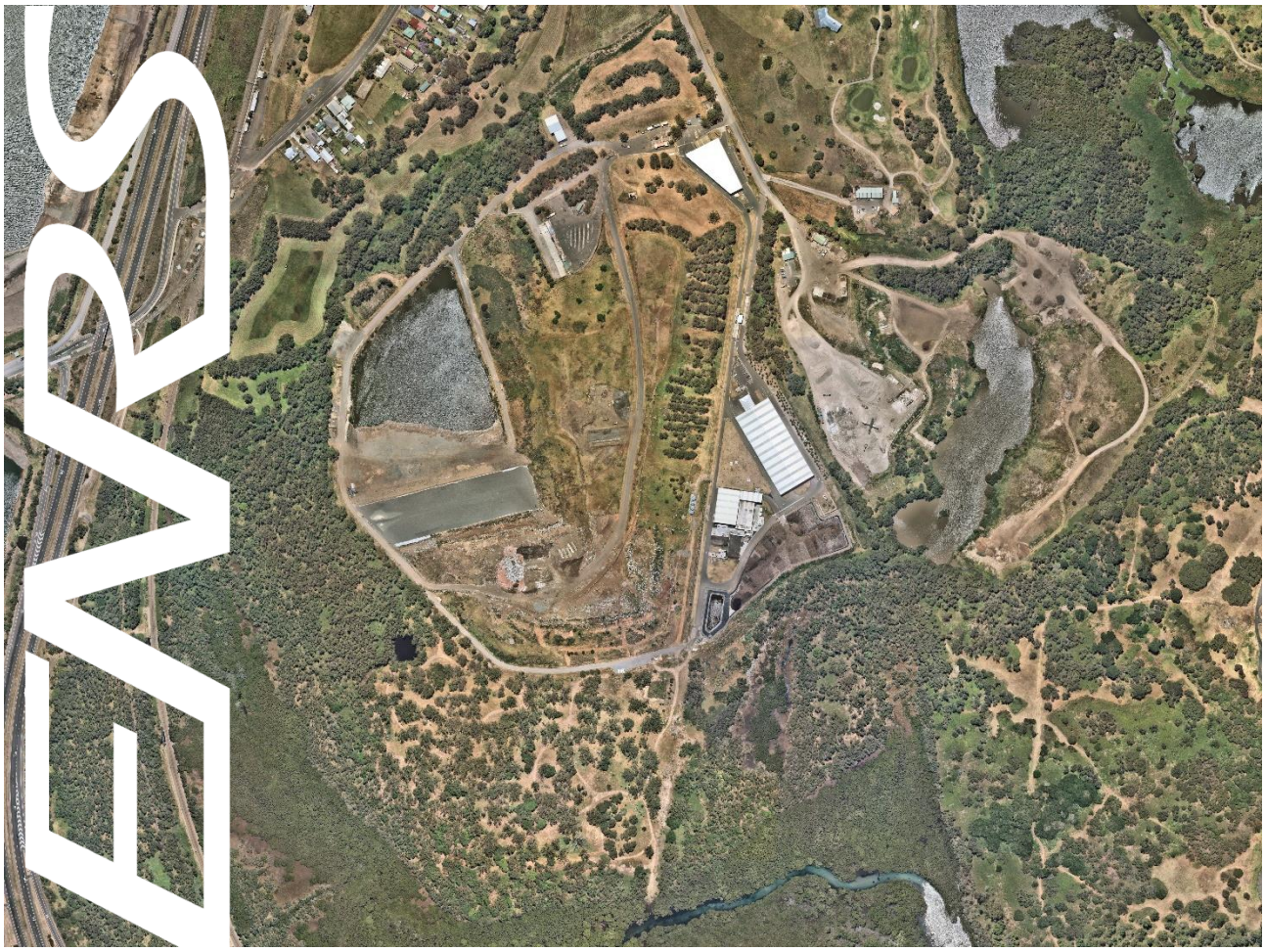

QUARTERLY ENVIRONMENTAL MONITORING REPORT (QEMR) MARCH 2022

DUNMORE RECYCLING & WASTE DEPOT
44 BUCKLEYS ROAD,
DUNMORE, NSW, 2529

ENVIRONMENT PROTECTION LICENCE (EPL) 5984

Prepared For: **Shellharbour City Council**
Project Number: **ENRS0033**
Date: **March 2022**

ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
108 Jerry Bailey Road, Shoalhaven Heads, NSW
T 02 4448 5490 E: projects@enrs.com.au
ABN 68 600 154 596 WWW.ENRS.COM.AU

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The project was conducted through close liaison with Shellharbour City Council (SCC) and ALS Environmental.

Author and Document Control

Written/Submitted by:	Reviewed / Approved by:
	
Taite Beeston (BSc.) *Geologist & Environmental Consultant*	**Rohan Last (BSc. MSc)** *Hydrogeologist & Environmental Scientist*

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EXECUTIVE SUMMARY

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent environmental consultants by *ALS Environmental* (Wollongong) on behalf of *Shellharbour City Council* (SCC) to prepare the Quarterly Monitoring Report for the Dunmore Recycling and Waste Depot (herein referred to as the Site).

This report summarises the results of field testing and laboratory analysis conducted by ALS for the March 2022 quarterly monitoring period. This Quarterly Report provides the necessary data assessment and analysis to meet requirements of the Site's Environment Protection Licence/s (EPL's); No.5984 and No.12903.

The Site was established in 1945 and has been managed by Shellharbour Council (SC) since 1983. The Site accepts putrescible and non-putrescible waste within its managed landfill cell. Recycling activities conducted at the site include Resource Recovery Centre, Revolve Centre and Food Organics and garden Organics (FOGO) processing.

Waste regulation in NSW is administered by the EPA under the Protection of the Environment Operations (POEO) Act (1997); the *Waste Avoidance and Resource Recovery Act* (2001).

The Site operates under the conditions of two (2) EPLs:

- **EPL No. 5984**. Landfill activities. Consisting of; extractive activities, waste disposal and composting.
- **EPL No. 12903**. Resource recovery activities. Consisting of; composting and waste storage within the FOGO Facilities and Resource Recovery Centre.

A copy of the relevant EPL sections outlining the sampling requirements is provided in **Appendix A** (EPL No. 5984). ENRS note that EPL No. 12903 does not specify sample points.

The objectives of this AEMR are to:

- Meet the environmental monitoring requirements of Sites EPLs; No. 5984 and 12903;
- Assess and analyse the environmental monitoring data for the Site against NSW EPA endorsed criteria;
- Identify trends of the environmental monitoring data over the reporting period;
- Identify any on-site or off-site impacts associated with operation of the Site;
- Advise SCC if the current environmental monitoring program is providing adequate information to identify potential environmental impacts from existing operations (if any) and provide recommendations on improvement to the monitoring program if required; and
- Document monitoring results in a Quarterly Environmental Monitoring Report.
- The scope of work for this QEMR comprised the collation, assessment and reporting of Site data made available to ENRS from the March 2021 monitoring period in regard to the following tasks:Review previous reports and document the hydrogeological setting;
- Tabulate results of all monitoring data for both water and dust samples, collected and provided by ALS as required by the EPLs for the respective reporting period.
- Analysis and interpretation of all monitoring data (water, dust and landfill surface gas);

- Review all quarterly environmental monitoring reports from the 2020-2021 reporting period and available data from the last three (3) years;Identification of any deficiencies in environmental performance identified by the monitoring data, trends or environmental incidents, and identification of remedial actions taken or proposed to be taken to address these deficiencies; and
- Recommendations on improving the environmental performance of the facility including improvement to the monitoring program.

Based on the findings obtained during the March 20221 monitoring program the following conclusions and recommendations are provided:

- Shallow groundwater flow is expected to mimic topography with low hydraulic gradients flowing towards the south and southeast towards Rocklow creek. The nearest sensitive receptors are likely to include; recreational users of the Minnamurra River estuary environs; down gradient stakeholders; and downgradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems near discharge zones;
- Groundwater throughout the monitoring period reported exceedances of the assessment criteria for; ammonia, heavy metals, nitrate, sulphate and salinity (EC) within multiple groundwater bores including; BH-1c, BH-3, BH-4, BH-9, BH-12r, BH-13, BH-14, BH-15, BH-18, BH-19r, BH-21 and BH-22. This was considered to be consistent with historical values;
- Rocklow Creek surface water samples (SWC-Up, SWC-2, SWC-down and SWC-down 2) were reported within the adopted Site Assessment Criteria;
- During the March 2022 quarter further reductions in analyte concentrations of all Rocklow Creek surface water samples (SWC-Up, SWC-2, SWC-down and SWC-down 2) were observed for Potassium, Calcium and Sulphate and Fluoride.
- Flare operating temperature were generally observed to be above the target operating threshold of 760 degrees Celsius but did fall below on four (4) occasions during the monitoring period. Operations taken by the operator to address the root causes of the low Flare Stack temperatures are outlined in the monthly LGI reports attached as Appendix G;
- Surface gas methane monitoring reported satisfactory results all within the adopted assessment criteria;
- Gas accumulation monitoring reported satisfactory results for all enclosures tested within 250m of emplaced waste or leachate storage facility;
- Dust deposition gauges recorded satisfactory results below the guidelines provided in AS3580.10.1. Monitoring should continue in accordance with EPL 5984 requirements;
- No non-compliances with the EPL were reported during the March 2022 monitoring period;
- Based on this review of the March 2022 monitoring period, contaminants associated with the landfill cell, leachate dam/s and general site uses are considered to be relatively consistent with the range of historical results;

- Should any change in Site conditions or incident occur which causes a potential environmental impact, a suitable environmental professional should be engaged to further assess the Site and consider requirements for any additional monitoring; and
- This report must be read in conjunction with the attached Statement of Limitations.

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1.0 INTRODUCTION

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent environmental consultants by *ALS Environmental* (Wollongong) on behalf of *Shellharbour City Council* (SCC) to prepare the Quarterly Environmental Monitoring Report (QEMR) for the Dunmore Recycling and Waste Depot (*herein referred to as the Site*).

This (QEMR) summarises the results of field testing and laboratory analysis conducted by ALS for the March 2022 monitoring period, and provides the necessary data assessment and analysis to meet requirements of the Site's Environment Protection Licence/s (EPL's); No.5984 and No.12903.

1.1 PROJECT BACKGROUND

1.1.1 Site History

The Site was established in 1945 and has been managed by Shellharbour City Council (SSC) since 1983. The Site accepts putrescible and non-putrescible waste within its managed landfill cell. Recycling activities conducted at the site include Resource Recovery Centre, Revolve Centre and Food Organics and garden Organics (FOGO) processing.

In late 2020 to July 2021 Shellharbour City Council moved away from sole reliance on traditional onsite leachate management techniques through initiating a secondary leachate treatment option in which leachate was transported from site for processing at a contractor facility.

In early 2021 Shellharbour City Council constructed a new Leachate Treatment Plant (LTP) on site, which was commissioned in July/August 2021. The LTP is comprised of three primary biological treatment units, including an anoxic reactor, nitrifying reactor, and sequencing batch reactor. The treated stream meets Sydney Water requirements for discharge into Sydney Water sewer, under a trade waste agreement. On average the LTP discharges 60kL/day of treated water, equating to approximately 22ML of leachate removal from site per annum.

1.1.2 EPL Requirements

Waste regulation in NSW is administered by the EPA under the Protection of the Environment Operations (POEO) Act (1997); the *Waste Avoidance and Resource Recovery Act* (2001).

The Site operates under the conditions of two (2) EPLs:

- **EPL No. 5984**. Landfill activities. Consisting of; extractive activities, waste disposal and composting.
- **EPL No. 12903**. Resource recovery activities. Consisting of; composting and waste storage within the FOGO Facilities and Resource Recovery Centre.

A copy of the relevant EPL sections outlining the sampling requirements is provided in **Appendix A** (EPL No. 5984). ENRS note that EPL No. 12903 does not specify sample points.

1.2 OBJECTIVES

The objectives of this AEMR are to:

- Meet the environmental monitoring requirements of Sites EPLs; No. 5984 and 12903;
- Assess and analyse the environmental monitoring data for the Site against NSW EPA endorsed criteria;
- Identify trends of the environmental monitoring data over the reporting period;
- Identify any on-site or off-site impacts associated with operation of the Site;
- Advise SCC if the current environmental monitoring program is providing adequate information to identify potential environmental impacts from existing operations (if any) and provide recommendations on improvement to the monitoring program if required; and
- Document monitoring results in an Annual Environmental Monitoring Report.

1.3 SCOPE OF WORK

The scope of work for this QEMR comprised the collation, assessment and reporting of Site data made available to ENRS from the March 2022 monitoring period in regard to the following tasks:

- Review previous reports and document the hydrogeological setting;
- Tabulate results of all monitoring data for both water and dust samples, collected and provided by *ALS* as required by the EPLs for the respective reporting period.
- Analysis and interpretation of all monitoring data (water, dust and landfill surface gas);
- Review all quarterly environmental monitoring reports from the 2020-2021 reporting period and available data from the last three (3) years;
- Identification of any deficiencies in environmental performance identified by the monitoring data, trends or environmental incidents, and identification of remedial actions taken or proposed to be taken to address these deficiencies; and
- Recommendations on improving the environmental performance of the facility including improvement to the monitoring program.

2.0 SITE DESCRIPTION

2.1 LOCATION

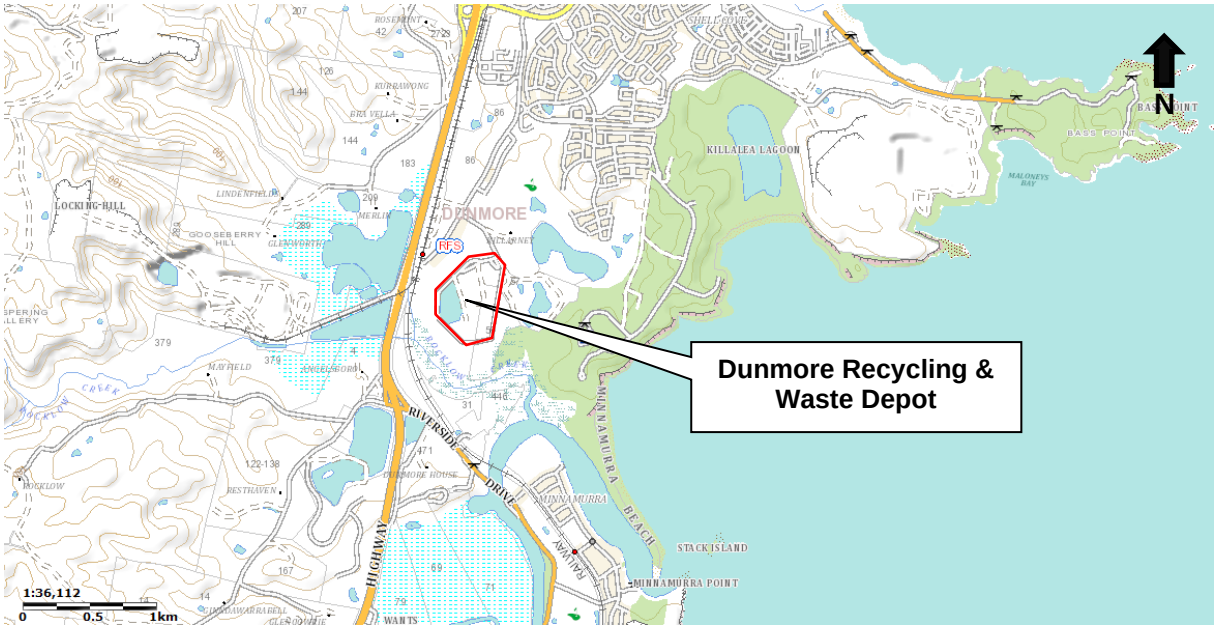
The Site is located at 44 Buckleys Road, Dunmore, NSW, 2529, legally defined as Lot 21 in Deposited Plan 653009 and Lot 1 Deposited Plan 419907. The Site is situated approximately three and a half (3.5) kilometres southwest of the Shellharbour town centre. The area's regional location is defined in **Figure 1** below. Details of the Site boundary and sampling points

are provided in the Site Plan (see **Figure 2**). The key features required to identify the Site are summarised in **Table 1**.

Table 1: Site Identification

Aspect	Description
Site	Dunmore Recycling and Waste Depot
Street Address	44 Buckleys Road, Dunmore, NSW 2529
Site Area	72.36 hectares
Title Identifier	Lot 21 DP 653009, Lot 1 DP 419907
Zoning	RU1 Primary Production
Local Government Area	Shellharbour City Council

Figure 1: Site Location Map



Source: SIX Maps (https://maps.six.nsw.gov.au/) (cited 16/01/2020)

2.2 SURROUNDING LANDUSE

The current activities and operations on adjacent properties and the surrounding area include:

Table 2: Surrounding Land use

Direction	Land Use
North:	Buckleys Road, commercial infrastructure and open grassland. Residential dwellings along the northwest border of the Site. Golf course further to the northeast.

Direction	Land Use
East:	Dunmore Resources and Recycling facility immediately to the east, bushland to the southeast.
South:	Bushland, Rocklow Creek (300m from landfill activities). Further to Kiama Community Recycling Centre and Riverside Drive.
West:	Bushland to the southwest, scattered trees immediately to the west and further to the Princes Highway. Boral Quarries complex beyond the Highway. Residential dwellings to the Northwest.

2.2.1 Sensitive Receptors

The nearest sensitive receptors are likely to include:

- Recreational users of the Minnamurra River estuary environs;
- Down gradient stakeholders; and
- Down gradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems (GDE) near discharge zones.

2.3 TOPOGRAPHY & DRAINAGE

A review of the current series Albion Park (90281N) 1:25,000 topographic map sheet was conducted to assess the regional topography and to identify potential runoff and groundwater controls in the region. Topography provides a useful indicator for groundwater controls including gradient and flow path.

The Site presents low topographic relief, remaining between approximately 3-5 mAHD across the entirety of the Site. The regional topographic gradient trends south-southeast towards Rocklow Creek and Minnamurra River.

2.4 SOIL LANDSCAPE

The previous annual monitoring report (Environmental Earth Sciences 2018) reported the soil profile at the Site as organic, black, massive sandy loam topsoil overlying loose bleached light grey sand with iron staining in the subsoil.

Review of the online *Shellharbour City Council* Acid Sulphate Soil Risk Map indicates that the Site lies within a **Class 3** area, suggesting that works beyond 1 metre below the ground level (mbGL) have the potential to encounter Acid Sulphate Soils (ASS).

2.5 GEOLOGY

A review of the Site geology was undertaken with reference to the Wollongong 1:250,000 geological series sheet (Si56.9) and the Shellharbour-Kiama area coastal quaternary 1:50,000 geology sheet (see **Figure 4**). The Site is predominately underlain by the Quaternary alluvial deposits (Qal) characterised as Holocene backbarrier flat; marine sand, silt, clay, gravel and shell (Qhbf). The northern most corner of the site is intersected by the Gerringong Volcanics (Pbb) characterised by Latite. Based on the mapped geology, previous investigations and

borehole logs, the Site infrastructure including the landfill cell is located within the alluvial deposits.

2.6 HYDROGEOLOGY

Groundwater resources in the area are expected to be associated with *Shallow unconfined* alluvial and unconsolidated systems, generally less than 20 m in depth with moderate to high transmissivity, variable water quality, and strongly controlled by rainfall recharge.

2.6.1 Existing Bores

A network of groundwater monitoring bores is installed at the Site to provide specific data on the quality and nature of groundwater. Given the spatial distribution of the bores and disturbed ground condition expected within the land fill cell, groundwater contours could not be accurately mapped.

A review of the *NSW Office of Water* (*NOW*) existing bore records was conducted to develop the conceptual understanding of regional groundwater conditions, including aquifer depths, yields, water quality, and distribution. A search of the Bureau of Meteorology Australian Groundwater Explorer groundwater database identified a total of eighty-eight (88) registered bores within one and a half (1.5) kilometres of the Site (see **Figure 5**). Registered bores in the area are predominantly associated with the Landfill Site and with the quarry complex (*Boral Site*) to the west of the EPL Site. The majority of bores are registered for monitoring purposes, excluding a single well (GW044447), which is registered for stock and domestic purposes. The stock bore is located approximately one (1) kilometre to the north of the Site, on the western side of the Princes Highway, which is considered to be up gradient of the Site and not in direct hydraulic connectivity. Registered bore depths are between 1.25 m and 22 m. Bore records indicate shallow unconsolidated aquifer systems.

2.6.2 Flow Regime

Previous reports (*Environmental Earth Sciences,* 2018) have identified that groundwater flows vary across the Site, but the general trend is south, towards Rocklow Creek.

Based on the unconfined nature of the aquifers, the shallow groundwater flow is inferred to mimic topography with low to moderate hydraulic gradients flowing towards the south.

The Site and adjoining land, was largely unsealed with potential for local recharge from rainfall infiltration. Likely discharge areas are predominantly to the south and east of the Site including swamps and Rocklow Creek. The waterbodies surrounding the Site are recognised as State Environmental Planning Policy No.14 (SEPP14) registered wetlands and Proximity Areas for Coastal Wetlands border the eastern, southern and western boundaries of the Site.

2.7 SURFACE WATER

The Site topography indicates that surface water flow will generally trend to the east towards off Site wetlands and southeast towards Rocklow Creek. These present the primary regional drainage structures for natural surface water and runoff. A series of stormwater infrastructure is present at the Site which is expected to capture run off. Infrastructure includes but not limited

to; stormwater drains; sedimentation ponds; levee banks; collection and diversion drains; and leachate dams.

3.0 ASSESSMENT CRITERIA

3.1 CONTAMINANTS OF POTENTIAL CONCERN

This section of the report provides a summary of the Contaminants of Potential Concern (CoPC) associated with the Site. CoPC's are identified in the Sites EPL/s which document the CoPC and water quality indicators required to be monitored. Analytical requirements for all water sampling are provided in Appendix A.

3.2 WATER QUALITY GUIDELINES

Nationally developed guidelines are provided in the National Water Quality Management Strategy (NWQMS): Guidelines for Groundwater Protection in Australia (ARMCANZ & ANZECC 1995). For the purpose of this assessment, the relevant criteria selected to protect environmental values are summarised in **Table 3** below:

Table 3: Groundwater Assessment Criteria

Environmental Value	Relevant Guideline
Ecosystems / Health Screening Levels	ANZG (2018) (Australian and New Zealand Guidelines for Fresh and Marine Water Quality).
	National Environment Protection Measure (NEPM) (2013).
Drinking Water	Australian Drinking Water Guidelines (ADWG) (2018)

3.2.1 ANZG Guidelines

The relevant criteria for this water quality assessment are the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG;2018). The ANZG (2018) provide Default Guideline Values (DGVs) for four (4) levels of protection categorised by the percentage of species possibly affected, being 80%, 90%, 95% or 99% of species. Values for a level of protection for 95% of species in a marine environment have been adopted and are displayed in **Table 4**. Where DVGs are not available reference is made against the ANZECC (2000) Trigger Values (TVs). The *NSW Office of Water* (DECCW;2007) endorsed groundwater management guidelines recommend assessment for aquatic ecosystems based on the ***95 per cent of species level of protection***.

Table 4: Adopted Guideline Criteria

Parameter	Groundwater Guideline	Surface water Guideline
Ammonia	0.9 mg/L	0.9 mg/L
Nitrate	10.6 mg/L	10.6 mg/L
pH	6.5-8.5 pH units	6.5-8.5 pH units

Parameter	Groundwater Guideline	Surface water Guideline
Soluble Iron	0.3 mg/L	0.3 mg/L
Manganese	1.9 mg/L	1.9 mg/L
Electrical Conductivity	125-2200 µS/cm	125-2200 µS/cm

3.2.2 National Environmental Protection Measure (NEPM)

The NSW EPA has endorsed the use of the Groundwater Investigation Levels (GILs) given in the 2013 ASC NEPM 'Schedule B(1) Guideline on the Investigation Levels for Soil and Groundwater'. The latest NEPM provide a framework for risk-based assessment of groundwater contamination.

Groundwater Health Screening Levels (HSLs) are provided for four (4) land use categories for vapour intrusion (Table 1A[4]) associated with Total Recoverable Hydrocarbons TRH (F1 & F2) and BTEX compounds.

NEPM	Description of Land use Categories
HIL A	Residential A with garden/accessible soil also includes children's day care centres, preschools and primary schools.
HIL B	Residential B with minimal opportunities for soil access; includes buildings with fully and permanently paved yard space such as high-rise buildings and apartments.
HIL C	Recreational C includes public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and unpaved footpaths.
HIL D	Commercial/industrial D includes premises such as shops, offices, factories and industrial sites.
GILs	Groundwater Investigation Levels (GILs) should be applied based on the receiving environment and groundwater resources. GILs are provided in NEPM Table 1C for; Fresh Waters; Marine Waters; and Drinking Water;
EILs	Ecological Investigation Levels (EILs) for common contaminants in the top two (2) metres of soil based on three (3) generic land use settings: • Areas of ecological significance; • Urban residential areas and public open space; and • Commercial and industrial land uses.

3.3 DUST DEPOSITION ASSESSMENT CRITERIA

Criteria for collection and assessment of dust deposition concentrations are provided within the Australian standard AS3580.10.1 - Methods for sampling and analysis of ambient air; method 10.1- Determination of particulate matter - Deposited matter - Gravimetric method. AS3580.10.1 provides an acceptable level of 4 g/m^2/month.

3.4 SURFACE METHANE GAS ASSESSMENT CRITERIA

The NSW EPA Solid Waste Landfill Guidelines 2nd Edition (2016) provides sampling methodologies and threshold for surface methane gas concentrations at landfill sites. The acceptable threshold for capped landfills is 500 parts per million (ppm) at 5 cm above the capping surface.

3.5 GAS ACCUMULATION MONITORING IN ENCLOSED STRUCTURES

The NSW EPA Solid Waste Landfill Guidelines 2nd Edition (2016) provides sampling methodologies and threshold gas levels to ensure that gas is not accumulating within enclosed structures on or withing 250m of deposited waste or leachate storage. The acceptable threshold for 1% (volume/volume).

4.0 SAMPLING METHODOLOGY

Field sampling was conducted by *ALS Environmental* (Wollongong) as commissioned by *SCC* on quarterly basis. ENRS understands that sampling was conducted in accordance with ALS sampling protocols with reference to current industry standards and Code of Practices. The following sub-sections provide a summary of the sampling methodologies.

Monitoring frequency is defined by the EPL's and is designed to capture necessary site data to support assessment of Site conditions (quarterly and annual), any long-term trends or overflow events. Monitoring is conducted quarterly and annually for selected analytes with additional overflow and event-based sampling triggered by Site conditions.

4.1 WATER SAMPLING

4.1.1 Location of Water Monitoring Points

Groundwater and surface water monitoring requirements are defined by the EPL No. 5984, as provided in Appendix A. The water sampling regime includes; five (5) surface waters, one (1) located onsite and four (4) located off-site; twelve (12) groundwater monitoring wells surrounding the landfill operations; and two (1) leachate point. Sampling locations are illustrated in **Figure 2** attached.

4.1.2 Depth to Water

Prior to sampling, the depth to the groundwater table was measured from the top of casing (TOC) using a water dipper and clear disposable bailer. The bores were inspected for the presence of hydrocarbon and the thickness of any LNAPL was measured visually in clear disposable bailers. ***No LNAPL was identified in monitoring Wells***.

4.1.3 Sample Collection

Sampling is conducted independently by *ALS Environmental* under contract with *SCC*. Chain of Custody records and field sheets are provided in Appendix D**.** ENRS understand sampling was conducted in accordance with *ALS* sampling protocols.

4.1.4 Groundwater Sampling

Groundwater wells were sampled in order of distance from any areas of known contamination to ensure that lower contaminated wells are sampled before likely higher contaminated wells. Groundwater bores were purged prior to sampling by removing at least three (3) well volumes or low flow parameter stabilisation methods applied with field sheets provided to document

pumping volumes and field parameters. Samples were collected using clear disposal bailers. and were sealed in laboratory-prepared sampling containers appropriate for the analysis. All samples were stored on ice immediately after their collection and transported to the laboratory under Chain of Custody (CoC) documentation.

Surface water and leachate samples were collected using as 'grab samples' from the midpoint of the structure and at mid-depth.

Any loss of volatile compounds was kept to a minimum by employing the following sampling techniques:

- Minimal practical disturbance during sampling;
- Samples placed in sample containers as soon as possible;
- Sample containers contain zero headspace;
- Samples placed directly on ice and transported to the laboratory as soon as possible; and
- Employing the most appropriate analytical method to minimise volatile losses at the laboratory.

4.1.5 Field Testing

Field testing was conducted during bore purging and sampling to record physical water parameters. A multi-probe water quality meter was used to measure the following parameters:

- Oxygen Reduction Potential (ORP, representing redox).
- Electrical Conductivity (Salinity - EC);
- Temperature; and
- pH (Acidity).

4.2 DUST DEPOSITION SAMPLING

Measurement of dust deposition was carried out in accordance with the Australian Standard AS3580.10.1 (2016). This Australian Standard provides a mean of determining the mean surface concentration of deposited matter from the atmosphere.

Dust collection gauges were set up for a one (1) month period between the dates; ***18th November*** and ***7th March 2022***. A total of four (4) dust monitoring locations were considered adequate to assess site conditions.

4.3 SURFACE METHANE GAS MONITORING

The concentration of methane gas (in units of ppm) at the Site was carried out in accordance with EPA Guidelines Solid Waste Landfill 2nd Edition 2016. On the day of sampling the wind speed was below 10 km/hr. Testing was conducted using a calibrated *LaserOne* portable gas monitor specifically designed for landfill gas monitoring. A calibration Certificate is provided in **Appendix F.**

One field technician commenced data collection along transect lines in a grid pattern across the landfill surface at 25-metre spacings. A site plan depicting the sampled transect line is provide in **Figure 3**. Transects were recorded using a Magellan *SporTrak* GPS. The concentration of methane gas was measured at a height of 5 cm above the ground in areas with intermediate or final cover over the emplaced waste.

4.4 GAS ACUMMULATION MOITORING IN ENCLOSED STRUCTURES

The concentration of methane gas (in units of percent volume/volume) inside all enclosed structures within 250m of emplaced waste or leachate storage facility at the Site was carried out in accordance with EPA Guidelines Solid Waste Landfill 2nd Edition 2016. On the day of sampling testing was conducted using a calibrated *LaserOne* portable gas monitor specifically designed for landfill gas monitoring. A calibration Certificate is provided in **Appendix F.**

The internal methane concentrations for each enclosed structure were recorded by a field technician. A site plan depicting the location onsite of each structure provided in **Figure 3**. Any depressions or surface fissures away from the sampling grid were also investigated.

4.5 LABORATORY ANALYSIS

ALS, a NATA accredited laboratory, was contracted by *SCC* to undertake the sample analysis in accordance with current standards. Laboratory QA/QC results are detailed in the Laboratory reports contained in the appendices section of this report.

4.6 FLARE MONITORING

Landfill gases (LFG) are formed through bacterial action on emplaced waste and are a normal by-product of Landfilling operations. Landfill gas is a mixture of many different gases, typically its major components include methane and carbon dioxide. Smaller concentrations of nitrogen, oxygen, ammonia, sulphides, hydrogen, carbon monoxide, and nonmethane organic compounds (NMOCs) and Volatile Organic Compounds (VOC's) may also be present.

When operated efficiently the use of a gas flare to burn landfill gas can significantly reduce emissions of methane, NMOCs and VOC's.

The flare was monitored, maintained and operated by *LGI LTD.* Copies of LFG reports for the relevant reporting period are included as **Appendix G**.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQO) are required to define the quality and quantity of data needed to support management decisions. The process for establishing DQO's is documented by Australian Standard: AS 4482.1-2005 and referenced by the National Environment Protection

(Assessment of Site Contamination) Measure (NEPC;2013). The DQO's for the investigation were to obtain representative data to allow assessment of:

- groundwater quality;
- The risks posed to human health and the environment, including potential future users of the Site; and
- The requirements for any further investigative works.

The assessment was conducted to a standard consistent with generally accepted and current professional consulting practice for such an investigation. The evaluation criteria adopted for the investigation are summarised in **Table 5**.

Table 5: Data Quality Objectives

DQO	Evaluation Criteria
Documentation completeness	Completion of field records, chain of custody documentation, laboratory test certificates from NATA-accredited laboratories.
Data comparability	Use of appropriate techniques for the sampling, storage and transportation of samples. Use of NATA accredited laboratory using NEPM endorsed procedures.
Data representativeness	Adequate sampling coverage of all areas of environmental concern at the Site, and selection of representative samples.
Precision and accuracy for sampling and analysis	Use properly trained and qualified field personnel and achieve field and laboratory QA/ QC criteria.

5.2 QA/QC PROCEDURES

It should be noted that whilst the EPL does not require field duplicates, ENRS recommend sampling include rinsate samples and field duplicates at the standard rate of 1 in 10, or field QA/QC is conducted in accordance with *ALS* procedures.

The majority of the QA/QC data provided for this report by SC was prepared by *ALS* and is included in the attached ALS QC and QCI reports. *ALS* is NATA accredited for field sampling and laboratory testing.

Relative Percent Difference (RPD) analysis of all duplicate and triplicate samples(s) results was performed by ENRS and is included in the report as **Table 9** and **Table 10**. Results were generally reported within the acceptance criteria documented in Table 4 of AS4482.1-2005, the RPD for inorganics was set at <30% and for organics set at <50%.

Since all QA/QC results complied with the required standards, or showed variations that would have no significant effect on the quality of the data or the conclusions of this environmental assessment. Therefore, the data was considered acceptable for use in this assessment.

5.3 EPL NON-COMPLIANCE

No non-compliances were noted during the March 2022 quarterly monitoring period. Monitoring requirements are defined by the EPL.

6.0 WATER QUALITY RESULTS

Laboratory results for groundwater and surface water were provided to ENRS for tabulation and comparison with relevant EPL assessment criteria. A summary of results is provided in **Table 9** with comparison against the relevant Site Assessment Criteria (SAC). The laboratory certificates of analysis are provided in Appendix B.

6.1 OVERFLOW RESULTS

Overflow samples were taken from SWP-1 on three (3) occasions during Q2 monitoring period. Summary results are included in **Table 6**. Results were consistent with EPA guidelines.

A full summary of results is provided in **Table 9** with comparison against the relevant Site Assessment Criteria (SAC). The laboratory certificates of analysis are provided in Appendix B.

Table 6: Summary Table of Overflow Events

Sample Date	pH	TSS	Ambient Temperature	Rainfall (mm) Previous 24Hrs
03/03/2022	8.1	17	23.1	101.8
10/03/2022	7.6	8	22.4	28.4
30/03/2020	7.8	12	22.9	19.8

6.2 FIELD TESTING

Field testing was conducted by ALS during sampling to record physical water parameters. A water quality meter is used to measure the following parameters in the field:

- Electrical Conductivity (Salinity);
- pH (Acidity); and
- Dissolved Oxygen (surface waters only).

6.3 PHYSICAL INDICATORS

6.3.1 Depth

Groundwater

Depth of ground water to top of casing (TOC) ranged between **0.49 mbgl** (BH-15, 10/03/2022) to **3.58 mbgl** (BH-12r, 10/03/2022). Across the Site groundwater levels were consistently higher in comparison to historical data sets.

6.3.2 Temperature

Groundwater

Temperature of groundwater in the March 2022 monitoring period ranged between **18.5 degrees Celsius** (BH-15, 10/03/2022) and **23.0 degrees Celsius** (BH-1C, 10/03/2022).

Results are consistent with historical data.

Surface Waters

Surface water temperature at SWP-1 was **18.1 degrees Celsius** (10/03/2022)

Results are consistent with historical data.

Leachate

Leachate Temperatures at the leachate Tank (LP-1) was **22.0 degrees Celsius** (07/03/2022).

Results are consistent with historical data.

6.3.3 Salinity (EC & TDS)

Salinity is reported by the laboratory as either Electrical Conductivity (EC) or Total Dissolved Solids (TDS). The ANZECC guidelines document a conversion ratio of 0.68 mg/L = 0.68 EC (µS/cm). Table 3.3.3 of the ANZECC (2000) guidelines document default TV for EC in lowland freshwater rivers between **125 µS/cm - 2,200 µS/cm** (~1,500 mg/L).

Groundwater

During the March 2022 monitoring period, salinity ranged between; **236 µS/cm** (BH-18, 10/03/2022) and **7,420 µS/cm** (BH-1C, 10/03/2022). Four (4) monitoring points reported salinity values in excess of freshwater SAC of **2,200 µS/cm**, **7,420 µS/cm** (BH-1c), **4,360 µS/cm** (BH-9), **2,460 µS/cm** (BH-12r), **2,460 µS/cm** (BH-21).

With the exception of BH1c and BH12r which were consistent with historical data, EC readings generally trended down across the site.

Surface Waters

Electrical Conductivity results for onsite surface water (SWP-1, 10/03/2022) was **1,470 µS/cm** which corresponds to a calculated Total Dissolved Solids result of **1,029 mg/L**. These results were below the TV.

Electrical conductivity for offsite surface waters ranged between **555 µS/cm** (SWC-DOWN, 10/03/2022) to **2,360 µS/cm** (SWC-UP, 10/03/2022).

Total Dissolved Solids results for offsite surface waters located along Rocklow Creek ranged between **350 mg/L** (SWC-DOWN, 10/03/2022) to **1,320 mg/L** (SWC-UP, 10/03/2022).

Although the results Total Dissolved Solids and EC results appear significantly lower than historical data they are consistent with a tidal creek experiencing heavy rainfall events.

Leachate

Salinity in leachate is expected to vary significantly with leachate concentration and stormwater dilution. Leachate salinity for March 2022 monitoring was **11,200 µS/cm** (LP1, 7/03/2022) which was above the TV. Results are consistent with historical data.

6.3.4 Dissolved Oxygen

Levels of Dissolved Oxygen (DO) were measured in the field during sampling. DO reflects the equilibrium between oxygen-consuming processes and oxygen-releasing processes. DO can initiate redox reactions resulting in the uptake or release of nutrients. Low DO concentrations can result in adverse effects on many aquatic organisms which depend on oxygen for their

efficient metabolism. At reduced DO concentrations many compounds become increasingly toxic, for example Zinc, Lead, Copper, phenols, cyanide, hydrogen sulphide and Ammonia.

The ANZECC (2000) guidelines Table 3.3.2 outlines a range between 85% to 110% saturation for low land rivers. Assuming a water temperature of 18°C this is equivalent to approximately 7-11 mg/L or ppm.

Surface Waters

Dissolved Oxygen at SWP-1 was **3.33 mg/L** (07/03/2022). SWP-1 was not discharging at the time of sampling and are consistent with previous data.

Dissolved Oxygen for the offsite surface waters at Rocklow Creek ranged from **2.43 mg/L** (SWC-UP, 10/03/2022) to **7.17 mg/L** (SWC-DOWN, 10/03/2022). These results are consistent with a tidal creek passing through a mangrove swamp and are consistent with previous data.

Leachate

Dissolved oxygen at LP1 (Leachate Tank) was **1.32 mg/L** (07/03/2022). Results were consistent with previous data.

6.3.5 pH

pH is a measure of hydrogen activity. pH determines the balance between positive hydrogen ions (H+) and negative hydroxyl ions (OH-) and provides a test of water acidity (low pH) or alkalinity (high pH). Most natural freshwaters have a pH in the range 6.5 to 8.0. Changes in pH may affect the physiological functioning of biota and affect the toxicity of contaminants. Both increases and decreases in pH can result in adverse effects, although decreases are likely to cause more significant problems. Low pH indicates acidic conditions which may increase the mobility of heavy metals, whilst high pH indicates alkaline conditions which may also generate Ammonia. Previous investigations of other regional Landfill Sites in the Illawarra-Shoalhaven (Forbes Rigby;1996) report regionally acidic groundwater with low readings in the range of 4.3 pH associated with silica saturation and oxidation of accessory marcasites grains (iron sulphide).

Groundwater

Groundwater pH was reported between **pH 6.0** (BH-14, 10/03/2022) and **pH 7.2** (BH-3, BH-19r and BH-21, 10/03/2022). With the exception of BH-14 all groundwater results were reported within the ANZECC recommended range of pH 6.5-8.0 and are generally consistent with historical data.

Surface Water

Surface water for the March 2022 monitoring period reported pH values of between **pH 7.1** (SWC-DOWN2 and SWC_UP, 10/03/2022) and **pH 7.6** (SWP-1, 10/03/2022). All surface water were reported within the ANZECC recommended range of pH 6.5-8.0 and are consistent with historical data.

Leachate

Leachate pH was as reported as **pH 8.8** (LP-1, 07/03/2022). Results were reported above the ANZECC recommended range of pH 6.5-8.5. Leachate pH has been trending upward since September 2021.

6.3.6 Total Suspended Solids (TSS)

TSS provides a measure of turbidity reported as the mass of fine inorganic particles suspended in the water. Measurement of TSS provides a valuable indication of the sediment and potential nutrient load. Elevated TSS decreases light penetration whilst phosphorus is absorbed onto sediment surfaces.

TSS was reported for surface water only. Concentrations for the March 2022 monitoring period were reported between **10 mg/L** (SWC-DOWN, 10/03/2022 and SWC- 2, 10/03/2022) and **12 mg/L** (SWC-DOWN2, 10/03/2022). All results were below the **50mg/L** TV.

TSS results are generally consistent with historical results.

6.4 INORGANIC ANALYTES

Nutrients

Water samples were analysed for select nutrients including Ammonia, Ammonium, Nitrate and Nitrite. The most bio-available forms of Nitrogen are Ammonium (NH4+) and Nitrate (NO3-). Ammonia is an oxygen-consuming compound and is toxic to aquatic biota at elevated concentrations. Ammonia toxicity increases under low oxygen levels and higher ph.

6.4.1 Ammonia

Groundwater

For the March 2022 monitoring period, ammonia was measured within groundwater monitoring bores between **0.20 mg/L** (BH18, 10/03/2022) and **347 mg/L** (BH-1c, 10/03/2022). With the exception of BH-18 all groundwater wells exceeded of the adopted trigger value of **0.91 mg/L** for the March 2022 monitoring period. However, since the corresponding pH was below 8.00 pH units it was not considered significant. This was consistent with historical values.

Surface Water

Ammonia in surface water samples ranged from **0.32 mg/L** (SWC_DOWN_2, 10/03/2022) to **2.21 mg/L** (SWP-1, 10/03/2022). The result for SWP-1, SWC_2, and SWC_UP all exceeded the adopted trigger value of **0.91 mg/L** during the monitoring period. However, since the corresponding pH was below 8.00 pH units it was not considered significant.

Leachate

Ammonia in leachate was reported between **1020 mg/L** (LP1, 07/03/2022). High ammonia concentrations are expected in untreated leachate.

6.4.2 Nitrate

Groundwater

Results for Nitrate in groundwater were reported between **<0.01 mg/L** in multiple bores and **46.10 mg/L** (BH-14, 10/03/2022). Although results generally continue to trend downward a total of four (4) groundwater wells reported exceedances above the TV of 0.7mg/L in the March 2022 monitoring period, including BH-3, BH-12r, BH-13 and BH-14.

Surface Water

The nitrate concentration of the onsite surface water SWP-1 in the March 2022 monitoring period was **0.05 mg/L** (SWP-1; 10/03/2022).

Nitrate concentration for Rocklow Creek surface water samples in the March 2022 monitoring period ranged between **<0.01 mg/L** (SWC-UP; 10/03/2022) and **0.22 mg/L** (SWC-DOWN_2; 10/03/2022).

The Nitrate concentration of all surface water samples was below the TV of **0.7mg/L.**

Leachate

Nitrate concentration of leachate (LP-1) was **<0.1mg/L** in the March 2022 monitoring period.

6.4.3 Nitrite

Groundwater

Results for Nitrate in groundwater during the March 2022 monitoring period were reported between **<0.01 mg/L** in multiple bores and **0.06 mg/L** (BH-3, 10/03/2022). No exceedances were reported for nitrite during the March 2022 monitoring period. All results are below the accepted TV and consistent with previous data.

Surface Water

During the March 2022 monitoring period surface water SWP-1 was reported as **0.08 mg/L**. Although higher than Results are below the accepted TV.

Leachate

Leachate LP1 result was reported as to **<0.1 mg/L** (07/12/2021). Results are below the accepted TV and consistent with previous data.

Anions

6.4.4 Chloride

Groundwater

Results for Chloride in groundwater were reported between **7 mg/L** in (BH-18, 10/03/2022) and **855 mg/L** (BH-1c, 10/03/2022). With the exception of BH-12r which remains consistent with previous data, mean ground water chloride concentration has been trending down since December 2019.

Surface Water

During the March 2022 monitoring period chloride results for surface water SWP-1 was **184 mg/L** (10/03/2022). The results are below the accepted TV and are generally consistent with historical data.

Leachate

Chloride at the Leachate Tank (LP-1) was 1290 **mg/L** (07/03/2022). Chloride results have been trending down since February 2019.

6.4.5 Fluoride

Groundwater

Results for Fluoride in groundwater were reported between **<0.1 mg/L** in multiple bores and **0.6 mg/L** (BH-14, 10/03/2022). Results are consistent with historical data.

Surface Water

Surface water results ranged from of **<0.1 mg/L** (SWC_DOWN and SWC_DOWN_2, 10/03/2022) and **0.4 mg/L** (SWP-1, 10-03-2022). Results are generally consistent with historical data.

Leachate

The fluoride result at the Leachate tank (LP-1) was **0.2 mg/L** (07/03/2022). Results are consistent with historical data.

6.4.6 Sulphate

Groundwater

Results for Sulphate in groundwater were reported between **4 mg/L** (BH-18, 10/03/2022) and **332 mg/L** (BH-22, 10/03/2022). Results are generally consistent with previous data.

Surface Water

Sulphate in surface water ranged from **34 mg/L** (SWC_DOWN, 10/03/2022 and **192 mg/L** (SWP-1, 10/03/2022). Historical data indicates a stepwise reduction in sulphate concentration levels for Rocklow Creek surface waters from 16/06/2021 with further reduction noted in Rocklow Creek during the March 2022 period.

Leachate

Sulphate level at the leachate tank (LP-1) in the March 2022 monitoring period was **<10 mg/L** (07/03/20221). The sulphate concentration in leachate has been trending down since 2017 and has been consistent at **<10 mg/L** since December 2020.

6.4.7 Total Alkalinity

Surface Water

Total Alkalinity at SWP-1 ranged was **276 mg/L** (10/03/2022). Results are consistent with historical data.

Leachate

Total Alkalinity in Leachate (LP-1) was **4,030 mg/L** (07/03/2022). Results are consistent with historical data.

6.4.8 Bicarbonate Alkalinity

Groundwater

Bicarbonate in groundwaters ranged from **76 mg/L** (BH-14, 10/03/2022) to **2,330 mg/L** (BH-1C, 10/03/2022). Results are generally consistent with historical data.

Metals & Metalloids

6.4.9 Manganese

Groundwater

Manganese was analysed as dissolved manganese in groundwater, total manganese in surface water and total manganese in leachate sampling points. Concentrations of dissolved manganese in groundwater for the March 2022 monitoring period were reported between **0.005 mg/L** (BH-3, 10/03/2022) and **0.540 mg/L** (BH-9, 10/03/2022). Results are generally consistent with historical data.

Surface Water

The total manganese concentration at SWP-1 was from **0.180 mg/L** (10/03/2022). Results are consistent with historical data.

Leachate

Total Manganese concentrations in leachate was reported as **0.129 mg/L** (Leachate Tank LP-1, 07/03/2022). A step change reduction in manganese has been noted for the last two (2) monitoring periods with the March 2022 result down by 72% lower on the mean manganese result since Feb 2019. These values are below the adopted TV (1.9 mg/L 95% of Species - freshwater) and are considered acceptable. Concentrations of Manganese should continue to be reviewed during subsequent monitoring events.

6.4.10 Iron (Total Fe)

Iron was measured as total Iron in selected surface water samples including SWP-1 and Leachate Tank.

Surface Water

Concentrations of total iron for onsite surface water was reported as **0.490 mg/L** (SWP-1, 10/03/2022). Results are generally consistent with historical data.

Leachate

Concentration of iron at the leachate Tank (LP-1) was reported between **1.08 mg/L** (07/03/2022). Results are generally consistent with historical data.

6.4.11 Iron (Dissolved Fe)

Groundwater

Dissolved iron was measured within selected groundwater and surface water sampling points. Groundwater results were reported between **0.05 mg/L** (BH3, 10/03/2022) and **12.2 mg/L** (BH1c, 10/03/2022). Results are generally consistent with historical data.

6.4.12 Calcium

Calcium was measured within selected groundwater and surface water sampling points.

Groundwater

Groundwater results were reported between **30 mg/L** (BH-18, 10/03/2022) and **229 mg/L** (BH12r, 10/03/2022). With the exception of BH-12r, reductions in calcium concentration were

observed for all groundwater samples ranging from a 7.46% reduction (BH-1C, 10/03/2022) to 66.4% reduction (BH-4, 10/03/2022).

Surface Water

Calcium in surface water ranged from **15 mg/L** (SWC_DOWN, 10/03/2022) to **42 mg/L** (SWP-1 10/03/2022).

In comparison to historical data calcium levels in Rocklow Creek continue to decline and have reached the lowest recorded levels in the March 2020 monitoring period with percent reductions ranging from 59.6% (SWC_2, 10/03/2020) to 95.1% (SWC_DOWN, 10/03/2022) when compared to mean calcium concentrations form November 2017.

Leachate

Calcium concentration in Leachate (LP-1) for the March 2022 monitoring period was **69 mg/L** (07/03/2020).

Historical observations indicate that low calcium levels have been observed for four (4) of the last six (6) sampling events since 15/12/2020 at LP-1. Leachate calcium concentration for the March 2022 period is 60.3% lower than the mean calcium concentration since 2017 of **174 mg/L**.

6.4.13 Potassium

Potassium was measured within selected groundwater and surface water sampling points.

Groundwater

Groundwater results were reported between **3 mg/L** (BH-18, 10/03/2022) and **205 mg/L** (BH1C, 10/03/2022). With the exception of BH-15 which continues to decrease the potassium levels for groundwaters are generally consistent with historical data.

Surface Water

During the March 2022 monitoring period potassium levels for the offsite groundwaters ex Rocklow Creek ranged from **6 mg/L** (SWC-DOWN, 10/03/2022) to **18 mg/L** (SWC-2 and SWC_UP, 10/03/2022).

Historical data indicates that potassium concentrations in surface waters have been trending down since 2018. A step change reduction which took place in June 2021 coupled with an addition step change reduction in March 2020 has produced the lowest potassium results on record for all Rocklow Creek sample locations with reductions of 62.7% (SWC_2, 10/03/2020) to 98.0% (SWC_DOWN, 10/03/2022) when compared to the mean potassium results for each site since November 2017.

6.5 ORGANIC ANALYTES

6.5.1 Total Organic Carbon

Total Organic Carbon (TOC) provides a measure of the total concentration of organic material in a water sample. TOC is typically higher in surface water than groundwater, however high TOC is also characteristic of leachate from landfill. TOC provides a marker for biological activity associated with contaminant degradation and can be used to delineate contaminant plumes. TOC influences geochemical processes by:

- acting as proton donors/acceptors;
- providing pH buffering;
- participating in mineral dissolution/precipitation reactions; and
- providing carbon substrate for microbe-based biodegradation.

TOC was reported during the March 2022 monitoring period at the following concentrations:

Groundwater

TOC levels ranged between **6 mg/L** (BH-18; 10/03/2022) and **182 mg/L** (BH-1c; 10/03/2022). Results are consistent with historical data.

Surface Water

In the March 2022 monitoring period the TOC levels ranged between 14 mg/L (SWC- DOWN, 10/03/2022) and 28 mg/L (SWC_UP, 10/03/2022). With the exception of SWP-1 results are generally elevated in comparison to historical data.

Leachate

For the March 2022 monitoring period TOC concentration in leachate was **498 mg/L** (LP-1 Leachate Storage Tank 07/03/2022). The results are generally consistent with previous data

7.0 DUST GAUGE RESULTS

The below table provides the results of the dust depositions results. A total of four (4) dust collectors were onsite for one (1) month between **8th February** and **9th March 2022**, in general accordance with AS3580.10.1. A summary of results is provided in **Table 7** below.

Table 7: Summary of Dust Gauge Results

Sample ID	Guideline Criteria (g/m^2/month)	Total Insolvable Matter (g/m^2/month)	Comments
DDG1	4	**0.1**	Satisfactory
DDG2		**<0.1**	Satisfactory
DDG3		**0.3**	Satisfactory
DDG4		**0.3**	Satisfactory

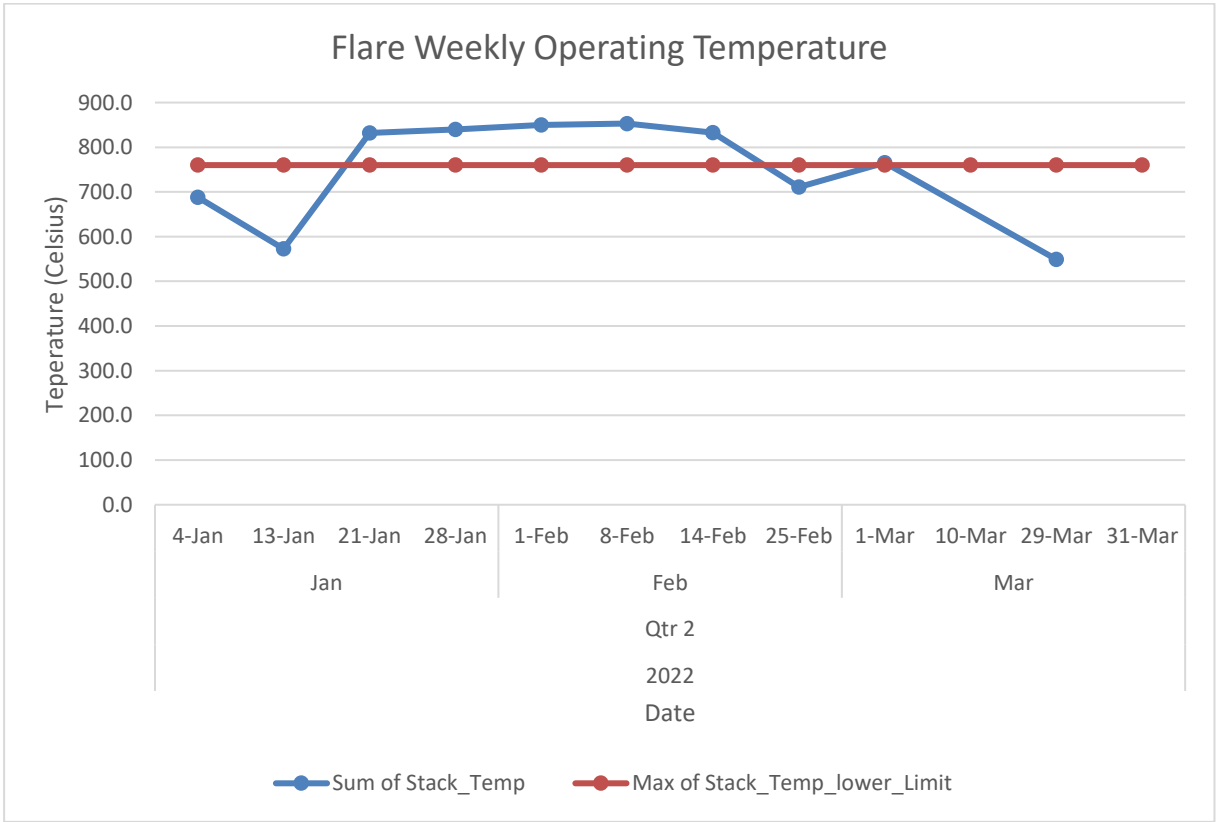
Results for depositional dust during the March 2022 quarterly monitoring period reported levels of dust below the adopted assessment criteria of **4 g/m^2/month**.

The results were considered satisfactory. Dust gauge locations are provided in **Figure 2** attached. It is recommended that monitoring is continued in accordance with EPL 5984.

Table 8: Summary of Flare Operating Temperatures

Monitoring Period	Month	Date	Average Flare Temp
Qtr 2	Jan	4-Jan	688.0
		13-Jan	573.0
		21-Jan	832.0
		28-Jan	840.0
	Mean January Temp		733.3
	Feb	1-Feb	850.0
		8-Feb	853.0
		14-Feb	833.0
		25-Feb	711.0
	Mean February Temp		811.8
	Mar	1-Mar	765.0
		10-Mar	
		29-Mar	549.0
		31-Mar	
	Mean March Temp		657.0
		Qtr 2 Total	**749.4**

Chart 1: Weekly Flare Operating Temperatures March Quarter 2022



Weekly average operating temperatures supplied by LGI displayed typical variation associated with a continuous process.

Weekly operating temperatures at the Flare were generally above the Lower Limit of 760 degrees throughout the March 2022 monitoring period only falling below the lower control limit on 4 out of 10 occasions.

LGI advise that reduced Flare temperatures are a consequence of high moisture levels within the landfill negatively impacting gas extraction operations. The actions taken to address the root causes are outlined in the LGI Gas Flare report included as **Appendix G**.

8.0 METHANE MONITORING

8.1 SURFACE GAS METHANE

The surface gas monitoring for the March 2022 monitoring period *DID NOT* detect any levels of methane above the EPA license limits of 500 ppm. The results were considered satisfactory. A table of results is provided in Appendix D.

8.2 GAS ACCUMULATION MONITORING IN ENCLOSED STRUCTURES

The internal methane testing for enclosed structures within 250m of the landfill during the March 2022 monitoring period *DID NOT* detect any levels of methane above the EPA license limits of 1% V/V. The results were considered satisfactory. A table of results is provided in Appendix D.

9.0 ENVIRONMENTAL ASSESSMENT

9.1 MONITORING POINT SUMMARY

Field measurements and NATA laboratory results for dust and methane results for the March 2022 monitoring period reported satisfactory results. Water results including leachate, groundwater, onsite and offsite surface water reported concentrations of analytes within the range historical values. Water results from the last four (4) years have been tabulated and presented **Charts 1-59** attached.

Groundwater and surface water within the Site boundary generally reported multiple high levels of analytes considered to be characteristic of landfill and leachate. Offsite sample locations within Rocklow Creek generally reported satisfactory results.

Generally, all dust gauges reported satisfactory results over the March 2022 monitoring period.

Results of surface methane gas monitoring recorded satisfactory results. The landfill surface cap was therefore considered intact and effective during the monitoring period.

Gas accumulation monitoring reported satisfactory results for all enclosed structures within 250m of emplaced waste or leachate storage facility.

Results for flare monitoring reported consistent temperature exceedances throughout the March 2022 monitoring period.

9.2 ENVIRONMENTAL MANAGEMENT

9.2.1 Landfill Operations

ENRS understand 'solid' waste (general solid waste putrescible and non-putrescible) landfill operations are ongoing at the Site. Landfill practices should be conducted in accordance with the Site's Landfill Environmental Management Plan (LEMP) and the EPA Solid Waste Landfill Guidelines (EPA; 2016).

9.3 ENVIRONMENTAL SAFEGUARDS

Appropriate management actions are required to continue to prevent and detect potential groundwater and surface water pollution. The nearest sensitive receptors for any uncontrolled Site water and leachate include; areas of adjoining bushland; recreational users of the Minnamurra River estuary environs, down gradient stakeholders; and down gradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems (GDE).

It is recommended that any drainage and detention structures are inspected annually by a suitably qualified environmental professional to assess their structural integrity and identify the need for any maintenance (such as removal of deep rooted vegetation, sediment, and re-lining).

Access tracks to sampling points should be inspected prior to each quaterly sampling events.

Continue to review annual surface and groundwater monitoring results from up and down gradient of the land fill cells and offsite sampling locations within Rocklow Creek. Continue to monitor surface methane gas in order to assess the cappping integrity of the landfill cells.

9.4 MONITORING PROGRAM

The water, dust and surface methane monitoring program are required to demonstrate that Site activities are not generating any off-site pollution. The Site's EPL's and monitoring regime should be reviewed annually.

Review of the March 2022 monitoring results indicate no significant change in environmental conditions at the Site during the past 3 months. Future sampling events should continue to monitor the key indicators of leachate within surface and ground waters, especially concentration of ammonia and nitrate.

Should monitoring continue to report any significant changes in analyte concentrations the need for additional monitoring locations should be reviewed, including additional groundwater monitoring bores both up and down gradient locations of areas with analytical exceedances.

It is recommended that water quality results from future monitoring rounds continue be forwarded to a suitably qualified environmental professional for review within the laboratory holding time to compare against relevant guidelines and identify any irregularities so that additional testing may be conducted within the holding time.

10.0 CONCLUSIONS

Based on the findings obtained during the March 2022 monitoring program the following conclusions and recommendations are provided:

- Shallow groundwater flow is expected to mimic topography with low hydraulic gradients flowing towards the south and southeast towards Rocklow creek. The nearest sensitive receptors are likely to include; recreational users of the Minnamurra River estuary environs; down gradient stakeholders; and downgradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems near discharge zones;
- Groundwater throughout the monitoring period reported exceedances of the assessment criteria for; ammonia, heavy metals, nitrate, sulphate and salinity (EC) within multiple groundwater bores including; BH-1c, BH-3, BH-4, BH-9, BH-12r, BH-13, BH-14, BH-15, BH-18, BH-19r, BH-21 and BH-22. This was considered to be consistent with historical values;
- Rocklow Creek surface water samples (SWC-Up, SWC-2, SWC-down and SWC-down 2) were reported within the adopted Site Assessment Criteria;
- During the March 2022 quarter further reductions in analyte concentrations of all Rocklow Creek surface water samples (SWC-Up, SWC-2, SWC-down and SWC-down 2) were observed for Potassium, Calcium and Sulphate and Fluoride.
- Flare operating temperature were generally observed to be above the target operating threshold of 760 degrees Celsius but did fall below on four (4) occasions during the monitoring period. Operations taken by the operator to address the root causes of the low Flare Stack temperatures are outlined in the monthly LGI reports attached as **Appendix G**;
- Surface gas methane monitoring reported satisfactory results all within the adopted assessment criteria;
- Gas accumulation monitoring reported satisfactory results for all enclosures tested within 250m of emplaced waste or leachate storage facility;
- Dust deposition gauges recorded satisfactory results below the guidelines provided in AS3580.10.1. Monitoring should continue in accordance with EPL 5984 requirements;
- No non-compliances with the EPL were reported during the March 2022 monitoring period;
- Based on this review of the March 2022 monitoring period, contaminants associated with the landfill cell, leachate dam/s and general site uses are considered to be relatively consistent with the range of historical results;
- Should any change in Site conditions or incident occur which causes a potential environmental impact, a suitable environmental professional should be engaged to further assess the Site and consider requirements for any additional monitoring; and
- This report must be read in conjunction with the attached Statement of Limitations.

11.0 LIMITATIONS

This report and the associated services performed by ENRS are in accordance with the scope of services set out in the contract between ENRS and the Client. The scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

ENRS derived the data in this report primarily from visual inspections, examination of available records, interviews with individuals with information about the site, and if requested, limited sample collection and analysis made on the dates indicated. In preparing this report, ENRS has relied upon, and presumed accurate, certain information provided by government authorities, the Client and others identified herein. The report has been prepared on the basis that while ENRS believes all the information in it is deemed reliable and accurate at the time of preparing the report, it does not warrant its accuracy or completeness and to the full extent allowed by law excludes liability in contract, tort or otherwise, for any loss or damage sustained by the Client arising from or in connection with the supply or use of the whole or any part of the information in the report through any cause whatsoever.

Limitations also apply to analytical methods used in the identification of substances (or parameters). These limitations may be due to non-homogenous material being sampled (i.e., the sample to be analysed may not be representative), low concentrations, the presence of 'masking' agents and the restrictions of the approved analytical technique. As such, non-statistically significant sampling results can only be interpreted as 'indicative' and not used for quantitative assessments.

The data, findings, observations, conclusions and recommendations in the report are based solely upon the state of the site at the time of the investigation. The passage of time, manifestation of latent conditions or impacts of future events (e.g., changes in legislation, scientific knowledge, land uses, etc) may render the report inaccurate. In those circumstances, ENRS shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of the report.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between ENRS and the Client. ENRS accepts no liability or responsibility whatsoever and expressly disclaims any responsibility for or in respect of any use of or reliance upon this report by any third party or parties.

It is the responsibility of the Client to accept if the Client so chooses any recommendations contained within and implement them in an appropriate, suitable and timely manner.

12.0 REFERENCES

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FIGURES

TABLES

CHARTS

APPENDICES

Appendix A

EPL 5984 Sampling Point Summary (NSW EPA, 10/05/2021)

2	Leachate monitoring	Leachate tank labelled LP1 on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
3	Groundwater monitoring	BH1c - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
5	Groundwater monitoring	BH3 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
6	Groundwater monitoring	BH4 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
7	Groundwater monitoring	BH15 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
10	Groundwater monitoring	BH13 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
11	Groundwater monitoring	BH14 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
16	Groundwater monitoring	BH19 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
17	Groundwater monitoring	BH12R - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).

18	Groundwater monitoring	BH9 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
19	Surface Water Monitoring	SWC_2 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
20	Surface Water Monitoring	SWC_UP - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
21	Surface Water Monitoring	SWC_DOWN - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
22	Surface Water Monitoring	SWC_DOWN2 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
23	Groundwater Monitoring	BH21 - as shown on drawing titled "Monitoring Point Location Plan - Dunmore Recycling and Waste Depot - EPL No. 5984" prepared by Cardno and attached to correspondence dated 7 April 2020 (EPA ref. no. DOC20/317779).
24	Groundwater monitoring	BH22 - as shown on drawing titled "Monitoring Point Location Plan - Dunmore Recycling and Waste Depot - EPL No. 5984" prepared by Cardno and attached to correspondence dated 7 April 2020 (EPA ref. no. DOC20/317779).
25	Groundwater monitoring	BH18 - as shown on drawing titled "Monitoring Point Location Plan - Dunmore Recycling and Waste Depot - EPL No. 5984" prepared by Cardno and attached to correspondence dated 7 April 2020 (EPA ref. no. DOC20/317779).

Appendix B

Laboratory Chain of Custody (COC) & Certificates of Analysis (COA) – Water Samples

Appendix C

Laboratory Chain of Custody (COC) & Certificates of Analysis (COA) – Dust Samples

Appendix D

Surface Gas (Methane) Field Sheets

Appendix E

Laboratory Chain of Custody (COC) & Certificates of Analysis (COA) – Overflow Event

Appendix F

Calibration Certificates

Appendix G

Gas Flare Reports