below is a list of considerations for post-closure LFG management:

- Well condition and pipework inspections
- Gas treatment plant capacity considerations, electrical interconnection and flaring requirements
- Provision of spare parts and repair response times
- Gas treatment plant maintenance and inspection schedule
- Condensate management.

Revegetation

All revegetation works will include a two-year maintenance period to ensure effective ground cover has been achieved. Where revegetation areas have not achieved at least 70% ground cover, maintenance measures will be implemented (e.g. seeding, fertiliser application, compost application etc.). If any tubestock planting was undertaken and was unsuccessful, the plants will be replaced.

Weed inspections will be undertaken annually and appropriate weed control measures will be implemented for at least 5 years' post-closure.

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APPENDIX A CITY OF DARWIN ENVIRONMENTAL POLICY

Title: **Environment - General**

Policy No: 006

Adopted By: Council

Next Review Date: 29/07/2018

Responsibility: General Manager City Futures

Document Number: 2078949

Version	Decision Number	Adoption Date	History
1	20\2501	23/02/2010	Adopted
2	21\2426	29/07/2014	Adopted

1 Policy Summary

The City of Darwin is committed to lead and advocate for sustainability and the protection of our environment. Council values biodiversity, the natural environment and the green open spaces that all contribute to the tropical lifestyle of this capital city. Council will strive to continually improve on its environmental performance and to foster a culture of environmental awareness and sustainability among its staff and the community.

This policy addresses environmental matters associated with Council operations including waste management and water management.

2 Policy Objectives

Through the implementation of this policy, Council aims to be a leader and champion of sustainability and environmental best practice.

The Darwin community will be well informed of Council initiatives and strategies that enhance and protect the environment.

Council will resource the implementation of this policy and monitor its environmental performance.

3 Background

City of Darwin has a commitment to reducing water consumption, improving resource recovery and generally to enhance preserve and protect the Darwin environment.

The *Evolving Darwin Towards 2020 Strategic Plan* (adopted in 2012) identifies Goal 3 –Environmentally Sustainable City

4 Policy Statement

To lead and advocate for environmental sustainability, the City of Darwin will:

- comply with and where possible, exceed the requirements of relevant legislation, policy and standards to continually improve its environmental performance
- work with the Darwin community to enhance the city's environmental quality, while respecting cultural, social and economic values
- regularly assess and audit its environmental performance and the effectiveness of its environmental management systems
- improve its environmental performance through setting measurable targets and key performance indicators
- ensure its employees, suppliers and contractors are aware of and able to respond to their environmental responsibilities
- support and implement waste reduction, reuse and recycling programs
- reduce resource consumption, including energy and water use

The City of Darwin will encourage the Darwin community to adopt a culture of environmental responsibility at work and at home and promote sustainable practices such as waste minimisation, water efficiency and sustainable transport.

5 Related Documents

Policy No. 059 - Climate Change
Policy No. 068 - Green Fleet
Policy No. 054 - Waste Management
Procedure No. 009 - Domestic Waste Reporting

6 Legislation

Water Act
Weeds Management Act
Environment Protection (Beverage Containers and Plastic Bags) Act
Environmental Assessment Act
Environmental Offences and Penalties Act
Waste Management and Pollution Control Act

Environment Protection and Biodiversity Conservation Act 1999
National Environment Protection Measures (Implementation) Act 1998

7 Evaluation and review

On-going evaluation of environmental performance is monitored by an external assessment process.

APPENDIX B WATER QUALITY MONITORING PLAN



Water Quality Monitoring Plan

Shoal Bay Waste Management Facility

City of Darwin



DOCUMENT CONTROL RECORD

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ACRONYMS AND ABBREVIATIONS

BTEX	benzene, toluene, ethylbenzene, xylene, naphthalene
CoD	City of Darwin
COD	chemical oxygen demand
DO	dissolved oxygen
EC	electrical conductivity
EcOz	EcOz Environmental Consultants
EPA	Environmental Protection Authority
EPL	Environmental Protection License
NH₄	ammonium ion
NO₂	nitrite
NO₃	nitrate
NO_x	nitrate NO ₃ + nitrite NO ₂
NT	Northern Territory
PFAS	per and poly-fluoroalkyl substances
pH	power of hydrogen
SBWMF	Shoal Bay Waste Management Facility
SWL	standing water level
TDS	total dissolved solids
TN	total nitrogen
TP	Total phosphorus
TOC	total organic carbon
TRH	total recoverable hydrocarbons
WQMP	Water Quality Monitoring Plan

1 INTRODUCTION

EcOz Environmental Consultants (EcOz) was engaged by City of Darwin (CoD) to develop a Water Quality and Monitoring Plan (WQMP) for the Shoal Bay Waste Management Facility (SBWMF) as required by the Northern Territory (NT) Environmental Protection Authority (EPA), 2013. *Guidelines for the Sitting, Design and Management of Solid Waste Disposal Sites in the Northern Territory*, and pursuant to an environmental protection license (EPL) EPL188 issued by the NT EPA.

CoD operate the SBWMF located 13 km north-east of Darwin City within Lot 3952, Town of Sanderson, in the suburb of Holmes. This facility is the main municipal waste resource recovery and disposal site servicing domestic and commercial customers in the Darwin area.

The operational area of the SBWMF is located within the southern part of the property and is bound to the north and east by floodplains, wetlands and mangroves of Leanyer Swamp, to the south by Holmes Jungle Nature Reserve and to the west by bushland. The nearest residential area to the SBWMF is the suburb of Karama, about 800 m to the south-west with a bushland buffer in between.

Water quality monitoring is undertaken on a regular basis at the SBWMF, to detect if contaminants from the landfills, or associated operations, are present in groundwater or surface water.

1.1 Scope

This WQMP includes:

- Monitoring objectives
- Details of monitoring sites
- List of analytes
- Frequency of sampling
- Sampling methodology
- Quality assurance/Quality Control requirements
- Analysis and reporting requirements

1.2 Amendments

This WQMP has been prepared as an update to the previous Shoal Bay Water Monitoring Plan (URS 2016). Changes implemented in this WQMP include;

- Amended site information to reflect current site conditions
- Amended monitoring sites to remove old sites and add new sites
- Updated monitoring map
- Included monitoring for the leachate treatment and irrigation areas, to be informed by the leachate treatment specialists engaged by CoD, as well as the Sampling and Analysis Quality Plan developed by EcOz for the baseline soil, groundwater and surface water sampling to be undertaken prior to leachate treatment and irrigation.
- Revised monitoring parameters and frequency. This will be informed by the historic data and trends (assessed as part of the data review and trend analysis currently being completed by EcOz). For example, parameters which are always below detection limit, or are not informative from a water quality perspective will be removed or reduced, while parameters which are currently not included in the WQMP, or analysed infrequently (e.g. PFAS) may be included/increased in frequency. Additionally, the frequency of sampling at various sites will be revised to reflect risks to water quality and the receiving environment, historic water quality data trends, and aspects such as seasonal variation (e.g. surface water).

2 MONITORING PROGRAM

2.1 Monitoring Objectives

In accordance with the NT EPA Guidelines this WQMP has the following objectives;

- To monitor leachate production and composition
- To determine the effects on the environment due to landfill on groundwater and surface water.
- To check compliance with regulatory requirements
- To identify the need for remedial/mitigation measures

To achieve these objectives, this WQMP incorporates water quality monitoring for groundwater, surface water and leachate.

2.2 Monitoring Sites

Monitoring sites include 44 groundwater bores, 3 surface water sites and 8 leachate sites. Figure 2-1 shows monitoring site locations.

2.2.1 Groundwater Monitoring Bores

The 44 groundwater monitoring bores are detailed in Table 2-1. This bore network aims to allow detection of landfill leachate, or other contaminants, migrating from the site in groundwater to areas down-gradient. Groundwater monitoring bores surround the entire site; both up-gradient (south) and down-gradient (west, north and east). There are also some bores centrally located within the site. Most bore locations include a shallow bore, screened between 1.5 and 3 m below ground level (mBGL), and a deeper bore, screened between 9 and 12 mBGL. Some sites also include a deep bore up to 30 m deep.

2.2.2 Surface Water Sites

Surface water monitoring aims to detect any landfill leachate, or other contaminants, in surface water runoff that could potentially flow offsite to environments downstream. Surface water monitoring site details are provided in Table 2-2

2.2.3 Leachate Sites

Leachate sampling aims to allow the characterisation of contaminant concentrations in leachate for comparison with groundwater and surface water results. Leachate monitoring site details are provided in Table 2-2

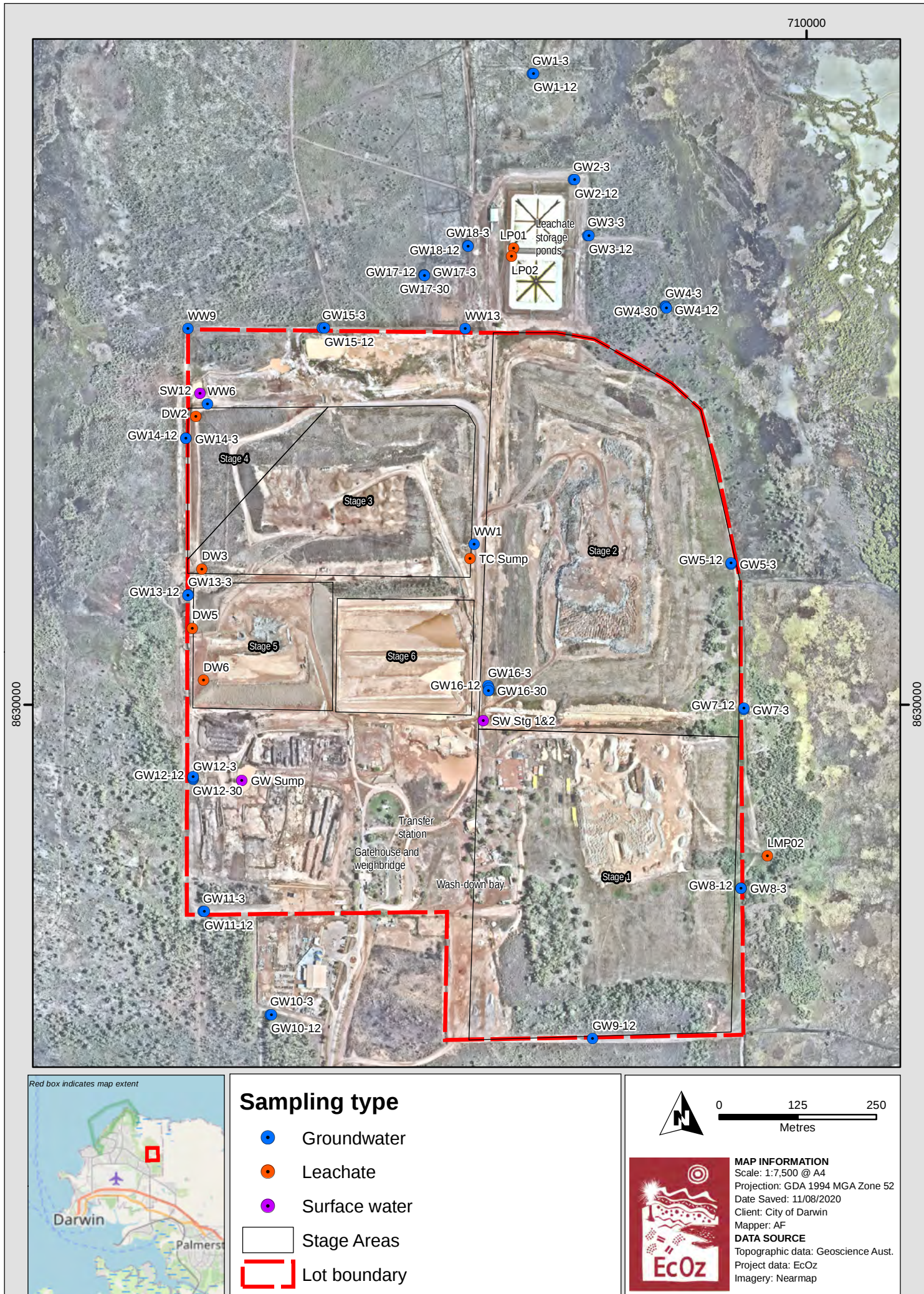


Figure 2-1. Map of SBWMF layout and monitoring site locations

Table 2-1 Groundwater monitoring bore details.

Bore ID	Easting	Northing	Location	TOC ³ outer elevation mAHD	TOC ² elevation mAHD	Ground elevation mAHD	Screened interval mBGL	Screened lithology
GW1-3	709564	8631004	On floodplain, 190 m north of leachate storage area	8.71	8.63	8.02	1.5-3	Siltstone
GW1-12	709566	8631004		8.71	8.59	8.00	9-12	Siltstone
GW2-3	709629	8630835	On north-east corner of leachate storage area	8.06	7.94	7.33	1.5-3	Siltstone
GW2-12	709631	8630835		8.08	7.94	7.28	9-12	Siltstone
GW3-3	709652	8630746	East of leachate storage area	9.94	9.80	9.12	1.5-3	Siltstone
GW3-12	709654	8630746		9.87	9.82	9.10	9-12	Siltstone
GW4-3	709775	8630634	On floodplain, north of Stage 2 landfill	5.65	5.49	4.88	1.5-3	Siltstone
GW4-12	709776	8630633		5.61	5.44	5.36	9-12	Siltstone
GW4-30	709777	8630631		5.50	5.20	5.33	15-21	Gravelly sand, Sandstone
GW5-3	709880	8630224	East of Stage 2 landfill	5.51	5.41	4.70	1.5-3	Siltstone
GW5-12	709880	8630226		5.48	5.33	4.70	9-12	Siltstone, Gravelly Clay
GW6-3	709464	8630022	Decommissioned when Stage 6 was constructed	N/A	N/A	N/A	N/A	Gravelly Sandy Silt, Siltstone
GW6-12	709464	8630021		N/A	N/A	N/A	N/A	Siltstone
GW6-30	709464	8630018		N/A	N/A	N/A	N/A	Siltstone, Sandstone
GW7-3	709900	8629992	South-east of Stage 2 and north-east of Stage 1	5.18	5.03	4.33	1.5-3	Siltstone
GW7-12	709900	8629994		5.16	5.08	4.33	9-12	Siltstone, Sandy Silt
GW8-3	709896	8629708	East of Stage 1	5.42	5.28	4.65	1.5-3	Claystone
GW8-12	709896	8629708		5.37	5.22	4.62	9.1-12.1	Claystone, Sandstone
GW9-12	709660	8629469	On southern boundary of SBWMF – up-gradient of all SBWMF operations and infrastructure	16.18	15.93	15.44	9-12	Siltstone
GW10-3	709147	8629507	South of SBWMF – up-gradient of all SBWMF operations and infrastructure	18.12	18.06	17.32	1.5-3	Siltstone
GW10-12	709149	8629507		18.13	17.98	17.37	9.1-12.1	Siltstone
GW11-3	709040	8629671	South-west corner of SBWMF	13.50	13.38	12.72	1.5-3	Siltstone
GW11-12	709042	8629671		13.52	13.38	12.84	9-12	Siltstone, Sandstone
GW12-3	709024	8629881	West of green waste area	12.20	12.07	11.44	1.5-3	Siltstone
GW12-12	709024	8629883		12.22	12.04	11.50	9-12	Siltstone
GW12-30	709024	8629885		12.21	12.05	11.55	24-30	Sandstone
GW13-3	709017	8630175	On south-west corner of Stage 3/4 and north-west corner of Stage 5 landfills	12.93	12.88	12.32	3-4.5	Siltstone
GW13-12	709016	8630174		12.91	12.86	12.25	10-13.5	Siltstone
GW14-3	709013	8630423	West of Stage 4 landfill	6.78	6.73	6.09	1.5-3	Siltstone
GW14-12	709013	8630424		6.77	6.64	6.08	9-12	Siltstone
GW15-3	709230	8630599	North of Stage 3/4 landfill	11.27	11.06	10.44	1.5-3	Siltstone
GW15-12	709233	8630599		11.20	11.04	10.44	9-12	Siltstone
GW16-3	709493	8630030	East of Stage 5/6	Yet to be surveyed			1.5-3	Sandy Claystone

Bore ID	Easting	Northing	Location	TOC ³ outer elevation mAHD	TOC ² elevation mAHD	Ground elevation mAHD	Screened interval mBGL	Screened lithology
GW16-12	709494	8630025	East of Stage 5/6	Yet to be surveyed			9-12	Siltstone
GW16-30	709495	8630021	East of Stage 5/6	Yet to be surveyed			30	Siltstone
GW17-3	Yet to be installed		Within the proposed treatment area				3	
GW17-12	Yet to be installed		Within the proposed treatment area				12	
GW17-30	Yet to be installed		Within the proposed treatment area				30	
GW18-3	Yet to be installed		Within the proposed treatment area				3	
GW18-12	Yet to be installed		Within the proposed treatment area				12	
WW1	709471	8630151	Between Stage 3 and Stage 2 landfills		16.60	15.90	0-6.3	-
WW6	709047	8630478	North-west corner of Stage 3/4 landfill		7.46	6.76	0-20.4	-
WW9	709016	8630598	North-west corner of SBWMF		7.09	6.39	1-9.8	Siltstone
WW13	709457	8630598	On northern boundary of SBWMF	+0.8	+0.7	Not available	1-10	Siltstone

Table 2-2. Surface water and leachate monitoring site details.

Site ID	Easting	Northing	Location	Context
Surface Water Sites				
STG1&2	709448	8629979	Surface drain between Stage 1 and Stage 2	Receives surface water runoff from central SBWMF areas
GW Sump	709102	8629880	Sump within green waste processing and storage area	Receives surface water runoff from green waste processing and storage area. Possibly also surface runoff from the Stage 3 and 5 landfills.
SW12	709035	8630495	Catchment dam at base of northwest corner of Stage 3/4 landfill	Receives surface water runoff (and potentially seepage) from the northern and western sides of the Stage 3/4 landfill cells
Leachate Sites				
DW2	709029	8630459	Deleaching well on southwest corner of Stage 3/4 landfill	Represents leachate from Stage 3/4 landfill cells
DW3	709038	8630216	Deleaching well on northwest corner of Stage 3/4 landfill	Represents leachate from Stage 3/4 landfill cells
DW5	709023	8630122	Deleaching well on west side of Stage 5 landfill	Represents leachate from Stage 5 landfill cell
DW6	709041	8630039	Deleaching well on southwest corner of Stage 5 landfill	Represents leachate from Stage 5 landfill cell
TC Sump	709465	8630233	Sump on southeast corner of Stage 3/4 landfill	Represents leachate from Stage 3/4 landfill cells
LMP02	709938	8629759	East of Stage 1	Sump that receives leachate from Stage 1 and 2 landfills via an interception trench that runs north-south along the eastern edge of the Stage 1 and 2 landfills.
LP01	709534	8630726	Northern leachate storage pond	Represents leachate in northern storage pond
LP02	709531	8630713	Southern leachate storage pond	Represents leachate in southern storage pond

2.3 Analytes and Frequency of Sampling

The frequency of sampling in the Wet season and the Dry season are outlined in Table 2-3, along with details of the standard suite of analytes used across all sites.

Table 2-3. Monitoring program sampling frequency and analytes

Month	Groundwater		Surface Water	Leachate	Standard suite
	Levels	Chemical parameters			
January	X	X	X	X	Field parameters: SWL, pH, EC, DO, temperature Lab parameters: • Major ions, NH₄, TDS, COD, TOC • Major ions (Na, K, Ca, Mg, alkalinity, chloride, SO₄), • Nutrients (NH₃ as N, NO₃, NO₂, NO_x) • Dissolved metals (chromium, copper, nickel, lead and zinc) • TRH and BTEXN • Total nitrogen (TN) and Total phosphorus (TP), • COD • PFAS
February	X		X		
March	X		X		
April	X	X	X	X	
May	X				
June	X				
July	X	X	X	X	
August	X				
September	X				
October	X	X	X	X	
November	X				
December	X		X		

3 SAMPLING METHODOLOGY

All sampling will comply with the Australian/New Zealand Standard on Water Quality Sampling - Part 1: *Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (AS/NZS 5667.1:1998).

Samples will be immediately chilled in eskies with ice bricks and delivered to a National Association of Testing Authorities (NATA) accredited laboratory each day.

3.1 Groundwater sampling

Groundwater sampling methods will comply with the Australian/New Zealand Standard on Water Quality Sampling – Part 11: *Guidance on sampling of groundwater* (AS/NZS 5667.11:1998).

Groundwater sampling involves:

- The measurement of physical parameters (pH, temperature, EC, DO, turbidity) in groundwater using hand-held field water quality meters calibrated immediately prior to mobilisation to site, and
- The collection of groundwater into laboratory-supplied sample bottles for sending to the laboratory for analysis.

Samples will be collected from groundwater bodies using a micropurge/low-flow bladder pump in the first instance, or with manual bailers if groundwater yields are insufficient to allow pumping. The micropurge/low-flow sampling set up is proven for minimal effect on water chemistry and obtaining representative samples (Sundaram 2009). If manual bailing is required, disposable Clear-View PVC bailers will be used; a new bailer for each bore.

In order to gain a representative sample of the surrounding groundwater aquifer quality and not stagnant water contained within the bore, the pump is lowered to within the screened interval, and the rate of pumping matched to the groundwater recharge rate; confirmed by constant monitoring of the standing water level (SWL), which must remain stable. Water quality parameters (pH, temperature, EC, DO, ORP) are constantly monitored in the groundwater as it is pumped from the bore using water quality meters that have been calibrated immediately prior to mobilisation to site. Pumping is continued until readings stabilise i.e. until three consecutive readings of all parameters measured at 5 minute intervals stabilise to within 5% of each other. This usually takes at least 30 minutes of pumping. Low dissolved oxygen (DO) and negative oxidation reduction potential (ORP) are also indicators of fresh groundwater, and not water from within the bore casing which is in contact with the air. Once stable readings are achieved, samples for laboratory analysis are collected directly into laboratory-supplied bottles.

When using manual bailers, a dedicated bailer is used for each bore, and the bore is purged until dry and then sampled once the bore has recharged and SWL has returned to its original level. If recharge in the bore means it doesn't completely empty, then three times volumes worth of standing water in the bore must be removed and the original standing water level allowed to return prior to sampling.

Samples for metals analysis will be field-filtered using a new disposable syringe and filter (0.45 µm) for each sample.

3.2 Surface water and leachate sampling

Surface water and leachate sampling methods will comply with the Australian/New Zealand Standard on Water Quality Sampling - Part 6: *Guidance on sampling of rivers and streams* (AS/NZS 5667.6:1998), Part 4: *Guidance on sampling from lakes, natural and man-made* (AS/NZS 5667.4:1998), and Part 10: *Guidance on sampling of waste waters* (AN/NZS 5667.10:1998).

Surface water and leachate sampling involves:

- The measurement of physical parameters (pH, temperature, EC, DO, turbidity) using hand-held field water quality meters calibrated immediately prior to mobilisation to site, and
- The collection of water into laboratory-supplied sample bottles for sending to the laboratory for analysis.

The specific method of sampling differs depending on the water source. The five different types of water sources and corresponding sampling methods are:

- Surface water bodies, ponds, and drains with safe direct access – will be sampled directly by placing field water quality meters into the water body for physical parameters, and collecting water samples for laboratory analysis directly into the laboratory-supplied sample bottles (note for bottles with preservative, sample will be decanted into the bottle from one of the unpreserved laboratory-supplied bottles to prevent loss of preservative).
- Surface water bodies, ponds, and drains without safe direct access – will be sampled using a clean, decontaminated jug on a pole, and the physical parameters measured immediately from within the jug. The jug on a pole will then be rinsed in the sample water several times prior to collecting sample for decanting into the laboratory-supplied sample containers for laboratory analysis.
- Sumps without a pump – will be sampled using a clean, decontaminated jug on a pole (as explained above) or a dedicated bailer. When using a bailer, the sample is decanted into a clean, decontaminated jug for measuring physical parameters and the sample poured directly into laboratory-supplied sample containers for laboratory analysis.
- Sumps with a pump – will be sampled by turning the tap on and the sample going into a clean, decontaminated jug for measuring physical parameters and then poured directly from the tap into laboratory-supplied sample containers for laboratory analysis.
- Leachate risers – will be sampled using a submersible pump lowered into the riser with the sample going from the hose into a clean, decontaminated jug for measuring physical parameters and then directly from the hose into laboratory-supplied sample containers for laboratory analysis.

For surface water bodies and sumps sampled either directly or using a sample pole or bailer, samples will be collected approximately 0.3 m below the water surface. When collecting samples from flowing water bodies, the sample must be collected a reasonable distance from the water's edge and facing into the flow direction, keeping hands and sampler equipment downstream to prevent contamination.

Samples for metals analysis (both surface water and leachate) will be field-filtered using a new disposable syringe and filter (0.45 µm) for each sample.

3.3 Quality Assurance / Quality Control

QA/QC samples will comprise:

- Field duplicate samples at 1 per 10 water samples per monitoring event, to identify the variation in analyte concentrations between samples collected from the same location and/or the repeatability of laboratory analysis.
- Field triplicate (split) samples at 1 per 20 water samples per monitoring event, analysed by a second laboratory, to verify the analytical proficiency of the primary laboratory.

Samples will be analysed by a NATA accredited laboratory and laboratory certificates will be NATA endorsed reports.

Upon receipt of the laboratory analytical results, the following elements will be assessed to ensure QA/QC of samples;

- Laboratory and field duplicates
- Trip blanks

- Laboratory internal standards and calibration blanks and method blanks
- Matrix spike, matrix spike duplicate and surrogate spikes
- The occurrence of apparent unusual or anomalous results, e.g. laboratory results that appear to be inconsistent with field observations or measurements.

4 REPORTING

The Australian and New Zealand Environment Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Marine and Freshwater Quality* trigger values for protection of 90 % of marine ecosystems have been adopted for reference when assessing the sample analytical results.

All electronic and hard copy files will be maintained electronically and/or in hardcopy to enable timely access. This includes all reports, laboratory analysis results, sampling documentation, chain of custody records, cad, GIS or surfer data and associated correspondence.

4.1 Exceedance Notification

The NT EPA will be notified in writing as soon as practicable (and in any case within 24 hrs) after becoming aware, when the guideline specified trigger values are exceeded;

- on three consecutive sampling occasions; or
- at greater than or equal to two times the trigger value; or
- at a median value for six consecutive monitoring results.

This notification should include as a minimum;

- when the exceedance was detected and by whom;
- the date and time of the exceedance;
- the actual and potential causes and contributing factors to the exceedance;
- the risk of environmental harm arising from the exceedance assessed in accordance with relevant standards as listed in the WQMP;
- the action(s) that have or will be undertaken to address the exceedance and/or environmental harm;
- if no action was taken, why no action was taken; and
- a date when an incident investigation report will be submitted to the NT EPA.

4.2 Annual Reporting

A completed Annual Return will be submitted via NT EPA Online within 10 business days after each anniversary date of EPL 188, which relates to the preceding 12 month period.

A completed Monitoring Report will be provided to the NT EPA, as prescribed by EPL 188, within 20 business days after each anniversary date of EPL 188.

This Monitoring Report should;

- be prepared in accordance with the requirements of the NT EPA '*Guideline for Reporting on Environmental Monitoring*';
- include tabulation of all monitoring data required as a condition of EPL 188;
- include long term trend analysis of monitoring data to demonstrate any environmental impact associated with the activity over a minimum period of three years (where the data is available); and
- include an assessment of environmental impact from the activity.

5 REFERENCES

- URS 2016, *Shoal Bay Waste Disposal Site Water Monitoring Plan*, March 2016, Report prepared for John Holland Pty Ltd, URS Australia, Darwin, NT.
- NT EPA 2016, *Environment Protection Licence EPL188*, Issued 1 July 2016, Expires 30 June 2021, Northern Territory Environment Protection Authority (NT EPA), Darwin, NT.
- NT EPA 2013, *Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory*, Northern Territory Environment Protection Authority (NT EPA), Darwin, NT.
- Australian/New Zealand Standard on Water Quality Sampling - Part 1: *Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (AS/NZS 5667.1:1998), Standards Australia, New South Wales.
- Australian Standard on Water Quality Sampling - Part 4: *Guidance on sampling from lakes, natural and man-made* (AS/NZS 5667.4:1998), Standards Australia, New South Wales.
- Australian/New Zealand Standard on Water Quality Sampling - Part 6: *Guidance on sampling of rivers and streams* (AS/NZS 5667.6:1998), Standards Australia, New South Wales.
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- Australian/New Zealand Standard on Water Quality Sampling – Part 11: *Guidance on sampling of groundwater* (AS/NZS 5667.11:1998), Standards Australia, New South Wales.
- Sundaram, B., Feitz, A., Caritat, P. de, Plazinska, A., Brodie, R., Coram, J. and Ransley, T., 2009. *Groundwater Sampling and Analysis – A Field Guide*. Geoscience Australia, Record 2009/27 95 pp.
- *Work Health and Safety (National Uniform Legislation) Act, and Work Health and Safety (National Uniform Legislation) Regulations*, NT Government.
- ANZECC & AMRCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.
- ANZECC & AMRCANZ 2000, *Australian Guidelines for Water Quality Monitoring and Reporting*, National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.



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