



Selfs Point Sewage Treatment Plant (STP) Expansion Project:
12 Selfs Point Road and part of 10 Selfs Point Road
LFG Rapid Screening Risk Assessment Report (FINAL)

Prepared for
TASWATER CDO
169 MAIN RD
MOONAH TAS 7009

20th February 2023
PROJECT REFERENCE: JN22392
Elgin Associates Pty Ltd
ABN 59123488639

DOCUMENT INFORMATION

Document Information

Author (s): Ms Erika Heiden Dr Luke Finley

Project Manager: Dr Luke Finley

Reviewed and Authorised by: Mr Andrew Roberts – Elgin
(CEnvP-SC No. SC41173) Date: 20th February 2023
Status: Final

External Peer Reviewer: Mr Nick Simmons – Australian Environmental Auditors
(CEnvP No. 1492)

Filename(s): JN22392_Selfs Point STP_LFG RSRA_20022023

Project: Elgin JN22392

Contact: **Elgin Associates Pty Ltd** ABN 59123488639
258 Argyle Street, North Hobart, TAS, 7000
Telephone: +61 417 598807 Fax: +61 3 86486336 www.elgin.com.au

Record of Report Status

Item	Status	Date	Prepared for:
1 Digital	Draft	1 st December 2022	ERA Planning and Environment
1 Digital	Final	20 th February 2023	ERA Planning and Environment

EXECUTIVE SUMMARY

Elgin Associates Pty Ltd (Elgin) was engaged by ERA Planning and Environment (ERA) to undertake a Landfill Gas (LFG) Rapid Screening Risk Assessment (RSRA) for the Selfs Point Sewage Treatment Plant (STP) expansion project, Tasmania. The LFG RSRA will inform an Environmental Impact Statement (EIS) for the expansion of the STP to a neighbouring land parcel, and identify potential risks from landfill gas, appropriate mitigation measures and liabilities.

The land subject to the proposed STP expansion includes the following:

- 12 Selfs Point Rd (existing STP), owned by TasWater, and
- part of 10 Selfs point Rd (known as the New Town Wetlands – a historic closed landfill), owned by Hobart City Council (HCC) and located to the south and southwest of the STP.

The extent of this RSRA is limited to 10 Selfs Point Road, which includes the New Town Wetlands. It is limited to the assessment of risks from potential landfill gas accumulation and potential implications for the construction and operation of the STP project at the site. Assessment of risks to off-site receptors, groundwater and surrounding land uses has been undertaken by external parties including GHD and Hobart City Council; these assessments are ongoing and unreported.

Based on a review of preliminary design plans, the expansion project footprint is proposed to incorporate the entirety of the wetlands and a Council laydown area at 10 Selfs Point Road. The geology of the ‘wetlands’ site is comprised of various strata, including dredged river sediments (from the River Derwent that were used to build the wetland), landfilling (municipal and trade waste), and biosolids disposal.

Previous works at the site, including a gap analysis (Elgin, 2022a) and a contaminated site assessment report (Elgin, 2022b), have both recommended further investigation and assessment of LFG risks.

Key findings of the assessment include:

General

- Elevated concentrations of methane and carbon dioxide in the subsurface were confirmed in landfill gas bores, retrofitted groundwater bores, escaping the ground surface, and in utility pits (such as stormwater pits).
- The subsurface geology intercepted during drilling LFG bores was highly variable, but dominated by sandy loam, clay, silt and gravel with cobbles and waste material comprised of brick, waste steel and wire, glass and wood. The depth of waste was deeper on the southern side (LFG05 and LFG06) where strong hydrocarbon odours and black sediments were noted at around 2.5 meters below ground level (mbgl) to the depth of investigation at ~8 mbgl.
- The extent of the landfilled area extends beyond the boundaries of 10 Selfs Point Road. Landfill material has been identified in previous investigations to at least 8.0 mbgl on the site, and this is consistent with observations made during this investigation. Groundwater was intercepted in some bores at approximately 7.0 mbgl, indicating that waste material may be saturated at times. Electrical conductivity varied from fresh to brackish in the groundwater bores on the site, suggesting that there may be some areas of the site that are influenced by tidal fluctuations. The potential for a tidal pumping effect (in addition to variations in atmospheric pressure) of LFG from the waste into adjacent soils, may increase the potential for LFG migration laterally and vertically.

On-site (wetlands at 10 Selfs Point Road)

EXECUTIVE SUMMARY

- LFG bores installed within the wetland parcel contained high concentrations of methane and carbon dioxide in exceedance of adopted trigger levels, with the exception of LFG01 and LFG02.
- Methane concentrations were within or above the explosive range in most bores, indicating that there is a risk of explosion if conditions are suitable.
- Low oxygen concentrations (oxygen depletion) was recorded in most wells, indicating there may be asphyxiant risks in the subsurface, and concentrations of carbon dioxide ranged from 5.0% to 29.9% v/v. Carbon dioxide is an asphyxiant and a toxic gas that is odourless, colourless and significantly denser than air. Toxic effects may become noticeable at 2% v/v and severe at 5% v/v so the results are significant.
- Landfill gas sweeps were limited to the perimeter of the wetlands parcel due to access issues (thick vegetation). Fugitive LFG emissions at low levels were detected escaping from the ground surface to the north of the Ten Lives cat centre.
- The presence of hard surfaces over, or adjacent to, LFG source material (such as the tarmacked carpark to the west of the wetlands) can promote subsurface lateral migration of LFG into underground services and buildings.
- A change in the permeability of the surface of the wetlands, such as with construction of the expanded STP and associated (impermeable) infrastructure, could increase fugitive emissions to migrate laterally in all directions (without appropriate controls), would potentially increase the risks off-site.
- The high concentrations of methane detected within the development footprint has implications for the ongoing use of the site as an STP, such as the accumulation of vapours within new structures (including asphyxiation risks from both methane and carbon dioxide). Measures to assess and control these risks during and post construction would be required.

Northern Boundary

- Methane was not detected in the two bores installed within the existing STP site. However, carbon dioxide concentrations ranged from 5% v/v to 12.2% v/v, which should be further investigated using continuous monitoring devices to ensure that these bores are not impacted by methane at other times.
- LFG sweeps in the northern boundary area detected low concentrations of methane escaping the ground surface adjacent to the fence separating the wetlands and the STP, indicating that a subsurface source or pathway of methane may be present at times.
- Fill materials were noted during drilling of LFG01 and LFG02 within the existing STP parcel, however, indicators of domestic waste were not encountered, with subsurface conditions more representative of reclaimed land comprising mixed soil containing gravel, cobbles, wood and brick. The uncertainty around a potential migration pathway via made ground needs to be further assessed to ensure the existing operation of the STP, and workers within site buildings are safe at all times.

Western Boundary (adjacent carpark, bridge club and rowing shed).

- LFG bores installed along the western boundary of the wetland parcel recorded concentrations of both methane and carbon dioxide in exceedance of adopted trigger levels. The highest concentrations were detected at LFG04 (located to the west between the wetland parcel and the Bridge Club) and at a new groundwater well MW09. It is noted that fill materials were present during drilling of LFG03 and LFG04, and based on observations of wood/bark fines, steel, glass, brick and tree branches, it is assumed that waste material underlies this location.

EXECUTIVE SUMMARY

- A confining surface layer of asphalt/concrete exists in this area, which would facilitate the migration of landfill gas via the permeable geology (waste), or in utility / service alignments. This was verified by the detection of low levels of methane in the carpark stormwater system and utility pits during the utility sweeps.
- Methane was recorded within or above the explosive limit in LFG04 and MW09, as well as levels of carbon dioxide above 5% v/v at all locations, combined with oxygen depletion. Methane gas sweeps of the carpark identified two occurrences of methane exceeding the action levels in utility pits or escaping the tarmac, with both exceedances recorded in the vicinity of the Bridge Club.
- The carpark, bridge club and rowing shed are surrounded by an area of impermeable surfaces which increases the risk of lateral migration of landfill gas.

Eastern and Southern boundaries

- Significant waste material was encountered in bores LFG05 and LFG06, which contained very high levels of methane and carbon dioxide. LFG migration is therefore likely occurring beyond these boundaries and should be investigated.
- Although LFG bores were drilled within the wetland parcel in the east and south, perimeter bores were not installed along these boundaries. Historical mapping layers indicate that landfilling extended southwards to the Rugby Park, however the area to the east is Selfs Point Road and then a cemetery.

Gas Screening Value (GSV) and Characteristic Gas Situation (CS)

Based on the monitoring results and the CSM, the overall CS classification of the site is CS4 – Moderate to High Risk, based on the data and current site conditions.

The GSV for the site should be recalculated when additional monitoring data becomes available and the CSM further refined when knowledge of the development's sub-structure and foundation arrangement are detailed. Determining the gas protection measures required to manage risks associated with the high concentrations of LFG at the site should be a key focus of the design team. The aim of the protection measures would be to protect existing and future users of existing buildings surrounding the site, including construction workers.

Appropriate gas protection measures can be selected based on the CS and the nature of the proposed development on the site. The types of controls considered appropriate for a CS4 site include:

- Passive sub-floor ventilation.
- Sub-floor ventilation with active abstraction or pressurisation.
- Reinforced concrete ground-bearing foundation raft slab with limited service penetrations cast into slab.
- Reinforced concrete cast in situ or post-tensioned suspended slab with minimal service penetrations and water bars around all penetrations and at joints.
- Proprietary gas-resistant membrane with a gas transmission rate for the gases of concern on the site that is certified and appropriate to the overall design of the gas protection system. It should be installed by a specialist to an appropriate level of workmanship with documented internal construction quality control (CQC), including integrity testing (e.g. tracer gas or smoke testing), under independent construction quality assurance (CQA) carried out by a certified specialist(e) or appropriately qualified and experienced professional with independent verification of the entire process.
- Permanent monitoring system installed in the occupied spaces of the building.

EXECUTIVE SUMMARY

- Permanent monitoring system installed in the underfloor venting or dilution system.

The following recommendations and management measures should be carried forward:

Before Construction – 10 Selfs Point Road (proposed development site)

- Further assessment of landfill gas risks to inform a LGRA and appropriate management of the development, including:
 - Assessment of the potential for landfill gas to migrate laterally using continuous LFG monitoring equipment, particularly adjacent to existing buildings such as the Selfs Point Laboratory.
 - Review the detailed design to assess and potential for increased risks from the expansion of the STP across the wetlands area.
 - Review of proposed landfill gas control measures required for the construction of the STP expansion.
 - The LGRA for the wetland parcel would inform the development of a Construction Environmental Management Plan (CEMP) to manage human and ecological risks during construction.

Before Construction – 12 Selfs Point Road (existing STP site)

A comprehensive LGRA that investigates the potential for landfill gas to migrate from the Wetland area, northwards to the existing STP, with considerations that include:

- Determine the extent of the LFG migration (if any) and risks to off-site receptors to the north.
- Reviewing the construction details of buildings to understand the likelihood of preferential pathways to be present that may allow LFG inside the building envelope.
- Regular monitoring of landfill gas bores, including continuous monitoring of bores (LFG01 & LFG02) that already exist, and continuous monitoring of the internal air quality to understand risk to occupants.
- Screening for landfill gas emissions in service alignments, utility pits, nearby buildings, and from passive surface emissions (hotspots) from the known landfill area using methane detection equipment.
- Delineate the extent of landfilling waste to inform potential source control measures.
- Inform on-site workers and utility service providers of the potential for LFG at the site.

During Construction

- Detailed risk control measures have not been defined in this RSRA, but will be required following the collection of additional information on the temporal behaviour of LFG in the vicinity of the development.
- A CEMP should be prepared to inform the construction, including the protection of workers, contaminated sites soils, detection of LFG emissions, accumulation of hazardous gases (explosive and asphyxiants), management of shallow groundwater, and appropriate responses to unexpected finds.

Post Construction

Landfill Gas will likely require on-going management at the site and would be managed under the guidance of an Operational Environmental Management Plan (OEMP).

TABLE OF CONTENTS

DOCUMENT INFORMATION	i
EXECUTIVE SUMMARY.....	ii
TABLE OF CONTENTS.....	v
LIST OF FIGURES, TABLES AND APPENDICES	vi
GLOSSARY.....	vii
1 INTRODUCTION	10
1.1 <i>Project Objectives</i>	10
1.2 <i>Scope of works</i>	10
1.3 <i>Limitations</i>	11
2 Background Information	12
2.1 <i>History</i>	12
2.2 <i>Site Details and Environmental Setting</i>	12
2.3 <i>Proposed Development at 10 Selfs Point Road</i>	13
2.4 <i>Current and proposed land use and zoning</i>	13
2.5 <i>Surrounding land use and zoning</i>	13
2.6 <i>Topography, Geology and Hydrogeology</i>	14
3 METHODOLOGY.....	16
3.1 <i>Fieldwork Methods</i>	16
3.2 <i>Landfill Gas Trigger Levels</i>	17
4 RESULTS	19
4.1 <i>Drilling Conditions and Subsurface Geology</i>	20
4.2 <i>Groundwater</i>	20
4.3 <i>LFG Screening Results</i>	21
5 DISCUSSION.....	23
5.1 <i>On-site (wetlands at 10 Selfs Point Road)</i>	23
5.2 <i>Northern boundary</i>	24
5.3 <i>Western Boundary (adjacent carpark, bridge club and rowing shed).</i>	24
5.4 <i>Eastern and Southern areas</i>	25
6 Updated Conceptual Site Model.....	26
7 Preliminary Landfill Gas Risk Assessment and Control Measures	28
7.1 <i>Gas Screening Value (GSV) and Characteristic Gas Situation (CS)</i>	28
7.2 <i>Control Measures</i>	28
7.3 <i>Recommendations and Management Measures</i>	32

TABLE OF CONTENTS

7.4	<i>Data Gaps and Uncertainties.....</i>	35
8	CONCLUSIONS AND RECOMMENDATIONS.....	36
8.1	<i>Landfill Gas levels</i>	36
8.2	<i>Recommendations and Management Measures.....</i>	38
9	REFERENCES	40
10	LIMITATIONS	42

LIST OF FIGURES, TABLES & APPENDICES

List of Tables (in text)

Table 1 Land Details.....	12
Table 2: Surrounding land use	13
Table 3. Subsurface geology identified from previous investigations.....	14
Table 4: LFG assessment criteria	17
Table 5 Fieldwork Summary	19
Table 7 LFG results exceeding the adopted action levels.....	21
Table 8 LFG sweep results exceeding the adopted action levels	22
Table 9 CS by site characteristic GSV (adopted from BS 8485:2015+A1:2019)	28
Table 10 Guidance values for gas protection (adapted from NSW EPA, 2020).....	29
Table 11 Scores for protection measures (adapted from Table 9, NSW EPA, 2020 - refer for further details)	30
Table 12 Recommendations and Management Measures Before, During and Post Construction	33

List of Appendices (Attached)

Appendix A	Figures
Appendix B	Tabulated results
Appendix C	Drilling Logs
Appendix D	Scanned Field notes

GLOSSARY

ASC-NEPM	National Environment Protection (Assessment of Site Contamination) Measure 1999, amended 2013
BPEM	Best Practice Environmental Management
BS	British Standard
CIRIA	Construction Industry Research and Information Association
CSM	Conceptual Site Model
CSU	Contaminated Sites Unit
DPIWE	Department of Primary Industries, Water and Environment
DQO	Data Quality Objectives
EMPCA	Environmental Management and Pollution Control Act 1994.
EPA	Environment Protection Authority
GSV	Gas Screening Value
LEL	Lower Explosive Limit
LFG	Landfill Gas
mbgl	Meters below ground level
mBTOC	Meters Below Top of Casing
SWMS	Safe Work Method Statements
RSRA	Rapid screening risk assessment
SPS	Sewage Pump Station
STP	Sewage Treatment Plant
SWL	Static Water Level
UEL	Upper Explosive Limit
VOC	Volatile Organic Compound
N/A	Not Applicable

INTRODUCTION

1 INTRODUCTION

Elgin Associates Pty Ltd (Elgin) was engaged by ERA Planning and Environment (ERA) to undertake a landfill gas rapid screening risk assessment (LFG RSRA) for the Selfs Point Sewage Treatment Plant (STP) expansion project, Tasmania. The investigations are required for the preparation of an EIS.

The land subject to the proposed STP expansion includes the following:

- 12 Selfs Point Rd (existing STP), owned by TasWater, and
- part of 10 Selfs point Rd (known as the New Town Wetlands – a historic closed landfill), owned by Hobart City Council (HCC) and located to the south and southwest of the STP.

Elgin has undertaken previous works at the site, which have included a gap analysis for the project in March 2022 and a contaminated site assessment report (CSA) in June 2022. The findings were provided in the following reports:

- Selfs Point STP Expansion – Environmental Data Gap Analysis and Recommendations for Further Sampling. Prepared for ERA Planning & Environment by Elgin Associates, 10 March 2022 (Elgin, 2022a).
- Selfs Point STP Expansion Project – Contaminated Site Assessment Report. Prepared for ERA Planning & Environment by Elgin Associates, 8th June 2022 (Elgin, 2022b).

Based on the Elgin 2022b report, a number of investigations were recommended including further assessment of LFG risks at the portion of the site that includes the New Town Wetlands (historic closed landfill). This report presents the findings of the LFG RSRA at the site in order to inform the EIS.

The site layout and location of the proposed infrastructure are shown in attached **Figure A1**. For the purposes of this report, the site is defined as the proposed project footprint within both 10 Selfs Point Road.

1.1 Project Objectives

The objectives of the investigation were to complete a LFG RSRA of landfill gas at the site in order to identify risks and management and mitigation measures for final design and construction of the STP expansion onto the former wetlands. The completed RSRA would also be used for consideration as part of the land acquisition due diligence for the wetlands portion of the site - so that potential liabilities are highlighted.

1.2 Scope of works

The scope of work included the following:

- Review of underground services, land ownership and service clearance for six LFG bore locations;
- Drilling and installation of dedicated LFG monitoring bores at the site;
- Completion of at least two LFG monitoring events during suitable climatic conditions;
- Screening the ground surface and utility pits around the wetland parcel for methane;
- Preparation of a RSRA report including:
 - Results of LFG bore monitoring and utility / surface screening events;
 - Preliminary Conceptual Site Model (CSM);

INTRODUCTION

- Highlight potential risks from LFG to current or future receptors on the wetland parcel; and
- If required, recommendations for control and mitigation measures of LFG for the construction and operational phases of the STP project.

1.3 Limitations

This RSRA is limited to the assessment of risks from potential landfill gas accumulation and potential implications for the construction and operation of the STP project at the site, as informed by the scope described in **Section 1.2**. Assessment of risks to off-site receptors, groundwater and surrounding land uses has been undertaken by external parties including GHD and Hobart City Council; these assessments are ongoing and unreported.

This report has been prepared with reference to relevant environmental legislation, standards and guidance including (but not limited to):

- CIRIA, 2007. Assessing Risk Posed by Hazardous Ground Gases to Buildings, Publication CIRIA C665, Construction Industry Research and Information Association (CIRIA). London, 2007.
- British Standard (BS) 2019. 8485: 2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. BS1 Standards Publication. ('BS8485').
- DPIWE, 2004. Landfill Sustainability Guide. Tasmania September 2004.
- EPA NSW, 2019. Assessment and management of hazardous ground gases. Contaminated Land Guidelines. Amended May 2020. NSW Environmental Protection Authority, Parramatta, NSW.
- EPA Victoria, 2018. Landfill Gas Fugitive Emissions Monitoring Guidelines, Publication 1684.
- EPA Victoria, 2015. Best Practice Environmental Management (BPEM); Siting, design, operation and rehabilitation of landfills. Publication 788.3. Environmental Protection Authority Victoria, August, 2015.
- *National Environmental Protection (Assessment of Site Contamination) Measure 1999 (amended 2013)* ('ASC-NEPM').
- Tasmania Environmental Management and Pollution Control Act, 1994 (EMPCA).

BACKGROUND

2 BACKGROUND INFORMATION

2.1 History

The New Town Bay wetlands were constructed over the top of a historic municipal landfill, which extended from the playing fields on the western side of the Brooker Highway, to the current location of the Selfs Point STP. This municipal landfill was known as Hobarts' largest and longest active landfill, which operated from around 1930 to 1963. The landfill accepted municipal waste, trade waste and building rubble (Tamvakis, M. 1994), although specific details on the extent of the landfilling area, including the depth of waste is not known. Clay material was used to cap the landfill area, which later provided a clay base for the construction of the wetlands, however, the landfill was never rehabilitated or capped appropriately and an ongoing use of the site, as wetlands, followed.

The wetlands were built in the late 1990's from material dredged from New Town Bay. The dewatered dredged material was placed on top of the clay base and shaped to create channels and crests. The area was then covered with approximately 0.3 m of a mixture of soil and organic rich sewage biosolids. The maximum height of the constructed wetland above the landfill material was designed to be 2 m (Koehnken, 2013). Hobart City Council temporarily decommissioned the wetlands, around 2011, to halt the ongoing build-up of salts and nutrients in the system, resulting in the wetlands drying out (Koehnken, 2013).

Additional information on the history of the site and previous investigations is provided in Elgin (2022a and 2022b).

2.2 Site Details and Environmental Setting

The site is located between the New Town Rivulet, New Town Bay and Selfs Point Road, New Town.

The northern portion of 10 Selfs Point Road (known as the New Town Bay Wetlands) has been most recently used as an artificial wetland, with a portion along Selfs Point Road that has been used by Council for the stockpiling of waste materials. The wetland and stockpiling area are fenced, although there is public access available to the wetlands off Marine Esplanade. The wetland area of 10 Selfs Point Road is heavily vegetated with grasses and blackberries. The remaining portions of 10 Selfs Point Road are used for playing fields (Rugby Park), the Council Depot and commercial use (TasCabling depot).

Land details are provided in **Table 1** below.

Table 1 Land Details

Property Address	Property ID	Authority	Current Land Use	Proposed Land Use*
12 Selfs Point Road	3286956	TasWater	Selfs Point STP	Selfs Point STP expansion to the area of open space to the north of the property
10 Selfs Point Road	3189590	Local Government Authority	New Town Bay Wetlands Rugby Park Council depot TasCabling depot	The portion known as New Town Bay Wetlands is proposed to be acquired by TasWater for Selfs Point STP expansion to the south

* As described in Drawing 0089-DWG-SELST01-GA-C-001 dated 04/05/2022

The northern portion of 12 Selfs Point Road (north of the current STP infrastructure) consists of an open space area used for stockpiling of soils and building waste and for the irrigation of treated sewage during peak periods (pers. comm Scott Lucas - TasWater). The area is fenced with no public access. The southern

BACKGROUND

portion of 12 Sels Point Road consists of the STP and associated infrastructure, internal road network and the Sels Point Laboratory. The laboratory is located on the north western side of the STP, adjacent to the north of the wetlands at 10 Sels Point Road.

2.3 Proposed Development at 10 Sels Point Road

The proposed STP expansion to 10 Sels Point Road is illustrated on **Figure A1 (Appendix A)** and based on the 75% concept design diagrams (drawing 0089-DWG-SELST01-GA-C-001, dated 04/05/2022). The design illustrates the layout of the site, which would include a number of industrial buildings (i.e. switchrooms, blower building, sludge handling), and infrastructure (i.e. bioreactors, tanks, treatment units, digesters). It is not known at this stage whether the site is proposed to be fully or partially sealed with concrete or other impermeable surface or if any sub-surface infrastructure is proposed to be installed. There does not appear to be any proposed buildings that would be in continual use by site workers (i.e. office or laboratory), however many of the buildings would require intermittent use, such as for maintenance, by workers on the site and may be enclosed.

2.4 Current and proposed land use and zoning

Zoning under the Tasmanian Interim Planning Scheme (2015) as shown on the LIST (2022) is as follows:

- 10 Sels Point Rd – 18.0 Recreation
- 12 Sels Point Rd – 28.0 Utilities

2.5 Surrounding land use and zoning

The site is located on the banks of the River Derwent in an industrial area, which includes commercial / industrial land, public open space, a cemetery and recreational land. A summary of surrounding land use is provided in **Table 2**.

Table 2: Surrounding land use

Direction	Zoning	Current land use	Additional information/Receptors
North (site)	28.0 Utilities	Sels Point STP (adjacent wetlands)	STP with associated control buildings, laboratory, service alignments, and other wastewater infrastructure.
North	29.0 Environmental Management 18.0 Recreation	River Derwent and banks	Located beyond the STP to the north. Recreational open space receptors.
East	18.0 Recreation	Commercial / Industrial	Council Depot with various containers and open storage areas; Ten Lives Cat Centre facility.
North east	31.0 Port & Marine	Commercial / Industrial	Former Shell Fuel storage 16 Sels Point Rd. Unknown if site is active.
South	18.0 Recreation	Commercial/ Industrial and then Public open space	TasCabling depot and part recreational zone dominated by rugby fields and associated sporting clubrooms.
West	18.0 Recreation	Public open space	Bridge Clubrooms, Rowing sheds, Council laydown compound, and a large carpark for visitors to the buildings.

BACKGROUND

2.6 Topography, Geology and Hydrogeology

The site elevation ranges between 0 and 10 meters Australian Height Datum (m AHD) and is generally level at 12 Sels Point Road, and elevated, but undulating due to the constructed wetland on the 10 Sels Point Road portion. The wetlands area is approximately 3-4 m higher than the Sels Point STP which slopes gently to the north-west.

The site is predominantly reclaimed material of man-made deposits including a municipal landfill, and land reclamation with fill (**Figure 1**). A summary of the soil profile is provided in **Table 3** and **Figure 1** below.

Table 3. Subsurface geology identified from previous investigations

Depth (mbgl)	Strata Description EM&C (2016)	Depth (mbgl)	Strata Description GHD (2021)
0.0-2.0	Fill: Silty sand and clayey sand	0.0-0.2	Topsoil
		0.2-0.5	FILL - Sandy Silt
		0.2-1.2	FILL – CLAY, gravelly/sandy
		0.8-2.0	FILL – CLAY with landfill
2.0-8.0	Fill: Landfill waste material (various rubbish, brick, wood, metal and paper) through a matrix of silt and clayey sand		
8.0-20.0	Organic silt and clay lenses with occasional shell fragments over weathered basalt and dolerite		
>20.0	Continuous basalt		

There were seven groundwater monitoring bores installed on the site in 2016 (four on 12 Sels Point Road and three installed on 10 Sels Point Road). Groundwater levels measured in April 2022 ranged between 0.210 and 1.454 mAHD at 12 Sels Point Road, and between 0.541 and 0.808 mAHD at 10 Sels Point Road. Additional groundwater wells were installed in 2022 by GHD for a separate investigation (currently unreported – well IDs shown in **Appendix A (Figure A1)**).

Electrical Conductivity in the groundwater bores ranged from 1,800 to 18,000 uS/cm, with the variability indicating potential impacts from the estuarine waters of New Town Bay. A portion of the base of the landfill (around 1.0 to 1.5 m) within the wetlands is likely submerged below groundwater, with potential immersion of waste occurring during fluctuations of the tide. However, the relationship between changes in groundwater level and fluctuating LFG concentrations should be confirmed using continuous monitoring of groundwater levels and LFG over days to weeks.

BACKGROUND

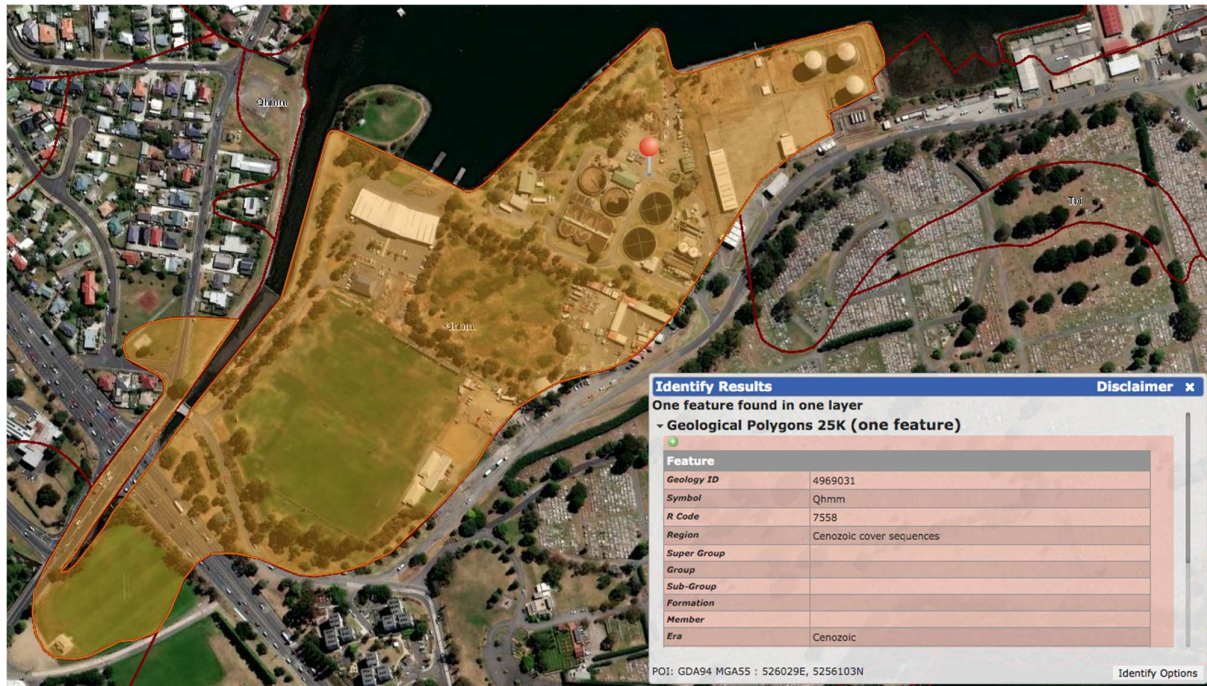


Figure 1: Distribution of landfilling or reclamation areas (man-made deposits), as indicated by the Qhmm geology code. (Source: ListMap 2022).

3 METHODOLOGY

3.1 Fieldwork Methods

The RSRA involved the installation of LFG bores around the perimeter of the wetlands site, gas monitoring from those bores, as well as utility pit and ground surface screening for methane. **Table 5** provides details of the fieldwork activities completed during the RSRA. The location of all monitoring wells and features of interest are illustrated in **Appendix A (Figures A1, A2 and A3)**.

3.1.1 Service Clearance and Underground Services

Service clearance was completed by Archers Underground Services (Archers) and a TasWater representative at all LFG well locations prior to drilling.

There are no known underground services within the wetlands. However, a sewer main lies adjacent the site to the south-east (along Selfs Point Road) and a water line and sewer main runs along the northern boundary of the site to the rowing club. A TasGas distribution pipe is present along Marine Esplanade to the west, which diverts northeasterly across the carpark to the west, connecting to the Rowing Club. Additional local drainage lines and pits were also noted within the carpark to the west (sewer and stormwater). Known services are shown in **Appendix A (Figure A1)**.

3.1.2 Drilling and Installation of Landfill Gas Bores

Landfill gas bores were drilled by KMR Drilling, with supervision by Elgin field staff, and overseen by a TasWater representative. For the protection of all workers, a lower explosive limit (LEL) meter was placed close to the borehole during drilling to enable detections of any potentially hazardous concentrations of landfill gases (i.e. methane) in the surrounding atmosphere. LEL alarms were not recorded at any locations during drilling.

Landfill gas bores were drilled to and terminated at the approximate intersection of the saturated zone. In some cases, a bentonite or gravel backfill was used to bring the depth of the open borehole out of the saturated zone. The screened interval was installed from 1mbgl to the base (target depth, just above saturated zone) of the borehole. Gravel pack was placed around the entirety of the screen, with a bentonite seal and grout used to complete each installation around a blank casing from 0 – 1mbgl. Bores were finished at surface with flush gatics or above-ground lockable monuments installed to protect the bore from damage. Each bore was fitted with a gas cap and LFG bore construction logs are presented in **Appendix C**.

3.1.3 Landfill Gas Monitoring Methodology

Landfill gas monitoring was conducted in accordance with EPA Victoria Publication 1684 (EPA Victoria 2018) which provides detailed guidance on methodologies and equipment suitable for monitoring of landfill gas. Elgin has also developed Standard Operating Procedures (SOPs) and Safe Work Method Statements (SWMS) to ensure that landfill gas data is collected safely and to a high standard. Data collected was continually assessed during monitoring to ensure that the data was representative of the expected site conditions and suitable for use.

3.1.4 Landfill Gas Sampling: Monitoring Bores

Subsurface landfill gas concentrations were monitored from nine (9) monitoring bores on-site and off-site, including six (6) purpose drilled landfill gas monitoring bores, two (2) historical groundwater bores and one (1) newly installed groundwater bore retrofitted with landfill gas caps. Refer to **Appendix B (Table B1)** and **Appendix A (Figure A3)** for LFG results.

METHODOLOGY

At each monitoring bore a GA5000 landfill gas analyser was used to measure the volumetric concentration (% v/v) of methane, carbon dioxide and oxygen, and the concentration of trace gases carbon monoxide and hydrogen sulphide in parts per million (ppm). Bore relative pressure (mb or hPa) and gas flow (L/Hr) were also measured, with meteorological information recorded from the Bureau of Meteorology following each monitoring event. The GA5000 calibrated by the rental company prior to shipping, and was field calibrated with fresh air prior to use.

The instrument was purged with fresh air between monitoring sites, as part of the standard operating procedure for this device. Field notes were made of any anomalous observations and reviewed as part of QA/QC procedures.

The standing water level (SWL) was gauged using an electronic interface probe after LFG sampling. Refer to **Appendix B (Table B4)** for groundwater gauging measurements.

3.1.5 Landfill Gas Sampling: Surface Sweeps

Surface emissions of methane were measured using an Inspectra laser spectrometer.

Methane surface emissions monitoring (or sweeps) were conducted in accessible areas (generally around the perimeter of the wetland due to inaccessible site vegetation) whilst maintaining the gas detection probe within 50 mm of the surface, observing the instrument readings, and recording geographic location using a handheld GPS of detections of landfill gas and the surface conditions. Sweeps were conducted when winds were low (<10km/h) and barometric pressure was dropping. The path taken during the sweeps was tracked by handheld GPS, and notable LFG detections recorded in the GPS unit. Refer to **Appendix A (Figure A2)**.

3.1.6 Landfill Gas Sampling: Utility Pit and Service Alignment Testing

On-site and off-site service locations, mostly utility pits, were monitored for methane during the surface sweeps. monitoring involved inserting the Inspectra laser spectrometer probe into the utility pits without disturbing the lid where possible. Air from within the utility pits was screened by inserting the probe into the pit, fluctuations in methane concentration observed, and the maximum gas readings recorded on sampling field sheets. The location of the utility pit was recorded in the handheld GPS. Refer to **Appendix B (Table B3)** for LFG sweep measurements.

3.2 Landfill Gas Trigger Levels

Trigger levels for both surface and subsurface methane concentrations have been adopted from the Landfill Sustainability Guide – Tasmania (DPIPWE, 2004). Where no Tasmanian guidance is provided, such as for carbon dioxide concentrations or methane within buildings, trigger levels have been adopted from EPA Victoria's Landfill BPEM (EPA Vic, 2015). The relevant trigger level from these documents are compiled in **Table 4** below

The criteria to assess the LFG results are provided in **Table 4** below and in **Appendix B (Table B1)**.

Table 4: LFG assessment criteria

Reason for Use	Criteria	Reference
Assessment of risks to on and off site users, construction workers and future	1% v/v or 10,000 ppm methane action level for gas in subsurface services on and adjacent the landfill*.	DPIPWE, 2004 / *EPA Vic, 2015

METHODOLOGY

Reason for Use	Criteria	Reference
Land use from exposure to methane and carbon dioxide gases.	1.25% v/v methane action level subsurface geology at the landfill boundary. 1.5% above background level* 0%) carbon dioxide action level. Total 1.5% v/v applied.	
Assessment of explosive risks to construction workers and future land use.	5% v/v LEL and 15% v/v UEL (lower and upper explosive limit) for methane in air.	Safe Work Australia, 2011

*Background carbon dioxide concentrations have not been established due to the lack of a suitable background bore location. Therefore, a value of 0 % (v/v) as the background level (providing a total of 1.5% v/v) is considered conservative given the lack of a background bore. This should be revised if a suitable background location becomes available.

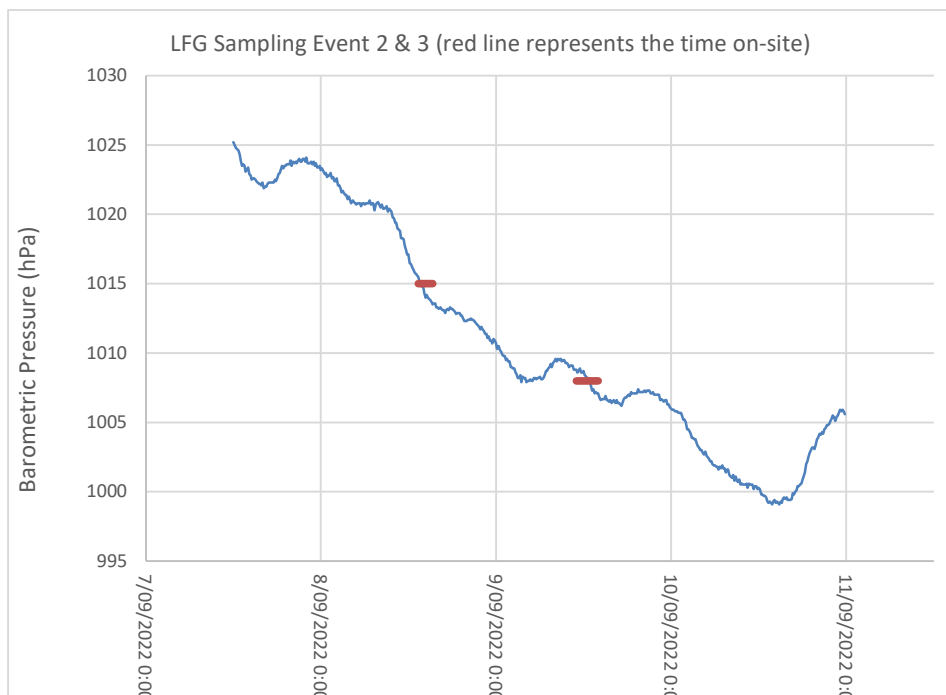
RESULTS

4 RESULTS

A summary of fieldwork is included in **Table 5**, including service clearance, bore installation, and sampling events.

Table 5 Fieldwork Summary

Activity	Method
Service Clearance	10 th August 2022
	Elgin field staff supervised service clearance with Archers Underground Services (Archers) and a TasWater representative at all new LFG wells locations.
LFG Monitoring Bore Drilling and Construction.	11 th to 12 th August 2022
	Six landfill gas monitoring bores were drilled and installed, with the location of the LFG bores shown in Appendix A (Figure A1) . LFG bore construction logs are presented in Appendix C .
LFG sampling	19 th August, 8 th and 9 th September 2022 (three events)
	All bores were sampled using a calibrated GA5000 landfill gas analyser during falling atmospheric pressure conditions, with barometric pressure obtained from the Hobart weather station (Battery Point – source BOM) for the three sampling events: Event 1 Date: 19th August 2022 Barometric pressure conditions: 1005.5 hPa at 9 am and 1004.8 hPa at 4 pm. Barometric pressure the previous day was 991hPa at 4pm LFG monitoring period: 11:30am to 14:30pm. Event 2 Date: 8th September 2022 Barometric pressure conditions: 1020.1 hPa at 9 am and 1014.4 at 4 pm LFG monitoring period: 13:20pm to 15:20pm. Event 3 Date: 9th September 2022 Barometric pressure conditions: 1009.4 hPa at 9am and 1007.1 hPa at 3pm LFG monitoring period: 11:00am to 14:00pm.



RESULTS

Activity	Method
Landfill Gas Utility Sweeps	19 th August 2022 and 9 th September 2022 Methane gas sweeps of available off-site utility pits and the perimeter area of the wetlands was completed, including utility access points, agricultural pipe outlets and stormwater pits. Refer to Appendix B (Table B2) for LFG utility sweep and ground surface measurements.

4.1 Drilling Conditions and Subsurface Geology

The subsurface geology, fill and landfilled waste intercepted during drilling of the LFG bores was highly variable, but was dominated sandy loam, clay, silt and gravel with cobbles and waste material comprised of wood, brick, waste steel and wire, glass and wood throughout the soil profiles. The depth of waste was deeper on the southern side (LFG05 and LFG06) where strong hydrocarbon odours and black sediments were noted at around 2.5 mbgl to the depth of investigation at ~8mbgl.

The bore installation logs are shown in **Appendix C**.

4.2 Groundwater

Drilling of LFG bores was terminated at the presence of moisture in the subsurface and then backfilled by approximately 0.2 m to 0.8 m to reduce the possibility of the screen intersecting groundwater. The new bores were dipped following installation and following monitoring, with only a small amount of water in LFG05 (0.2m) and LFG04 (0.1m) which is unlikely to impact LFG results. All other LFG bores were dry.

Dissolved methane concentrations were high in groundwater bores within the wetland parcel, including MW5s (7,870µg/L) and MW6 (11,900µg/L), but low in the deeper bore MW5d (393µg/L) (**Appendix B, Table B5**). Off-site to the north, dissolved methane was also present in MW2 (7,690µg/L) and MW4 (3,800µg/L).

RESULTS

4.3 LFG Screening Results

4.3.1 LFG Bore Results

Summary

Landfill gas concentrations were elevated and exceeded both the adopted trigger levels for methane (1% v/v and 1.25% v/v) and carbon dioxide (1.5% v/v) at all LFG bore locations (**Appendix B, Table B1**), with the exception of methane in LFG01 and LFG02 along the north-eastern boundary (boundary with 12 Sells Point Road).

Relative Pressure: Relative pressure ranged from -0.19 mb (LFG02 1st event) to 0.16 mb (MW5s 2nd event).

Methane: Concentrations ranged from 0% v/v (LFG01 and LFG02 – all events) to 56.7% v/v (MW5s – event 3) and exceeded the trigger value at LFG03, LFG04, LFG05, LFG06, MW5s, MW6 and in MW09 (new GHD bore). Methane concentrations were also within or above the explosive range of 5 – 15% v/v, indicating that a risk of explosion from LFG migration exists at the site, particularly if the subsurface is excavated.

The concentrations of methane at the same bores did not vary greatly between sampling events, although any fluctuations with atmospheric pressure would need to be assessed using a continuous monitoring device.

Methane was not delineated in the subsurface to the south, east and west directions, indicating that further assessment is required immediately. Although methane was not detected to the north of the wetland parcel, elevated carbon dioxide and oxygen depletion can also be indicators of LFG migration in the subsurface. Continuous monitoring in LFG01 or LFG02 in future may identify that methane can migrate to these locations under specific conditions.

Carbon dioxide: Concentrations ranged from 5 to 29.9% and exceeded the trigger value at all bores (**Appendix B, Table B1**) and was not delineated any direction.

Oxygen: Oxygen concentrations were generally depleted in wells with the highest concentrations of methane or carbon dioxide, including LFG. The maximum concentrations of oxygen in the subsurface were identified in bores LFG01 (11.9% O₂) and LFG02 (13% O₂), but this is still well below the atmospheric concentration of 21% O₂ (**Appendix B, Table B1**).

Hydrogen Sulfide: Concentrations of hydrogen sulfide were generally low in all wells (0 ppm to 3 ppm) with the highest concentration detected in well MW5s previously on 4th May 2022 (**Appendix B, Table B1**).

Flow Rates: The landfill gas bore flow rate ranged between -0.1 and 0.1 l/h which is considered very low. Although a low flow rate reduces the risk of landfill gas migration through unsaturated geology, the high concentrations of both methane and carbon dioxide present a high risk on their own. Furthermore, flow rates may be higher at other times, with the installation of continuous monitoring devices required to adequately assess this risk.

The results of the LFG monitoring are summarized in **Table 7** below, which presents LFG results exceeding adopted action levels.

Table 6 LFG results exceeding the adopted action levels

Boundary	Location of Methane Detection Exceeding Trigger Level	Range (%v/v CH ₄)	Location of Carbon Dioxide Detection Exceeding Trigger Level [^]	Range (%v/v CO ₂)
North (on-site)	None	Not detected	LFG01, LFG02	5-12.2

RESULTS

Boundary	Location of Methane Detection Exceeding Trigger Level	Range (%v/v CH ₄)	Location of Carbon Dioxide Detection Exceeding Trigger Level [^]	Range (%v/v CO ₂)
North-west corner (on-site)	MW5s	51.7-56.7	MW5s	22.5-24.3
South (on-site)	LFG06	5.6 – 9.2	LFG06	12.9 – 13.7
East (on-site)	LFG05, MW6	38.5 – 52.7	LFG05, MW6	23.3 – 29.9
West (off-site near boundary with wetland parcel)	LFG03, LFG04, LFG04b	2.2-23.2	LFG03, LFG04, LFG04b	7.3-23.3

[^]Interim Carbon Dioxide trigger adopted as 1.5% above an interim trigger level of 3.5% (5%).

Tabulated LFG results have been provided in **Appendix B (Table B1)** and are also shown on **Figure A3**.

4.3.2 Landfill Gas Sweeps

Offsite landfill gas migration from the historic closed landfill was detected in LFG sweep measurements, with methane detections at the surface of the tarmac adjacent the bridge club, during LFG sweeps in the carpark to the west of the wetlands. This included methane at or above the adopted action levels of 10,000 ppm, including 10,000 ppm under a green lid in tarmac adjacent to the bridge club and 99,000 ppm from the tarmac adjacent to bridge club in May 2022 (as reported in Elgin, 2022b) (**Table 8**). The concentrations detected in May adjacent the bridge club were within the explosive range of 5 – 15% (5,000 - 15,000 ppm).

LFG sweeps were also undertaken across other accessible ground surfaces to the west (vicinity of the carpark and rowing club), to the north (along STP boundary), around the eastern boundary and along the southern boundary of the wetlands. At the time of the LFG sweeps, no other exceedances of the adopted criteria were detected (**Appendix A, Figure A2**).

It is noted that during the LFG sweeps, that two larger banksia trees were dying in the vicinity of MW6.

The results of the LFG sweeps are summarised in **Table 8** below, which presents results exceeding adopted action levels.

Table 7 LFG sweep results exceeding the adopted action levels

Adjacent Boundary	to	Location	Concentration (%)	Criteria exceeded (%)
West (off-site)		Methane in Tarmac adjacent to Bridge Club	99,000 ppm, or 9.9%	10,000 ppm (EPA Vic BEPM Action Level) 5% LEL (Worksafe Lower Explosive Limit)
West (off-site)		Methane in Green lid - in tarmac adjacent to Bridge Club (unknown utility type)	10,000 ppm, or 1%	15% UEL (Worksafe Upper Explosive Limit)

Tabulated landfill gas sweep results have been provided in **Appendix B (Table B3)** and are also shown on **Figure A2**.

5 DISCUSSION

The wetlands site of the proposed STP expansion contains concentrations of landfill gas that exceed the adopted trigger levels for methane and carbon dioxide, including concentrations of methane that are within or above the explosive range. Based on these findings, any development situated on the wetlands site requires further assessment and determination of the need for and type of gas protection measures in accordance with BS8485:2015+A1 2019. Further, to ensure safe work conditions, any construction activities for future development would need to be undertaken in accordance with a construction environmental management plan to address the elevated concentrations of methane and carbon dioxide identified.

Based on a review of preliminary design plans, the expansion project footprint is proposed to incorporate the entirety of the wetlands and council stockpiling area at 10 Selfs Point Road. The 'wetlands' site is situated directly on top of river sediments dredged from the River Derwent to build the wetland, historic landfilling, and biosolids disposal. Elevated concentrations of methane and carbon dioxide in the subsurface have been confirmed in retrofitted groundwater bores, dedicated landfill gas bores, and escaping the ground surface and in utility pits (such as stormwater capture systems) and at off-site locations surrounding the wetlands.

The extent of the landfilled area is known to extend beyond the boundaries of 10 Selfs Point Road, particularly to the south-west (towards Rugby Park; **Appendix A, Figure A1**). Previous investigations by others identified waste landfill material to at least 8.0 mbgl on the site, indicating that at least 1.0-1.5 m of waste may be submerged by groundwater. Similarly, during installation of the LFG bores during this investigation, waste materials were identified to continue beyond the depth of the installed bores (particularly in the south-western (LFG04) and south-eastern portion of the site (LFG05 and LFG06)) with water encountered at or near the base of the installed wells. Due to the proximity of New Town Bay and the range of electrical conductivity identified in the groundwater bores on the site, groundwater may be tidally influenced where levels on the site fluctuate with the tide. Based on the data analysed, this may create an additional pumping effect (in addition to variations in atmospheric pressure) of LFG from the waste into adjacent soils, thus increasing the potential for migration laterally and vertically. Further assessment of this effect would require detailed investigation, such as using continuous monitoring of LFG and groundwater levels.

5.1 On-site (wetlands at 10 Selfs Point Road)

LFG bores that were installed on the site identified concentrations of both methane and carbon dioxide in exceedance of adopted trigger levels, with the exception of LFG01 and LFG02 (see **Section 5.2**). The highest concentrations were detected at LFG05 (located in the council stockpiling area to the east), at MW5s (located in the wetlands to the north-west) and at MW6 (located in the wetlands to the east). Concentrations at LFG06 (located to the south) were also high and well above the adopted criteria.

Methane concentrations were within or above the explosive range in most bores, indicating that there is a risk of explosion if conditions are suitable. Low oxygen concentrations (oxygen depletion) were recorded in most wells, indicating there may be potential asphyxiant risks in the subsurface. Concentrations of carbon dioxide within the wetlands parcel were in the range of 5.0% v/v (LFG02 event 1) to 29.9% v/v (MW6 event 1). Carbon dioxide is an asphyxiant and a toxic gas that is odourless, colourless and significantly denser than air. Toxic effects may become noticeable at 2% v/v and severe at 5% v/v (NSW EPA, 2020).

The high concentrations of LFG recorded within the wetland bores are confined at depth by the construction of the wetland and/or adjacent hard surfaces such as the tarmacked carpark to the west. This is causing subsurface lateral migration of LFG towards surrounding land parcels, underground services and buildings.

DISCUSSION

Accessing the internal areas of the wetland to complete LFG sweeps were difficult due to the area being overgrown with long grass and weeds such as blackberries. Fugitive LFG emissions at low levels were detected escaping from the ground surface to the north of the Ten Lives cat centre (**Appendix B, Table B3**).

A change in the permeability of the surface of the wetlands, such as with construction of the expanded STP and associated (impermeable) infrastructure, would likely increase migration of LFG laterally in all directions, increasing the potential risks off-site into surrounding buildings and service pits.

The presence of methane within or above the explosive range of 5 – 15% v/v has implications for both the construction of the site and for collection of vapours within new structures (including asphyxiation risks from both methane and carbon dioxide). Measures to assess and control these risks during and post construction would be required, such as monitoring of methane using a lower explosive limit (LEL) gas monitor (calibrated with methane) or permanent alarm system and engineering controls (such as gas extraction).

5.2 Northern boundary

The two LFG bores installed along the northern boundary (LFG01 and LFG02) were installed to assess LFG risks to the north, toward the current STP and Selfs Point Laboratory. Concentrations of methane detected along the northern boundary with the STP were below action levels and the LEL, however the levels of carbon dioxide here remained high and above criteria. The concentrations of carbon dioxide ranged from 5% v/v to 12.2% v/v, which should be further investigated using continuous monitoring devices to ensure that these bores are not impacted by methane at other times.

LFG sweeps of this area identified low concentrations of methane (below the adopted criteria) at the surface adjacent to the fence separating the wetlands and the STP, indicating that a subsurface source of methane may be present at greater concentrations.

Fill materials were noted during drilling of LFG01 and LFG02, however, fill materials in these locations were less representative of domestic waste, with subsurface conditions more representative of reclaimed land comprising mixed soil containing gravel, cobbles, wood and brick. While it is uncertain that the extent of landfilling has been delineated in this direction, the low level detections of methane in this vicinity suggests that putrescible waste may be close, or there is a preferential pathway, such as via service alignments.

5.3 Western Boundary (adjacent carpark, bridge club and rowing shed).

LFG bores installed along the western boundary of the wetland parcel identified concentrations of both methane and carbon dioxide in exceedance of adopted trigger levels. The highest concentrations were detected at LFG04 (located to the west in the direction of the bridge club) and at retrofitted groundwater well MW09. It is noted that fill materials present during drilling of LFG03 and LFG04, indicated that LFG03 comprised of mainly soil fill with some wood/bark fines, while fill material present at LFG04 comprised of significant waste including steel, glass, brick and tree branches. While the extent of landfilling has not been delineated to the west of the wetland parcel, it is assumed that waste material underlies this location. A confining upper layer of asphalt/concrete exists in this area, which would facilitate the migration of landfill gas via the permeable geology, fill and waste and via utility / service alignments. This was verified by the detection of low concentrations of methane in the carpark stormwater system during the utility sweeps (**Appendix B, Table B3**).

Explosive risks from methane within or above the explosive limit were identified in LFG04 and MW09 as well as concentrations of carbon dioxide above 5% v/v at all locations. Low levels of oxygen were also present. Methane gas sweeps of the carpark identified two occurrences of methane exceeding the action levels in

DISCUSSION

utility pits, with both exceedances present in the vicinity of the Bridge Club. The carpark, bridge club and rowing shed are surrounded by an area of low permeability surfaces which increases the risk of lateral migration of landfill gas.

5.4 Eastern and Southern areas

LFG bores were not installed along the eastern or southern boundaries of the wetland parcel. Historical information reviewed for the site indicates that landfilling likely extended southwards to Rugby Park and beyond (**Figure 1**), however there is no current information on the extent of landfilling to the east. The most eastern located bores are LFG05 and LFG06 and both of these bores were drilled into significant landfill material and contained very high levels of methane and carbon dioxide. LFG migration is therefore likely occurring beyond these boundaries and should be investigated.

6 UPDATED CONCEPTUAL SITE MODEL

A CSM was developed for the site and reported in Elgin 2022b. Based on the results of the RSRA, the following updated CSM has been provided.

6.1.1 Sources

The site is located in an area previously used as a municipal landfill, artificial wetland and also for the disposal of sewage biosolids. The landfill accepted municipal waste, trade waste and building rubble, and operated from around 1930 to 1963. Landfilling extends from ~1.0-2.0 mbgl to at least 8.0 mbgl with a portion of the landfill being submerged in underlying groundwater (~6.0 mbgl and beyond).

Clay material was used to cap the landfill material, which later provided the base for the construction of the wetlands, which comprised of material dredged from New Town Bay. The wetlands were built in the late 1990's and were decommissioned around 2011.

The landfilling has resulted in the site being raised above the surrounding (post landfill) ground level, with the area approximately 3-4 m higher than the Selfs Point STP. Since this time, the area has vegetated with a combination of grasses, native shrubs and blackberries.

The LFG assessment undertaken in 2022 identified the following:

- Exceedance of the methane action level of 1.25% v/v in all wells except LFG01 and LFG02 along the northern boundary.
- Methane concentrations were within or above the explosive range of 5 – 15% v/v, with a maximum concentration of 56.7% v/v in MW5s.
- Concentrations of carbon dioxide in the subsurface exceeded the action levels at all bores monitored and are above the toxic range (>5% v/v).
- The landfill gas bore flow rate ranged between -0.1 and 0.1 l/h which is considered low.
- Methane sweep results reported gas concentrations between 1.5 ppm to 10,000 ppm (1.0%) on 19th August and in a previous event from 1.0 ppm to 99,000 ppm (9.9%) on the 31st May 2022 adjacent to public open areas, car parking and buildings to the west of the wetland.
- The highest concentrations of methane in subsurface services were recorded on and near the tarmac adjacent to the Bridge Club to the west. This upper reading exceeded the action level of 10,000 ppm for landfill gas in a service alignment by a factor of 10 and was within the 5-15% v/v explosive range.

In addition to LFG, the underlying landfill waste material at the site has not been fully delineated. Human and Ecological Receptors

The following human receptors have been identified for the proposed STP upgrade:

- Workers involved in excavations and construction;
- Current site users;
- Neighbouring property users; and
- Future site users (commercial/industrial use as STP).

The following ecological receptors have been identified for the proposed works:

- New Town Bay and River Derwent, adjacent to the site;
- On-site and off-site vegetation; and

CONCEPTUAL SITE MODEL

- Aquatic and terrestrial organisms.

6.1.2 Potential Exposure On-site

The potential hazards identified to human and ecological receptors on and adjacent to the site are:

- Asphyxiation and explosive risks of from landfill gases and inhalation of vapours from hydrocarbon impacted soils (construction workers; future commercial site users; ecological receptors);
- Asphyxiation and explosive risks of from landfill gases and inhalation of vapours from groundwater during excavation or dewatering (construction workers; ecological receptors);
- Intrusion of landfill gases or hydrocarbon vapours into current and future buildings and underground structures (future commercial site users);
- The development of the site with a low permeability layer (such as a slab for new development) may alter the current pathways for LFG migration, potentially increasing concentrations of LFG migrating towards off-site receptors;
- Dermal contact or ingestion of contaminated groundwater or soil (construction workers);
- Run-off of impacted surface and groundwater into the River Derwent during excavation and dewatering (ecological receptors);
- Exposure to contaminated dust during construction (off-site human receptors).

6.1.3 Migration Pathways and off-site exposure

The potential pathways by which the identified human and ecological receptors may be exposed to landfill gas present off-site would be:

- From the landfilled waste to off-site current and future receptors via the subsurface geology, fill and waste materials;
- Via the backfill material around subsurface services (water, electrical, communications etc);
- From the subsurface geology and/or subsurface services backfill via service entry points into current and future buildings on and around the site;
- From the subsurface geology and/or subsurface services backfill via flux through the building/structure floor into current and future buildings on and around the site; and
- From the subsurface geology and/or subsurface services backfill via the surface on-site and off-site

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

7 PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND CONTROL MEASURES

7.1 Gas Screening Value (GSV) and Characteristic Gas Situation (CS)

Gas Screening Values (GSV) and the characteristic gas situation (CS) for the collected landfill gas monitoring data were calculated and considered within the context of the CSM as a preliminary risk assessment. This data is presented in attached **Appendix B (Table B2)** and the ranking of CS by GSV is shown in **Table 9** below. The GSV's were calculated as per British Standard 8485:2015+ A1:2019 (British Standards Institution, 2019) using bore methane and carbon dioxide concentration and bore flow rate.

Table 8 CS by site characteristic GSV (adopted from BS 8485:2015+A1:2019)

CS	Hazard potential	GSV L/h	Additional factors
CS1	Very low	<0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	0.07 to <0.7	Typical measured flow rate <70 L/h (otherwise consider an increase to CS3)
CS3	Moderate	0.7 to <3.5	-
CS4	Moderate to high	3.5 to <15	-
CS5	High	15 to <70	-
CS6	Very High	>70	-

Based on the GSVs calculated from the limited monitoring (3 events – note 2 of these events were 24 hours apart), the classification of the site would be considered CS2 – Low Risk. While GSV is based on measured data, it is ultimately derived using professional judgement. Based on the monitoring results and the CSM, the overall classification of the site is considered to be CS4 – Moderate to High Risk, based on:

- Very low to zero gas flow rates in all bores;
- Very high concentration of methane and carbon dioxide measured in the subsurface via LFG monitoring bores with a response zone in the LFG bores from 0.5 mbgl up to 7.0 mbgl and in the GW wells from 5.6 mbgl up to 8.57 mbgl);
- Very high concentrations of methane measured off-site in subsurface services and at the ground surface off-site;
- Depletion of oxygen in the subsurface;
- An ongoing source of landfill gas generation at the site;
- No LFG control measures at the source site;
- No gas protection measures in existing on-site or off-site receptors;
- Data is limited to three sampling events.

The GSV for the site should be calculated again once additional monitoring data becomes available and when knowledge of the development's sub-structure and foundation arrangement are more adequately understood and the CSM further refined. The additional data and CSM refinements can be used to determine the scope of gas protection measures needed for future buildings and LFG controls at the source site to protect users of existing buildings surrounding the site.

7.2 Control Measures

Appropriate gas protection measures can be selected based on the CS and the nature of the proposed development on the site. Guidance values are shown in **Table 10** below.

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

Table 9 Guidance values for gas protection (adapted from NSW EPA, 2020)

CS	Required gas protection guidance value				
	Low-density residential	Medium-to high-density residential (strata title)	Public buildings, schools, hospitals and shopping centres	Standard commercial buildings (offices, etc.)	Large commercial (warehousing) and industrial buildings
1	0	0	0	0	0
2	3	3	3	2	1 (a)
3	4	3	3	2	2
4	6	5	5	4	3
5	-	6	6	5	4
6	-	-	6	6	6

a). If maximum measured methane concentration exceeds 20% v/v, increase to CS3.

Shaded values depict preliminary classification of the site.

Based on **Table 10**, the guidance value appropriate for the site, for gas protection, is 3.

It is noted that a more accurate assessment of the CS and subsequent mitigation measures, including the costs and design of any of these protection measures, could be significantly improved by increasing the confidence in the site investigation data (through further assessment) and by undertaking further modelling and risk assessment of the pathways and accumulation risks.

The guidance values from **Table 10** can be used to assess appropriate gas protection measures (or combination of measures) that are appropriate for the site conditions. The combined score should equal or exceed the required guidance value. **Table 11** below (adapted from NSW EPA, 2020) lists a range of scores for protection measures.

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

Table 10 Scores for protection measures (adapted from Table 9, NSW EPA, 2020 - refer for further details)

Measure or system element	Score	Comments
Venting and dilution measures		
Passive sub-floor ventilation with very good performance – the steady-state concentration of methane over 100% of the ventilation layer remains below 1% v/v at a wind speed of 0.3 metres per second (m/s) ^(a)	2.5	The design of the venting layer (i.e. granular medium with inlet/outlet pipes versus open-void or modular drainage system) ^(b) must be considered when modelling steady-state concentrations
Passive sub-floor ventilation with good performance – the steady-state concentration of methane over 100% of the ventilation layer remains below 1% v/v at a wind speed of 1 m/s and below 2.5% v/v at a wind speed of 0.3 m/s) ^(a)	1.5	If post-installation testing of passive ventilation indicates that it cannot meet this requirement, inlets and outlets must be upgraded. If this is unsuccessful, it will be necessary to retrofit an active system
Sub-floor ventilation with active abstraction or pressurisation	2.5	Not appropriate for NEPM HIL A residential settings because robust management systems, including alarms, must be in place to ensure long-term operation and maintenance... Achieving the full score requires a design with adequate redundancy and full coverage of the building footprint.
Ventilated car park (basement or undercroft)	4.0 ^(d)	Assumes that the car park is vented to deal with exhaust fumes in accordance with BCA ^(c) requirements. The design of a car-park and the specifications of its ventilation system need to be considered in assigning an appropriate score of up to four.
Horizontal soil barriers beneath building footprint		
Horizontal clay or amended soil barriers designed to achieve defined permeability and diffusivity of the gases of concern placed, compacted and tested under appropriate engineering supervision	^(d)	Requires appropriate engineering input and integration with the building design from the earliest possible stage. This must consider the effects of any proposed piling on the gas regime
Floor slabs		
Reinforced concrete ground-bearing floor slab or waffle pod slab	0.5	At a minimum, it is good practice to install ventilation in all foundation systems to relieve pressure. Breaches in floor slabs, such as joints, have to be effectively sealed against gas ingress to maintain performance
Reinforced concrete ground-bearing foundation raft slab with limited service penetrations cast into slab	1.0	
Reinforced concrete cast in situ or post-tensioned suspended slab with minimal service penetrations and water bars around all penetrations and at joints	1.5	

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

Measure or system element	Score	Comments
Fully tanked basement	2.0 ^(d)	The design of a basement and the specifications of its ventilation system need to be considered in assigning an appropriate score. Fully tanked means designed to be waterproof under the range of groundwater conditions likely at the site, to the extent that supplementary internal drainage is not required.
Membranes		
Proprietary gas-resistant membrane with a gas transmission rate for the gases of concern on the site that is certified and appropriate to the overall design of the gas protection system. It should be installed by a specialist to an appropriate level of workmanship with documented internal CQC, including integrity testing (e.g. tracer gas or smoke testing), under independent CQA carried out by a certified specialist ^(e) or appropriately qualified and experienced professional with independent verification of the entire process ^(f)	2.0	Membrane performance depends on the membrane material and thickness specified, design and quality of the installation, protection from and resistance to damage after installation, and the integrity of joints in membranes that require joints. Materials that offer some degree of self-sealing and repair are preferred. Long-term performance depends on the durability of the material, including its resistance to chemical degradation in the environment in which it is installed
Monitoring and detection (alarms)		
Intermittent monitoring using hand-held equipment	0.5	Monitoring and alarm systems are only valid as part of a combined gas protection system. Where fitted, permanent systems should be installed in the underfloor venting system but can also be provided in the occupied space as a back-up
Permanent monitoring system installed in the occupied space of the building	1.0	
Permanent monitoring system installed in the underfloor venting or dilution system	2.0	
Pathway intervention external to building footprint		
Vertical barriers	^(g)	Required for residential and public buildings at CS 4 and above
Vertical venting systems (source depressurisation)	^(g)	
^(a) Verified by post-construction monitoring ^(b) See Appendix 6 ^(c) Building Code of Australia ^(d) Score depends on site-specific conditions and design ^(e) For example, Geosynthetic Certification Institute – Inspectors Certification Program ^(f) See Appendix 7 ^(g) Score depends on site-specific conditions and design, but scores of 4.0+ should be achievable		

Based on the above options, potential design and mitigation options[^] for the development may include:

- Passive sub-floor ventilation.
- Sub-floor ventilation with active abstraction or pressurisation.
- Reinforced concrete ground-bearing foundation raft slab with limited service penetrations cast into slab.
- Reinforced concrete cast in situ or post-tensioned suspended slab with minimal service penetrations and water bars around all penetrations and at joints.
- Proprietary gas-resistant membrane with a gas transmission rate for the gases of concern on the site that is certified and appropriate to the overall design of the gas protection system. It should be installed by a specialist to an appropriate level of workmanship with documented internal construction quality control (CQC), including integrity testing (e.g. tracer gas or smoke testing), under independent construction

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

quality assurance (CQA) carried out by a certified specialist(e) or appropriately qualified and experienced professional with independent verification of the entire process.

- Permanent monitoring system installed in the occupied spaces of the building.
- Permanent monitoring system installed in the underfloor venting or dilution system.

^The relevant documentation and advice should be reviewed by the designer to select methods of LFG protection suitable for the site setting, LFG results, and detailed design.

Following implementation of appropriate strategies, the basis of the design of the gas protection measures, the installation of the measures and the verification inspections, monitoring and testing of the measures should be recorded in a report or series of reports, with design and as-built drawings.

7.3 Recommendations and Management Measures

Based on the updated CSM outlined in **Section 6**, and the preliminary LFG assessment outlined above, there may be unacceptable human health and ecological risks associated with the proposed works. Further works and management measures to mitigate these risks are presented in **Table 12**. The recommendations and management measures presented in **Table 12** should be reviewed along with the recommendations presented in the *Contaminated Site Assessment Report, Selfs Point STP expansion project* (Elgin, 2022b).

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

Table 11 Recommendations and Management Measures Before, During and Post Construction

Media	Location	Recommendations for Further Investigation	Management Measures
Before Construction			
Landfill Gas	Wetlands, 10 Sells Point Road	As previously reported (Elgin, 2022b) a preliminary assessment of landfill gas has been completed, along with this RSRA. Potential for elevated risks exist on and around the site, but due to limited data and spatial coverage of testing a more comprehensive Landfill Gas Risk Assessment (LGRA) is required (including additional monitoring). The aim of a site-specific LGRA would be to assess risks more accurately for the planned development and potential existing pathways to the adjacent Sells Point STP (noting that other parcels of land are owned by Hobart City Council and are being assessed by others).	Further assessment of landfill gas risks is required to inform a LGRA and the gas protection required for the STP expansion development. Measures would include: • Further measurement of landfill gas in subsurface and its potential lateral extent using instrumentation for continuous LFG concentration, flow, atmospheric pressure and bore relative pressure monitoring. • Assessing the risks from the STP expansion design in and near the wetlands area. • Assessment of landfill gas control measures required for the construction of the STP expansion. The LGRA will inform the development of a Construction Environmental Management Plan (CEMP) to manage human and ecological risks during construction.
Landfill Gas	Existing STP, 12 Sells Point Road	Defining the extent of the landfilled area – which may allow for source control measures to be implemented (beyond the scope of this assessment at 10 Sells Point Road).	A more detailed and comprehensive LGRA would investigate landfill gas beyond the Wetland area to the existing STP, with considerations that include: • Delineate the extent of landfilling waste to inform potential control measures. Determine the extent of the LFG migration (if any) and risks to off-site receptors to the north. • Inform on-site workers and utility service providers of the potential for LFG at the site. • Reviewing the construction details of buildings to understand the likelihood of preferential pathways to be present that may allow LFG inside the building envelope. • Regular monitoring of landfill gas bores, including continuous monitoring of bores (LFG01 & LFG02) that already exist, and continuous monitoring of the internal air quality to understand risk to occupants. • Screening for landfill gas emissions in service alignments, utility pits, nearby buildings, and from passive surface emissions (hotspots) from the known landfill area using methane detection equipment.
During Construction			
Landfill Gas	Northern portion of 12 Sells Point Road Wetlands, 10 Sells Point Road	Preliminary assessment of landfill gas has been completed, with elevated risks existing. Landfill Gas Risk Assessment required to assess actual risks.	Further assessment of risk control measures are required. More detailed risk control measures required for construction would be an output of the LGRA. A CEMP should be prepared to inform the construction, including the protection of workers, contaminated sites soils, detection of LFG emissions, accumulation of

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

Media	Location	Recommendations for Further Investigation	Management Measures
			hazardous gases (explosive and asphyxiants), management of shallow groundwater, and appropriate responses to unexpected finds.
Post Construction			
Landfill Gas	Northern portion of 12 Sels Point Road Wetlands, 10 Sels Point Road Off-site risks	Based on the outcomes of a detailed Landfill Gas Risk Assessment, ongoing testing of LFG concentrations in the subsurface and at the surface. Ongoing management protocols are likely.	Landfill Gas may require on-going management at the site and would be managed under the guidance of an ongoing EMP.

PRELIMINARY LANDFILL GAS RISK ASSESSMENT AND MANAGEMENT OPTIONS

7.4 Data Gaps and Uncertainties

The identified data gaps and uncertainties include:

- The precise nature and extent of the landfill gas pathway to off-site receptors requires further investigation (including within key service alignments) to inform remedial interventions.
- The concentrations of methane and carbon dioxide in the subsurface have not been appropriately delineated. The extent of landfilling waste has also not been delineated.
- The dataset is considered to be robust for the purposes of this rapid screening landfill gas risk assessment for the scope herein; however, given the proposed development works, the risk profile can change rapidly and risk to key receptors should be continuously monitored to ensure risk does not escalate.
- The gas protection measures discussed in this rapid screening landfill gas risk assessment are not final recommendations. The final gas protection measures must be based on further LFG monitoring data and refinements to the CSM.
- This rapid screening landfill gas risk assessment does not fully consider risks to the off-site receptors surrounding the wetlands site.
- The background carbon dioxide concentration has not been assigned and a conservative value of 0% has been adopted.
- During drilling of the LFG bores areas of waste were recorded. Given the underlying landfilling and reclamation, excavation works may uncover contaminants and unexpected finds. Waste materials and/or contaminated material encountered during development works and should be managed appropriately.
- It is noted that source control measures on the wetlands site (for protection of off-site receptors) cannot be recommended (at this stage) due to the unknown extent of the source which likely extends beyond 10 Selfs Point Road.

CONCLUSIONS AND RECOMMENDATIONS

8 CONCLUSIONS AND RECOMMENDATIONS

This report presents the findings of a Rapid Screening Risk Assessment (RSRA) undertaken for the Selfs Point Sewage Treatment Plant (STP) expansion project. The RSRA informs the EIS for the expansion of the STP to a neighbouring land parcel, and highlights potential risks from landfill gas, appropriate mitigation measures and liabilities.

The extent of this RSRA is limited to 10 Selfs Point Road, which includes the New Town Wetlands. It is limited to the assessment of risks from potential landfill gas accumulation and potential implications for the construction and operation of the STP project at the site. Assessment of risks to off-site receptors, groundwater and surrounding land uses has been undertaken by external parties including GHD and Hobart City Council; these assessments are ongoing and unreported.

8.1 Landfill Gas levels

General

- Elevated concentrations of methane and carbon dioxide in the subsurface have been confirmed in landfill gas bores, retrofitted groundwater bores, escaping the ground surface, and in utility pits (such as stormwater pits).
- The subsurface geology intercepted during drilling LFG bores was highly variable, but was dominated by sandy loam, clay, silt and gravel with cobbles and waste material comprised of brick, waste steel and wire, glass and wood. The depth of waste was deeper on the southern side (LFG05 and LFG06) where strong hydrocarbon odours and black sediments were noted at around 2.5 mbgl to the depth of investigation at ~8mbgl.
- The extent of the landfilled area extends beyond the boundaries of 10 Selfs Point Road. Landfill material has been identified in previous investigations to at least 8.0 mbgl on the site, and this is consistent with observations made during this investigation. Groundwater was intercepted in some bores at approximately 7.0 mbgl, indicating that waste material may be saturated at times. Electrical conductivity varied from fresh to brackish in the groundwater bores on the site, suggesting that there may be some areas of the site that are influenced by tidal fluctuations. The potential for a tidal pumping effect (in addition to variations in atmospheric pressure) of LFG from the waste into adjacent soils, may increase the potential for LFG migration laterally and vertically.

On-site (wetlands at 10 Selfs Point Road)

- LFG bores installed within the wetland parcel contained high concentrations of methane and carbon dioxide in exceedance of adopted trigger levels, with the exception of LFG01 and LFG02.
- Methane concentrations were within or above the explosive range in most bores, indicating that there is a risk of explosion if conditions are suitable.
- Low oxygen concentrations (oxygen depletion) was recorded in most wells, indicating there may be asphyxiant risks in the subsurface, and concentrations of carbon dioxide ranged from 5.0% to 29.9% v/v. Carbon dioxide is an asphyxiant and a toxic gas that is odourless, colourless and significantly denser than air. Toxic effects may become noticeable at 2% v/v and severe at 5% v/v so the results are significant.
- Landfill gas sweeps were limited to the perimeter of the wetlands parcel due to access issues (thick vegetation). Fugitive LFG emissions at low levels were detected escaping from the ground surface to the north of the Ten Lives cat centre.

CONCLUSIONS AND RECOMMENDATIONS

- The presence of hard surfaces over, or adjacent to, LFG source material (such as the tarmacked carpark to the west of the wetlands) can promote subsurface lateral migration of LFG into underground services and buildings.
- A change in the permeability of the surface of the wetlands, such as with construction of the expanded STP and associated (impermeable) infrastructure, could increase fugitive emissions to migrate laterally in all directions (without appropriate controls), would potentially increase the risks off-site.
- The high concentrations of methane detected within the development footprint has implications for the ongoing use of the site as an STP, such as the accumulation of vapours within new structures (including asphyxiation risks from both methane and carbon dioxide). Measures to assess and control these risks during and post construction would be required.

Northern Boundary

- Methane was not detected in the two bores installed within the existing STP site. However, carbon dioxide concentrations ranged from 5% v/v to 12.2% v/v, which should be further investigated using continuous monitoring devices to ensure that these bores are not impacted by methane at other times.
- LFG sweeps in the northern boundary area detected low concentrations of methane escaping the ground surface adjacent to the fence separating the wetlands and the STP, indicating that a subsurface source or pathway of methane may be present at times.
- Fill materials were noted during drilling of LFG01 and LFG02 within the existing STP parcel, however, indicators of domestic waste were not encountered, with subsurface conditions more representative of reclaimed land comprising mixed soil containing gravel, cobbles, wood and brick. The uncertainty around a potential migration pathway via made ground needs to be further assessed to ensure the existing operation of the STP, and workers within site buildings are safe at all times.

Western Boundary (adjacent carpark, bridge club and rowing shed).

- LFG bores installed along the western boundary of the wetland parcel recorded concentrations of both methane and carbon dioxide in exceedance of adopted trigger levels. The highest concentrations were detected at LFG04 (located to the west between the wetland parcel and the Bridge Club) and at a new groundwater well MW09. It is noted that fill materials were present during drilling of LFG03 and LFG04, and based on observations of wood/bark fines, steel, glass, brick and tree branches, it is assumed that waste material underlies this location.
- A confining surface layer of asphalt/concrete exists in this area, which would facilitate the migration of landfill gas via the permeable geology (waste), or in utility / service alignments. This was verified by the detection of low levels of methane in the carpark stormwater system and utility pits during the utility sweeps.
- Methane was recorded within or above the explosive limit in LFG04 and MW09, as well as levels of carbon dioxide above 5% v/v at all locations, combined with oxygen depletion. Methane gas sweeps of the carpark identified two occurrences of methane exceeding the action levels in utility pits or escaping the tarmac, with both exceedances recorded in the vicinity of the Bridge Club.
- The carpark, bridge club and rowing shed are surrounded by an area of impermeable surfaces which increases the risk of lateral migration of landfill gas.

Eastern and Southern areas

CONCLUSIONS AND RECOMMENDATIONS

- Significant waste material was encountered in bores LFG05 and LFG06, which contained very high levels of methane and carbon dioxide. LFG migration is therefore likely occurring beyond these boundaries and should be investigated.
- Although LFG bores were drilled within the wetland parcel in the east and south, perimeter bores were not installed along these boundaries. Historical mapping layers indicate that landfilling extended southwards to the Rugby Park, however the area to the east is Selfs Point Road and then a cemetery.

Gas Screening Value (GSV) and Characteristic Gas Situation (CS)

Based on the monitoring results and the CSM, the overall CS classification of the site is CS4 – Moderate to High Risk, based on the data and current site conditions.

The GSV for the site should be recalculated when additional monitoring data becomes available and the CSM further refined when knowledge of the development's sub-structure and foundation arrangement are detailed. Determining the gas protection measures required to manage risks associated with the high concentrations of LFG at the site should be a key focus of the design team. The aim of the protection measures would be to protect existing and future users of existing buildings surrounding the site, including construction workers.

Appropriate gas protection measures can be selected based on the CS and the nature of the proposed development on the site. The types of controls considered appropriate for a CS4 site include:

- Passive sub-floor ventilation.
- Sub-floor ventilation with active abstraction or pressurisation.
- Reinforced concrete ground-bearing foundation raft slab with limited service penetrations cast into slab.
- Reinforced concrete cast in situ or post-tensioned suspended slab with minimal service penetrations and water bars around all penetrations and at joints.
- Proprietary gas-resistant membrane with a gas transmission rate for the gases of concern on the site that is certified and appropriate to the overall design of the gas protection system. It should be installed by a specialist to an appropriate level of workmanship with documented internal construction quality control (CQC), including integrity testing (e.g. tracer gas or smoke testing), under independent construction quality assurance (CQA) carried out by a certified specialist(e) or appropriately qualified and experienced professional with independent verification of the entire process.
- Permanent monitoring system installed in the occupied spaces of the building.
- Permanent monitoring system installed in the underfloor venting or dilution system.

8.2 Recommendations and Management Measures

The following recommendations and management measures are recommended based on the RSRA:

Before Construction – 10 Selfs Point Road (proposed development site)

- Further assessment of landfill gas risks is recommended to inform a LGRA and appropriate management of the development, including:
 - Assessment of the potential for landfill gas to migrate laterally using continuous LFG monitoring equipment, particularly adjacent to existing buildings such as the Selfs Point Laboratory.
 - Review the detailed design to assess and potential for increased risks from the expansion of the STP across the wetlands area.

CONCLUSIONS AND RECOMMENDATIONS

- Review of proposed landfill gas control measures required for the construction of the STP expansion.
- The LGRA for the wetland parcel would inform the development of a Construction Environmental Management Plan (CEMP) to manage human and ecological risks during construction.

Before Construction – 12 Selfs Point Road (existing STP site)

A comprehensive LGRA that investigates the potential for landfill gas to migrate from the Wetland area, northwards to the existing STP, with considerations that include:

- Determine the extent of the LFG migration (if any) and risks to off-site receptors to the north.
- Reviewing the construction details of buildings to understand the likelihood of preferential pathways to be present that may allow LFG inside the building envelope.
- Regular monitoring of landfill gas bores, including continuous monitoring of bores (LFG01 & LFG02) that already exist, and continuous monitoring of the internal air quality to understand risk to occupants.
- Screening for landfill gas emissions in service alignments, utility pits, nearby buildings, and from passive surface emissions (hotspots) from the known landfill area using methane detection equipment.
- Delineate the extent of landfilling waste to inform potential source control measures.
- Inform on-site workers and utility service providers of the potential for LFG at the site.

During Construction

- Detailed risk control measures have not been defined in this RSRA but will be required following the collection of additional information on the temporal behaviour of LFG in the vicinity of the development.
- A CEMP should be prepared to inform the construction, including the protection of workers, contaminated sites soils, detection of LFG emissions, accumulation of hazardous gases (explosive and asphyxiants), management of shallow groundwater, and appropriate responses to unexpected finds.

Post Construction

Landfill Gas will likely require on-going management at the site and would be managed under the guidance of an Operational Environmental Management Plan (OEMP).

REFERENCES

9 REFERENCES

Australian Standard, 2005. AS4482.1 Guide to the investigation and sampling of sites with potentially contaminated soil. Part 1: non-volatile and semi-volatile compounds. AS 4482.1-2005.

Australian Standard, 1999. AS4482.2 Guide to the sampling and investigation of potentially contaminated soil. Part 2: volatile substances. AS 4482.2-1999.

British Standard (BS) 2019. 8485: 2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. BS1 Standards Publication.

CIRIA, 2007. Assessing Risk Posed by Hazardous Ground Gases to Buildings, Publication CIRIA C665, Construction Industry Research and Information Association (CIRIA). London, 2007

Department of Primary Industries Water and Environment (DPIWE), 2004. Landfill Sustainability Guide. Tasmania September 2004. Environment Division, Hobart, Tasmania.

Elgin Associates, 2022a. Selfs Point Sewage Treatment Plant (STP) Expansion Project: Environmental Data Gap Analysis and Recommendations for Further Sampling; prepared by Elgin Associates for ERA Planning and Taswater. Hobart, Tasmania. 10 March 2022.

Elgin Associates, 2022b. Selfs Point Sewage Treatment Plant (STP) Expansion Project: 12 Selfs Point Road and part of 10 Selfs Point Road Contamination Site Assessment Report. Prepared by Elgin Associates for ERA Planning and Taswater. Hobart, Tasmania. 8 June 2022.

EPA NSW, 2019. Assessment and management of hazardous ground gases. Contaminated Land Guidelines. Amended May 2020. NSW Environmental Protection Authority, Parramatta, NSW.

EPA Tasmania, Environment Protection Authority, 2018. Information Bulletin No. 105. Classification and Management of Contaminated Soil for Disposal, version 3.

EPA Tasmania, Environment Protection Authority, 2021. Default Guidelines Values (DGVs) for Aquatic Ecosystems of the Derwent Estuary-Bruny Catchment. Environment Protection Authority, Hobart Tasmania.

EPA Tasmania, Environment Protection Authority, 2020. Environmental Management and Pollution and Control (Underground Petroleum Storage System) Regulations 2020. Section 102. Environment Protection Authority, Hobart Tasmania.

EPA Victoria, 2015. Best Practice Environmental Management (BEPM); Siting, design, operation and rehabilitation of landfills. Publication 788.3. Environment Protection Authority Victoria, August, 2015.

EPA Victoria, 2018. Landfill Gas Fugitive Emissions Monitoring Guidelines, Publication 1684. Environmental Protection Authority Victoria 2 February 2018.

EPA Victoria, 2000. Groundwater Sampling Guidelines, Publication 669. Environment Protection Authority State Government of Victoria, April 2000.

ERA Planning, 2021. Selfs Point STP Expansion – Natural Values Assessment, Hobart, Tasmania. 4th October 2021.

REFERENCES

Friebel, E & Nadebaum, P 2011. Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 2: Application document, CRC CARE Technical Report No.10, CRC for Contamination Assessment and Recommendation of the Environment, Adelaide, Australia.

GHD c/o ERA Planning, 2022, 75% Concept Design Stage 2, Drawing # 0089-DWG-SELST01-GA-C-001. Hobart, Tasmania. 4th May 2022.

HEPA, 2020. PFAS National Environmental Management Plan 2.0. National Chemicals Working Group of the Heads of EPA Australia and New Zealand. January 2020.

Koehnken, L, 2013. Review of New Town Bay 'Wetlands'. Hobart Tasmania. March 2013.

Mineral Resources Tasmania, 1:25,000 digital geology map of Tasmania. Accessed 28 October 2022.

National Environmental Protection Council 1999. National Environment Protection (Assessment of Site Contamination) Measure (NEPM) (1999 as amended 2013); ASC-NEPM.

Safe Work Australia, 2011. Code of Practice for Confined Spaces, December 2011.

Tasmanian Government, 1994. Environmental Management and Pollution Control Act 1994 (EMPCA).

Tamvakis, M, 1994. Old tip sites in Hobart: Benefits and Impacts. Coursework Master Thesis, University of Tasmania. Hobart, Tasmania.

The LIST, (2022): Tasmanian Interim Planning Scheme
<https://maps.thelist.tas.gov.au/listmap/app/list/map;jsessionid=9D7A7EB15D0FB2CBDE81882012FA3B93.wombat4o> Accessed 28 October 2022.

LIMITATIONS

10 LIMITATIONS

Elgin Associates Pty Ltd has prepared this report for the sole use of TasWater in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. The methodology adopted and sources of information used by Elgin Associates are outlined in this report. Elgin Associates has made no independent verification of this information beyond the agreed scope of works and Elgin Associates assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to Elgin Associates was false.

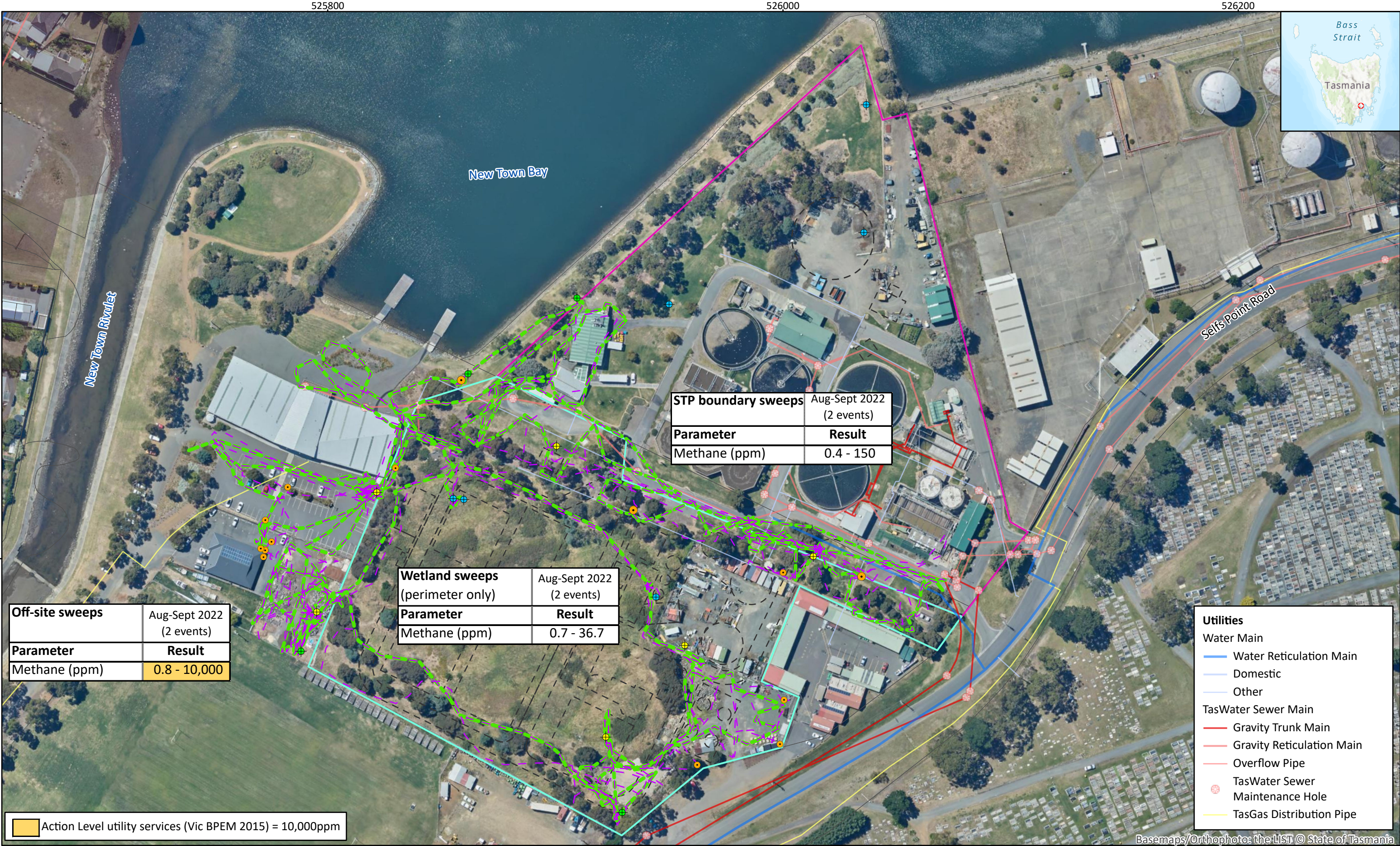
This report was prepared in August-November 2022 and is based on the conditions encountered and information reviewed during that period up to the time of preparation. Elgin Associates disclaims responsibility for any changes that may have occurred after this time. Opinions and recommendations contained in this report are based upon information gained during desktop study and fieldwork and information provided from government authorities' records and other third parties. The information in this report is considered to be accurate at the date of issue and reflects at the site at the dates sampled. This document and the information contained herein should only be regarded as validly representing the site conditions at the time of the fieldwork unless otherwise explicitly stated in a preceding section of this report.

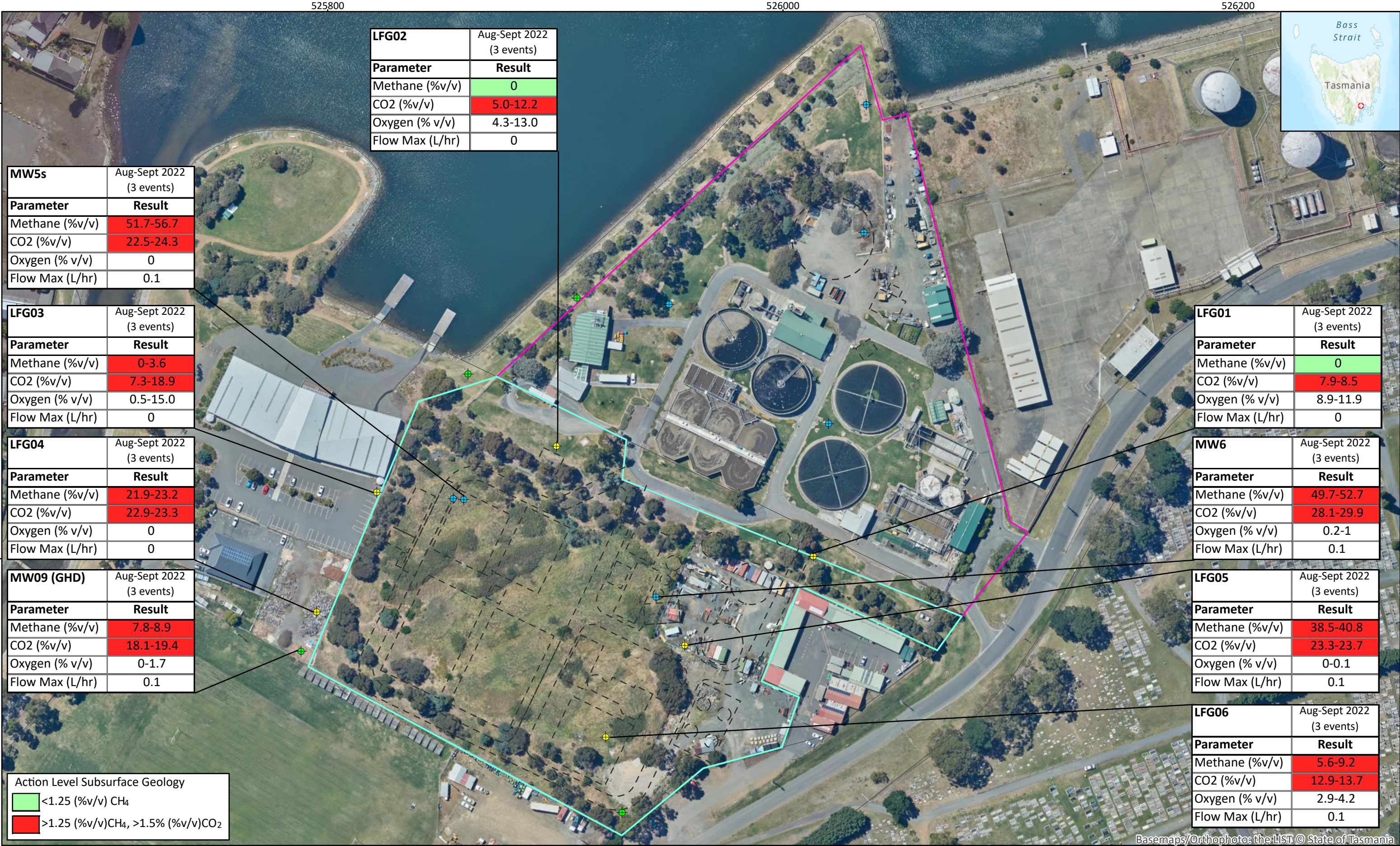
This report should be read in full together with all other reports referenced by this report. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

Figures



Legend - Landfill Gas Bore (Elgin 2022) - Groundwater well (EM&C 2016) - Monitoring Well (GHD 2022) - Cadastral parcels Site Boundaries - Proposed STP Expansion Boundary - Existing STP Site - Proposed 75% Concept Design Stage 2	N Scale = 1:1,500 0 12.5 25 50 Meters	Site: Selfs Point STP Concept Design 10-12 Selfs Point Road, New Town, TAS	Client: ERA Planning for TasWater	Title: Site Layout - Landfill Gas Bores and Groundwater Well Locations	elgin associates
		Date: 22 November 2022 Size: A3 Version: A Job Number: JN22392	Drawn: MU Approved: LF		





Legend

- Landfill Gas Bore (Elgin 2022)
- Groundwater Well (EM&C 2016)
- Monitoring Well (GHD 2022)
- Cadastral parcels

Site Boundaries

- Proposed STP Expansion Boundary
- Existing STP Site
- Proposed 75% Concept Design Stage 2

N

Scale = 1:1,500

012.52550

Meters

Site:
Selfs Point STP Concept Design
10-12 Selfs Point Road,
New Town, TAS

Date: 22 November 2022
Size: A3 Version: A
Job Number: JN22392

Client:
ERA Planning for TasWater

Drawn: MU
Approved: LF

Title:
Landfill Gas Screening Values

Figure 3

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 2020
Scale Factor: 0.9996
Units: Meter

Document Path: C:\Users\Owner\Elgin Associates Dropbox\Elgin_GIS\Tasmania\JN22392 Selfs Point LFG\1.1 Project aprx\Fig3 JN22392 Selfs Pt LFG Results 221122.aprx

Tables

Attached Table B1 - Landfill Gas Preliminary Screening Results - Bores
JN22392: Selfs Point CSA

Well ID	Date	Barometric Pressure mb	Well Pressure mb	Internal flow l/h	Methane (CH ₄) % v/v	Carbon Dioxide (CO ₂) % v/v	Oxygen (O ₂) % v/v	Carbon Monoxide (CO) ppm	Hydrogen Sulfide (H ₂ S) ppm	Nitrogen Balance (N) % v/v	Peak Methane (CH ₄) % v/v	Peak Carbon Dioxide (CO ₂) % v/v	Min O ₂ % v/v	Aspiration Time seconds	SWL m	Well Screen Interval as measured 4th May 2022 m	Exposed Screen? m	Total Well Depth (bTOC) m	Comments
Action Levels					<1.25	<1.5%													
DPIPWE LSG 2004 Action Level - Subsurface					>1.25														
EPA Vic BPEM 2015 Action Level - Subsurface Geology					>1.0	>1.5%*													
Lower Explosive Limit (LEL) for methane in air (SWA, 2011)					5														
Upper Explosive Limit (UEL) for methane in air (SWA, 2011)					15														
On-site																			
LFG01	19-Aug-22	1005	0.12	0	0	7.9	8.9	0	1	83.2	0	8.4	8.6	300	Dry	1.0-1.6	0.6	1.460	Loose cap
	08-Sep-22	1016	0.02	0	0	8.5	11.5	0	0	80	0	8.5	11.5	180	NR	1.0-1.6	-	NR	
	09-Sep-22	1010	0	0	0	8.1	11.9	0	0	80	0	8.2	11.7	180	Dry	1.0-1.6	0.6	1.460	Moisture on base
LFG02	19-Aug-22	1005	-0.19	0	0	5.0	13	1	1	82	0	5	13	300	Dry	1.0-2.2	1.2	2.045	
	08-Sep-22	1016	-0.03	0	0	11.5	5.5	0	0	83	0	11.5	5.5	180	NR	1.0-2.2	-	NR	
	09-Sep-22	1010	0.03	0	0	12.2	4.3	0	0	83.4	0	12.2	4.3	180	Dry	1.0-2.2	1.2	2.050	
LFG05	19-Aug-22	1004	0.05	0	38.5	23.4	0.1	6	0	38.1	38.5	23.4	0.1	300	7.450	1.0-7.0	6	7.640	
	08-Sep-22	1015	0.07	0.1	40.7	23.7	0	1	1	35.6	43.2	24.8	0	180	NR	1.0-7.0	6	NR	
	09-Sep-22	1009	0.09	0	40.8	23.3	0.1	2	1	35.8	42.2	23.3	0.1	180	7.385	1.0-7.0	6	7.640	
LFG06	19-Aug-22	1004	0.02	0	5.6	13.7	2.9	7	0	77.8	5.6	13.7	2.9	400	Dry	1.0-7.0	6	7.500	
	08-Sep-22	1015	0	0.1	7	12.9	4.2	2	0	75.9	7.1	12.9	4.2	180	NR	1.0-7.0	6	NR	
	09-Sep-22	1008	0.09	0	9.2	13.4	3.9	4	0	73.4	9.2	13.4	3.9	180	Dry	1.0-7.0	6	7.500	Opened cap - Left on 45min before sampling
MW5s	04-May-22	1009	0.1	0.1	53.9	23.6	0	1	3	22.6	54	23.6	0	180	6.802	5.60 - 8.26	1.202	8.264	Retrofitted GW well
	31-May-22	982	-0.04	0	54.7	24.3	0	1	0	21	54.8	24.3	0	180	6.550	5.60 - 8.26	0.950	8.264	Retrofitted GW well
	19-Aug-22	1005	0.12	0	56.7	24.3	0	0	1	19	56.7	24.4	0	300	6.870	5.60 - 8.26	1.270	8.420	Retrofitted GW well
	08-Sep-22	1015	0.16	0.1	51.9	22.9	0	0	0	25.1	52	23	0	180	NR	5.60 - 8.26	-	NR	Retrofitted GW well
	09-Sep-22	1008	0.02	0	51.7	22.5	0	1	0	25.9	51.7	22.5	0	180	6.615	5.60 - 8.26	1.015	8.290	Retrofitted GW well
MW6	04-May-22	1009	0.07	-0.1	46.9	27.5	0.2	0	0	25.4	47	27.5	0.2	180	6.701	5.75 - 8.57	0.951	8.574	Retrofitted GW well
	31-May-22	982	0.07	0	50.8	29.1	0.9	1	0	19.3	50.9	29.1	0.9	180	6.460	5.75 - 8.57	0.710	8.574	Retrofitted GW well
	19-Aug-22	1004	0.07	0	52.7	29.9	0.2	0	0	17.2	52.7	30.1	0.2	300	6.635	5.75 - 8.57	0.885	8.520	Retrofitted GW well
	08-Sep-22	1015	0.12	0.1	49.7	28.2	1	0	0	21.2	49.8	28.2	1	180	NR	5.75 - 8.57	-	NR	Retrofitted GW well
	09-Sep-22	1008	0.12	0.1	49.8	28.1	0.8	1	0	21.2	49.9	28.2	0.8	180	6.482	5.75 - 8.57	0.732	8.555	Retrofitted GW well
Off-site																			
LFG03	19-Aug-22	1005	0	0	0	7.3	15	2	0	77.7	0	7.3	15	300	Dry	0.5-3.2	2.7	3.000	Loose cap allowing interaction with atmosphere
	08-Sep-22	1016	0.03	0	3.6	18.9	0.6	0	0	76.9	3.6	18.9	0.6	180	NR	0.5-3.2	2.7	NR	
	09-Sep-22	1010	0.09	0	2.2	18.4	0.5	1	0	79	2.2	18.4	0.5	180	Dry	0.5-3.2	2.7	3.000	
LFG04	19-Aug-22	1004	0	0	21.9	23.3	0	2	0	54.8	21.9	23.3	0	300	Dry	1.0-3.2	2.2	3.835	
	08-Sep-22	1016	0.02	0	23.2	23.2	0	1	1	53.6	23.2	23.2	0	180	NR	1.0-3.2	-	NR	
	09-Sep-22	1009	0	0	23.1	22.9	0	1	1	54	23.1	22.9	0	180	3.710	1.0-3.2	2.2	3.820	
MW09 (GHD)	19-Aug-22	1004	0.04	0	7.8	18.1	1.7	4	0	72.4	7.9	18.3	1.6	300	4.768	--	-	5.490	LFG odour;
	08-Sep-22	1015	-0.07	0.1	8.5	19.3	0	0	0	72.2	8.8	19.3	0	180	NR	--	-	NR	Retrofitted GW well
	09-Sep-22	1009	-0.7	0	8.9	19.4	0.1	1	0	71.7	9.2	19.6	0	180	4.865	--	-	5.490	Retrofitted GW well
MW1	04-May-22	1008	0.03	0	0.1	7.2	14.1	0	0	78.5	0.1	7.2	14.1	180	2.186	1.50 - 3.92	0.686	3.920	Retrofitted GW well
MW2	04-May-22	1008	-0.03	0	0	6.1	16.1	0	0	77.8	0	6.1	16.1	180	1.902	0.70 - 4.21	1.202	4.205	Retrofitted GW well
MW4	04-May-22	1009	-5.91	-2.9	0.1	4.9	13	0	0	82	0.1	5	13	180	1.858	1.95 - 2.75	-0.092	2.750	Retrofitted GW well
MW5d	04-May-22	1009	15.54	6.9	0.1	1.5	20.1	0	0	78.3	2.5	1.6	20.1	180	6.76	~10.5	-3.74	13.150	Retrofitted GW well

Notes

EPA Victoria BEPM (2015). Best practice environmental management; Siting, design, operation and rehabilitation of landfills. Publication 788.3.
TAS DPIWE (2004) Landfill Sustainability Guide; Landfill gas

Safe Work Australia (2011), Confined Spaces - Code of Practice

* Preliminary value based on interim background of 0% + 1.5%

1.81 SWL above screened interval

NR No Reported

Attached Table B2 - Calculated Gas Screening Values (GSVs) August-September 2022
JN22392: Selfs Point CSA

	Aug-Sept 2022	Aug-Sept 2022	Aug-Sept 2022	Aug-Sept 2022	Aug-Sept 2022	Aug-Sept 2022	Aug-Sept 2022			
Bore	Methane (%v/v)	CO2 (%v/v)	Oxygen (% v/v)	Methane (%v/v) - MAX	CO2 (%v/v) - MAX	Oxygen (% v/v) - MIN	Flow Max (L/hr)	GSV = % CH4/100 x flow	GSV = %CO2/100 x flow	Hazard potential based on GSV
Onsite										
LFG01	0	7.9-8.5	8.9-11.9	0	8.5	8.9	0	0.00	0.00	Very Low Risk
LFG02	0	5.0-12.2	4.3-13.0	0	12.2	4.3	0	0.00	0.00	Very Low Risk
LFG05	38.5-40.8	23.3-23.7	0-0.1	40.8	23.7	0	0.1	0.04	0.02	Very Low Risk
LFG06	5.6-9.2	12.9-13.7	2.9-4.2	9.2	13.7	2.9	0.1	0.01	0.01	Very Low Risk
MW5s	51.7-56.7	22.5-24.3	0	56.7	24.3	0	0.1	0.06	0.02	Very Low Risk
MW6	49.7-52.7	28.1-29.9	0.2-1	52.7	29.9	0.2	0.1	0.05	0.03	Very Low Risk
Offsite										
LFG03	0-3.6	7.3-18.9	0.5-15.0	3.6	18.9	0.5	0	0.00	0.00	Very Low Risk
LFG04	21.9-23.2	22.9-23.3	0	23.2	23.3	0	0	0.00	0.00	Very Low Risk
MW09 (GHD well)	7.8-8.9	18.1-19.4	0-1.7	8.9	19.4	0	0.1	0.01	0.02	Very Low Risk

Notes:

GSV Gas Screening Value

<0.07 very low risk	<0.07 very low risk
<0.7 low risk	<0.7 low risk
<3.5 medium risk	<3.5 medium risk
<15 Moderate to High Risk	<15 Moderate to High Risk
<70 High Risk	<70 High Risk
>70 Very High Risk	>70 Very High Risk

Attached Table B3 - Landfill Gas Preliminary Screening Results - Utilities / Service Alignments
JN22392: Selfs Point CSA

					Date	04-May-22	04-May-22	31-May-22	31-May-22	19-Aug-22	19-Aug-22	09-Sep-22	09-Sep-22
Methane Sweep location	Type	Easting	Northing	Units		ppm	%	ppm	%	ppm	%	ppm	%
Action Level utility services on and adjacent landfill (Vic BPEM 2015)						10,000	1.0%	10,000	1.0%	10,000	1.0%	10,000	1.0%
Lower and Upper Explosive Limit (LEL / UEL) for methane in air (SWA, 2011)							5% / 15%		5% / 15%		5% / 15%		5% / 15%
Sewer valve cover - southern side car park (Sewer1)	Sewer	525772	5256017			3,542	0.35%	2.0		31.7		2.2	
Grated pit adjacent rowing shed and car park (GP1)	Stormwater	525805	5256036			6.4		3.6		2.1		11.3	
Grated pit with Ag pipe (3 pipes) central car park (GP2)	Stormwater	525782	5256031			32.6		790		673		2369	0.2%
Grated pit central garden bed car park (GP3)	Stormwater	525763	5256040			5.5 - 28.9		2.4		1.5		1.9	
Grated pit near Marine Pde (GP4)	Stormwater	525752	5256059			2.9		2.0		2.1		2.4	
Ag Outlet - open space - NE rowing shed	Stormwater	525838	5256076					1.3					
Stop Valve - open space - NE rowing shed	Water	525844	5256082					1.0					
Fire Point - open space - NE rowing shed	Fire Valve	525845	5256081					1.3					
Crack near Rowing shed	Tarmac	525778	5256059					89.6					
Water Valve (WV1) adjacent Rowing shed	Water	525791	5256044					1.4		2.1		4.3	
Water Valve (WV2) adjacent Rowing shed	Water	525794	5256072					1.3					
Water Point (WP1) - NE Rowing shed	Water	525835	5256060					1.0					
Grated pit Bridge Club car park (GP5)	Stormwater	525775	5256007					7.3		137		11.4	
Grated Pit Bridge Club car park (GP6)	Stormwater	525747	5256016					1.4					
Grated pit Bridge Club car park (GP7)	Stormwater	525732	5256000					1.0					
Crack in Tarmac Bridge Club car park	Tarmac	525758	5256008					29.9					
Green Lid - in tarmac adjacent to Bridge Club (unknown utility type)	Water	525772	5256001					6,700	0.67%	10,000	1.0%	50	
Stormwater Trap - in tarmac adjacent to Bridge Club	Stormwater	525773	5256004					339		798		140	
Wall Vent 1 - outer brickwork Bridge Club	Structure	525749	5255993					48.9					
Wall Vent 2 - outer brickwork Bridge Club	Structure	525752	5255992					51.9					
Wall Vent 3 - outer brickwork Bridge Club	Structure	525755	5255990					83.9					
Tarmac adjacent to Bridge Club	Tarmac	525771	5256004					99,000	9.9%	385		2.2	
Water meter - adjacent 1st parking bay	Water	526034	5255992							150			
Southwestern fence - adjacent 2nd parking bay	Sweep	525934	5256021							19.8		2.4	
Sweeps - area from front entrance to Lab sheds	Sweep									0.4 - 3.0		1.6 - 2.8	
Sweeps - area adjacent to Lab sheds	Sweep									0.7		2.3 - 2.5	
Sweeps - area adjacent to LFG04	Sweep									1.7-2.6		0.8 - 1.2	
Fence between LFG04 and Bridge Club	Spot check	525778	5255992							8.6		1.2	
Sweeps - wetland western fence	Sweep									1.3		0.9	
Sweeps - wetland southern fence	Sweep									1.5		0.8	
Sweeps - area between LFG06 and Ten Lives shed	Sweep									0.8		0.7 - 2.8	
Sweeps - area north of Rowing shed and New Town Bay	Sweep											2.1	
Black lid - adjacent to fence south of LFG01	Spot check	526005	5255991									5.2	
Area adjacent to fence between yellow shipping container and LFG01	Spot check	526000	5255993									48.3	
Wetland eastern fence - Back of old shed and south of Ten Lives	Spot check	525962	5255909									5.6	
Wetland eastern fence - south of Ten Lives	Spot check	525998	5255918									36.7	
Wetland eastern fence - south of Ten Lives	Spot check	526000	5255938									16.7	
Walkway area between east of rowingn shed and west of wetland	Spot check	525829	5256039									7.5	

Notes

EPA Victoria BEPM (2015). Best practice environmental management; Siting, design, operation and rehabilitation of landfills. Publication 788.3.

TAS DPIWE (2004). Landfill Sustainability Guide; Landfill gas

Safe Work Australia (2011), Confined Spaces - Code of Practice

Attached Table B4 - Groundwater Gauging Results
JN22392: Selfs Point CSA

Well ID	Round Measured	Easting	Northing	Type	Casing (m)	SWL (m below TOC)	TWD (m below TOC)	Water Column (m)	Surveyed TOC Elevation - Elgin (mAHD)	Blank Casing above GL (m)	RL - SWL (mAHD)	RL - TWD (mAHD)	Surveyed GL Elevation - Elgin (mAHD)
On-site													
LFG01	August 2022	526016.28	5256004.53	Flush Gatic		Dry	1.460	Dry	3.521	-0.027	--	2.061	3.548
LFG01	September 2022	526016.28	5256004.53	Flush Gatic		Dry	1.460	Dry	3.521	-0.027	--	2.061	3.548
LFG02	August 2022	525897.73	5256049.19	Flush Gatic		Dry	2.045	Dry	2.844	-0.110	--	0.799	2.954
LFG02	September 2022	525897.73	5256049.19	Flush Gatic		Dry	2.050	Dry	2.844	-0.110	--	0.794	2.954
LFG05	August 2022	525963.89	5255954.28	Stick-Up		7.450	7.640	0.19	8.512	0.676	1.062	0.872	7.836
LFG05	September 2022	525963.89	5255954.28	Stick-Up		7.385	7.640	0.26	8.512	0.676	1.127	0.872	7.836
LFG06	August 2022	525923.63	5255919.07	Stick-Up		Dry	7.500	Dry	9.649	0.544	--	2.149	9.105
LFG06	September 2022	525923.63	5255919.07	Stick-Up		Dry	7.500	Dry	9.649	0.544	--	2.149	9.105
MW5d (deep)	April 2022	525855.12	5256026.52	Stick-Up	0.700	6.962	13.150	6.19	7.503	0.700	0.541	-5.647	
MW5s (shallow)	April 2022	525855.28	5256030.47	Stick-Up	0.755	6.895	8.264	1.37	7.538	0.755	0.643	-0.726	6.832
MW5s (shallow)	August 2022	525856.91	5256023.65	Stick-Up		6.870	8.420	1.55	7.526	0.694	0.656	-0.894	6.832
MW5s (shallow)	September 2022	525856.91	5256023.65	Stick-Up		6.615	8.290	1.68	7.526	0.694	0.911	-0.764	6.832
MW6	April 2022	525944.20	5255983.18	Stick-Up	0.750	6.855	8.574	1.72	7.663	0.750	0.808	-0.911	7.054
MW6	August 2022	525941.68	5255987.51	Stick-Up		6.635	8.520	1.89	7.652	0.598	1.017	-0.868	7.054
MW6	September 2022	525941.68	5255987.51	Stick-Up		6.482	8.555	2.07	7.652	0.598	1.170	-0.903	7.054
MW10 (GHD well near LFG06)	August 2022	525928.10	5255886.64	Stick-Up		7.697	14.770	7.07	9.004	0.852	1.307	-5.766	8.152
Off-site													
LFG03	August 2022	525822.56	5256028.47	Flush Gatic		Dry	3.000	Dry	4.672	-0.147	--	1.672	4.819
LFG03	September 2022	525822.56	5256028.47	Flush Gatic		Dry	3.000	Dry	4.672	-0.147	--	1.672	4.819
LFG04	August 2022	525798.71	5255975.20	Stick-Up		Dry	3.835	Dry	6.151	0.677	--	2.316	5.474
LFG04	September 2022	525798.71	5255975.20	Stick-Up		3.710	3.820	0.11	6.151	0.677	2.441	2.331	5.474
MW09 (GHD well near LFG04)	August 2022	525788.19	5255959.21	Stick-Up		4.768	5.490	0.72	6.321	0.708	1.553	0.831	5.613
MW09 (GHD well near LFG04)	September 2022	525788.19	5255959.21	Stick-Up		4.865	5.490	0.63	6.321	0.708	1.456	0.831	5.613
MW1	April 2022	526036.61	5256199.32	Flush Gatic		2.155	3.920	1.77	2.365		0.210	-1.555	
MW2	April 2022	525949.96	5256111.78	Flush Gatic		1.880	4.205	2.33	2.334	-0.056	0.454	-1.871	2.390
MW2	August 2022	525951.23	5256113.60	Flush Gatic		0.927	4.220	3.29	2.330	-0.060	1.403	-1.890	2.390
MW3 (well lost)	EM&C - May 2016	526035.58	5256143.32			1.620			2.306		0.686	2.306	
MW4	April 2022	526020.04	5256059.36	Flush Gatic		1.810	2.750	0.94	3.065		1.255	0.315	
MW08 (GHD well near rowing shed)	August 2022	525857.42	5256078.76	Flush Gatic		1.520	2.280	0.76	2.124	-0.184	0.604	-0.156	2.308

Notes
m: meters
SWL: Standing Water Level
TWD: Total Well Depth
TOC: Top of Casing
GL: Ground Level
mAHD: meters Australian Height Datum
RL: Reduced Level
***Surveyed Elevation - ELGIN:** Round August 2022 only
Groundwater monitoring wells

Attached Table B5 - Dissolved Gases Groundwater Results
JN22377: Selfs Point CSA

Parameter Suite	Analyte Name	Units	Sample ID	MW1	MW2	MW4	MW5d	MW5s	MW6
			Sampling Date	7/04/2022	7/04/2022	7/04/2022	7/04/2022	7/04/2022	7/04/2022
Parameter Suite	Analyte Name	Units	LOR						
Gauging	Depth to Water (DTW)	mBTC		2.16	1.88	1.81	6.96	6.90	6.86
	Total Well Depth (TD)	mBTC		3.92	4.21	2.75	13.15	8.26	8.574
	Well Screen Interval as measured 4th May 2022	mBTC		1.50 - 3.92	0.70 - 4.21	1.95 - 2.75	~10.5 -13.15	5.60 - 8.26	5.75 - 8.57
CO2 - Free and Total	Free Carbon Dioxide	mg/L	1	96	----	----	20	241	496
	Total Carbon Dioxide	mg/L	1	1560	----	----	426	2170	2230
C1-C4 Hydrocarbon Gases	Methane	µg/L	10	----	7690	3800	393	7870	11900
	Ethene	µg/L	10	----	<10	<10	<10	<10	<10
	Ethane	µg/L	10	----	<10	<10	<10	<10	<10
	Propene	µg/L	10	----	<10	<10	<10	<10	<10
	Propane	µg/L	10	----	<10	<10	<10	<10	<10
	Butene	µg/L	10	----	<10	<10	<10	<10	<10
	Butane	µg/L	10	----	<10	<10	<10	<10	<10

Borelogs

CLIENT:	ERA Planning/TasWater CDO			JOB NUMBER:	JN22392
PROJECT:	Selfs Point LFG			DATE COMMENCED:	11/08/2022
BORE LOCATION:	Selfs Point			DATE COMPLETED:	11/08/2022
CONTRACTOR:	KMR			LOGGED BY:	EH
Drill Model:	Scout	Easting (MGA):	Bore Size:	n/a	BCL No: n/a
RL:	n/a	Northing (MGA):	Drilling Fluid:	n/a	

Method	Casing	Depth (m)	Material Description				Sampling	Field Records/Construction Information
			Graphic Log	Type, colour/mottling, plasticity/particle size,secondary/minor components, soil origin	Moisture	Oil Pan Test		
Hollow auger/NDD		0.5		FILL, sandy loam, gravel, angular cobbles, dark brown, loose	D			Gatic Concrete
		1.0		FILL, sandy clay, pieces of wood and brick, dark brown, low plasticity				
		1.5						Benonite / Solid Casing
		2.0		EOH 1.8m bgl	W			Gravel / Solid Casing
		2.5						Gravel / Slotted Casing
		3.0						Backfill to 1.6m
		3.5						
		4.0						
		4.5						
		5.0						
		5.5						
		6.0						
		6.5						
		7.0						
		7.5						
		8.0						

CLIENT:	ERA Planning/TasWater CDO			JOB NUMBER:	JN22392
PROJECT:	Selfs Point LFG			DATE COMMENCED:	11/08/2022
BORE LOCATION:	Selfs Point			DATE COMPLETED:	11/08/2022
CONTRACTOR:	KMR			LOGGED BY:	EH
Drill Model:	Scout	Easting (MGA):	Bore Size:	n/a	BCL No: n/a
RL:	n/a	Northing (MGA):	Drilling Fluid:	n/a	

Method	Casing	Depth (m)	Material Description				Field Records/Construction Information			
			Graphic Log	USCS Classification	Type, colour/mottling, plasticity/particle size,secondary/minor components, soil origin	Moisture	Oil Pan Test	PID (ppm)	Sampling	Odour, staining, groundwater observations/regime, additional information
Hollow auger/NDD		0.5			FILL, sandy loam, gravel, angular cobbles, dark brown, loose	D-M				Gatic and Concrete
		1.0				M				Benonite / Solid Casing
		1.5								Gravel / Solid Casing
		2.0								Gravel / Slotted Casing
		2.5				W				Backfill to 2.2m
		3.0			EOH 2.5m bgl					
		3.5								
		4.0								
		4.5								
		5.0								
		5.5								
		6.0								
		6.5								
		7.0								
		7.5								
		8.0								

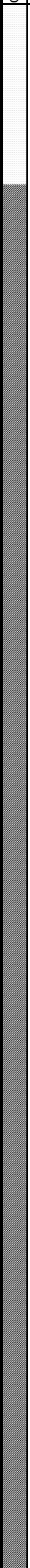
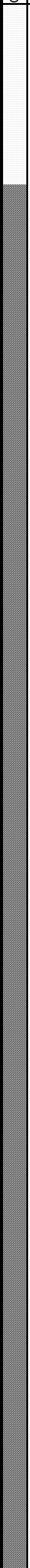
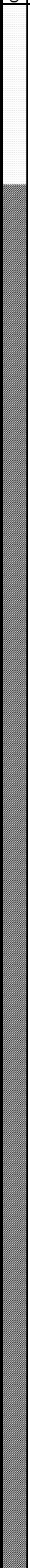
CLIENT:	ERA Planning/TasWater CDO			JOB NUMBER:	JN22392
PROJECT:	Selfs Point LFG			DATE COMMENCED:	12/08/2022
BORE LOCATION:	Selfs Point			DATE COMPLETED:	12/08/2022
CONTRACTOR:	KMR			LOGGED BY:	LF
Drill Model:	Scout	Easting (MGA):	Bore Size:	n/a	BCL No: n/a
RL:	n/a	Northing (MGA):	Drilling Fluid:	n/a	

Method	Casing	Depth (m)	Material Description				PID (ppm)	Sampling	Field Records/Construction Information	
			Graphic Log	USCS Classification	Type, colour/mottling, plasticity/particle size,secondary/minor components, soil origin	Moisture			Oil Pan Test	Odour, staining, groundwater observations/regime, additional information
Hollow auger/NDD		0.5			FILL, gravel, grey, blue metal 20mm present	D				Concrete (gatic surface)
		1.0				D				Benonite / Solid Casing
		1.5								Gravel / Solid Casing
		2.0								
		2.5								
		3.0								
		3.5								
		4.0								
		4.5								
		5.0								
		5.5								
		6.0								
		6.5								
		7.0								
		7.5								
		8.0								

CLIENT:	ERA Planning/TasWater CDO			JOB NUMBER:	JN22392
PROJECT:	Selfs Point LFG			DATE COMMENCED:	12/08/2022
BORE LOCATION:	Selfs Point			DATE COMPLETED:	12/08/2022
CONTRACTOR:	KMR			LOGGED BY:	EH/LF
Drill Model:	Scout	Easting (MGA):	Bore Size:	n/a	BCL No: n/a
RL:	n/a	Northing (MGA):	Drilling Fluid:	n/a	

Method	Casing	Depth (m)	Material Description				Field Records/Construction Information			
			Graphic Log	USCS Classification	Type, colour/mottling, plasticity/particle size,secondary/minor components, soil origin	Moisture	Oil Pan Test	PID (ppm)	Sampling	Odour, staining, groundwater observations/regime, additional information
Hollow auger/NDD		0.5			FILL, silty clay, black/dark grey, waste steel fragments, fragments of glass, brick, tree branches	D				(Stick up 0.6m) Concrete
		1.0				D				Benonite / Solid Casing
		1.5								
		2.0				D				Gravel / Solid Casing
		2.5								
		3.0								Gravel / Slotted Casing
		3.5			EOH 3.2m bgl - Refusal	D-M				
		4.0								
		4.5								
		5.0								
		5.5								
		6.0								
		6.5								
		7.0								
		7.5								
		8.0								

CLIENT:		ERA Planning/TasWater CDO		JOB NUMBER:	JN22392
PROJECT:		Selfs Point LFG		DATE COMMENCED:	11/08/2022
BORE LOCATION:		Selfs Point		DATE COMPLETED:	11/08/2022
CONTRACTOR:		KMR		LOGGED BY:	EH/LF
Drill Model:	Scout	Easting (MGA):	Bore Size:	n/a	BCL No: n/a
RL:	n/a	Northing (MGA):	Drilling Fluid:	n/a	

Method	Casing	Depth (m)	Material Description				Field Records/Construction Information			
			Graphic Log	USCS Classification	Type, colour/mottling, plasticity/particle size,secondary/minor components, soil origin	Moisture	Oil Pan Test	PID (ppm)	Sampling	Odour, staining, groundwater observations/regime, additional information
Hollow auger/NDD		0.5			FILL, gravelly, black, broken up tarmac	D				(Stick up 0.6m) Concrete
		1.0			FILL, clay, black					Benonite / Solid Casing
		1.5								Gravel / Solid Casing
		2.0								No odour, no staining
		2.5								No odour, no staining
		3.0			FILL, silt, black, soft, gravel fines angular <5mm					Gravel Slotted Casing
		3.5								Strong HC odour, no staining LFG05_3.0m
		4.0								
		4.5								
		5.0			clay content increasing					HC odour reducing, no staining
		5.5								Gravel Slotted Casing
		6.0			FILL, clay, silty (river silt), wood fines, sticky					Slight odour (HC?), no staining
		6.5								
		7.0			fragment of alloy wire 4mm					Slight odour (HC?), no staining
		7.5								Backfill to 7 m
		8.0			EOH 7.8m bgl - Refusal					

CLIENT:		ERA Planning/TasWater CDO		JOB NUMBER:		JN22392	
PROJECT:		Selfs Point LFG		DATE COMMENCED:		11/08/2022	
BORE LOCATION:		Selfs Point		DATE COMPLETED:		11/08/2022	
CONTRACTOR:		KMR		LOGGED BY:		EH/LF	
Drill Model:	Scout	Easting (MGA):	Bore Size:	n/a	BCL No:	n/a	
RL:	n/a	Northing (MGA):	Drilling Fluid:	n/a			

Method	Casing	Depth (m)	Material Description				Field Records/Construction Information			
			Graphic Log	USCS Classification	Type, colour/mottling, plasticity/particle size,secondary/minor components, soil origin	Moisture	Oil Pan Test	PID (ppm)	Sampling	Odour, staining, groundwater observations/regime, additional information
Hollow auger/NDD		0.5			FILL, silty clay (dredged sediment?), dark brown	D				(Stick up 0.6m) Concrete
		1.0								Benonite / Solid Casing
		1.5								Gravel / Solid Casing
		2.0								Gravel Slotted Casing
		2.5			FILL, silty clay, black, granular waste	D				Moderate HC odour, no staining
		3.0				M				Strong HC odour
		3.5			FILL, silty clay, black to grey, wood and glass					
		4.0			becoming denser, dark black	M		0.7	X	Very strong HC odour LFG06_4.0m
		4.5								Very strong HC odour
		5.0								Gravel Slotted Casing
		5.5			FILL, sandy clay, dark grey/black, low plasticity, brick and metal	M				Moderate HC odour
		6.0								
		6.5								
		7.0								
		7.5				W				Backfill to 7m Strong HC odour, metal
		8.0			EOH 7.5m bgl - Refusal					

Field Sheets

Project & Site:	JN22392 - Self Point RSRA	GA5000 Number:	
Date:	19/08/22	Calibration Cert Photo?	Y / N
Monitoring Personnel:	LF & AH	Fresh Air Check Done?	(Y) / N
Nearest BOM station:	Hobart		

Start Time: 1140	End Time: 1500
Atmospheric Pressure 12 hrs PRIOR (BOM):	~~1005.5~~ 1001.6
Atmospheric Pressure at START (BOM): 1005.5	Atmospheric Pressure at END (BOM): 1004.7
Atmospheric Pressure at START (GA5000) 1005	Atmospheric Pressure at END (GA5000): 1005

[illegible]

Start Time: 1320	End Time: 1530
Atmospheric Pressure 12 hrs PRIOR (BOM):	1022.5
Atmospheric Pressure at START (BOM): 1015.8	Atmospheric Pressure at END (BOM): 1014.1
Atmospheric Pressure at START (GA5000): 1016	Atmospheric Pressure at END (GA5000): 1015

[illegible]

Start Time: 1108	End Time: 1450
Atmospheric Pressure 12 hrs PRIOR (BOM):	* 1011
Atmospheric Pressure at START (BOM): 1009	Atmospheric Pressure at END (BOM): 1007
Atmospheric Pressure at START (GA5000): 1010	Atmospheric Pressure at END (GA5000): 1008

[illegible]

opened cap - left
on another
45 mins
before
sampling.