



Douglas Partners

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Integrated Practical Solutions

Long Term Environmental Management Plan

Georges Cove Residential Development
146 Newbridge Road, Moorebank

Prepared for
Benedict Industries Pty Ltd

Project 71459.06
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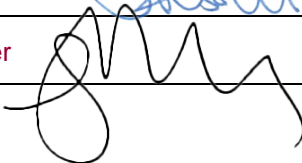
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Executive Summary

This Long Term Environmental Management Plan (LTEMP) has been prepared by Douglas Partners Pty Ltd (DP) for the Georges Cove Residential Development located at 146 Newbridge Road, Moorebank, which is legally defined as Lot 2 in DP1246745 and covers 8.399 ha (the 'Site') (Drawing 1, Appendix A). The Site is used for medium density residential housing managed under a Community Title Scheme together with Council owned road reserves, drainage reserves and open space / parks.

The purpose of this LTEMP is to provide a framework for the ongoing passive management of on-site remediation measures that were designed and constructed so that contamination underlying the 2.5 m to 3 m thick cap does not adversely impact the currently approved land use. The (post construction) LTEMP includes, among other things:

- Procedures for the management and maintenance of the cap and landfill gas mitigation systems;
- Procedures for scenarios where the capping or landfill gas mitigation systems need to be penetrated and reinstated;
- Restrictions on land use; and
- Responsibilities for implementation of the LTEMP.

Normal day to day operation of the Site does not trigger the implementation of this LTEMP. Normal gardening activities (e.g., lawn watering or cutting, shrub planting) that do not significantly disturb the physical barrier system in any way can be undertaken without triggering the implementation of the LTEMP. The gas mitigations incorporated into the building have the same design life as the building and should not require routine maintenance, with the exception of the wind-driven turbine ventilators fitted to the roof of each home and garage.

This LTEMP is triggered through works that disturb or penetrate the physical barrier (including disturbing of surface coverings, excavating into soils and accessing buried services that are not confined to the upper excavated natural material (ENM) portion of the cap - comprising of crushed sandstone tunnel spoil). The management requirements for such works are outlined in the Section 5.3.

This LTEMP is also triggered through illegal development works or accidental damage (e.g., house fire) that damages a component of the gas mitigation system e.g., breaching the slab or tearing the sub-slab gas proof membrane or seizing-up of the wind-driven turbine ventilator. The management requirements for such works are outlined in the Section 6.3.

In addition, this LTEMP is triggered through works involving the drilling of groundwater abstraction or monitoring wells (abstraction wells are prohibited under this LTEMP). The management requirements for such works are outlined in the Section 7.3.

This Executive Summary provides a pragmatic quick reference guide of general control actions for the Community Association and landholders and their associated consultants and contractors in Table E1 (do's and don'ts). Adherence to these control actions by landholders should assist with maintaining compliance with this Long Term Environmental Management Plan (LTEMP). Table E2 provides a pragmatic quick reference guide of general control actions for Council (do's and don'ts) in relation to their road and public open space assets. Table E3 provides a pragmatic quick reference guide of

general control actions for Contractors (do's and don'ts) undertaking on-site works having the potential to impact the integrity of the cap or a landfill gas mitigation system.

Table E1: Summary of Control Actions for Community Association on behalf of the Landholders under this LTEMP (Do's and Don'ts)

Actions that should <u>not</u> be undertaken by Community Association and land owners:	Actions which should be undertaken by Community Association land owners:
<ul style="list-style-type: none"> • DO NOT undertake any works that will involve breaching the slab of the building(s) without seeking prior approval from the Community Association, and Liverpool City Council. • DO NOT undertake <u>any</u> excavations which remain permanently open. • DO NOT undertake any temporary excavations (e.g., for planting shrubs) more than 0.5 m deep. • DO NOT undertake any works in excess of 2.5 m below ground level within any part of the Site without seeking prior approval from the Community Association and obtaining development consent from Liverpool City Council. Backyard / front yard pools are NOT permitted. • DO NOT engage a contractor who is not suitably qualified, licensed and experienced to undertake work at the Site having the potential to disturb the cap or the landfill gas mitigation system. • DO NOT ignore gas odours or unidentified odours, DO report such odours immediately to the Community Association and Liverpool City Council. • DO NOT open, damage, block or interfere with the risers and perimeter manifolds for gas relief at building exteriors. • DO NOT block, damage or interfere with the roof top ventilators, which act to exhaust gas to the atmosphere. • In the event that an authorised excavation is undertaken DO NOT ignite naked lights or cause sparks. 	<ul style="list-style-type: none"> • Be responsible for implementing the LTEMP. • Ensure that the LTEMP and any subsequent revisions are provided to all relevant land holders / owner / occupiers within the Site. • Contractors engaged by the Community Association / landowners who are to undertake work having the potential to disturb the cap or the landfill gas mitigation system must: <ul style="list-style-type: none"> o Be provided with a copy of this LTEMP prior to the commencement of their work; o Comply with the requirements of this LTEMP; and o Notify the Community Association / land owners / occupiers without delay if they become aware of any defects to the cap or the landfill gas mitigation system. • Rectify defects to the cap and / or landfill gas mitigation system as required by the LTEMP. • The Community Association must have periodic inspections undertaken by an Environmental / Geotechnical Consultant of the condition and integrity of the cap and landfill gas mitigation. • Implement contingency measures as required by the LTEMP. • Monitor and document the implementation of the LTEMP. • Periodically review and up-date the LTEMP in light of any new environmental information resulting from events, incidents or monitoring. • Provide a mechanism for landholder / occupier feedback through an ongoing community consultation mechanism.

<p>Actions that should <u>not</u> be undertaken by Community Association and land owners:</p>	<p>Actions which should be undertaken by Community Association land owners:</p>
<ul style="list-style-type: none"> • DO NOT investigate cracks, breakage or other forms of distress in the pavement, slab, gas control system or any other section of the building or exterior with a naked flame or light. Battery-operated torch is acceptable. Seek advice from the Community Association or Liverpool City Council if in doubt. • DO NOT handle (without relevant PPE) or ingest any soils or wastes materials sourced from below a depth of 2.5 m that may become exposed at the surface for any reason. • DO NOT burn any materials on site. Gas-fired BBQ and above-ground charcoal BBQ is acceptable. • DO NOT use groundwater pumped from beneath the Site for any purpose (groundwater pumping / abstraction is prohibited). 	<ul style="list-style-type: none"> • DO submit a development application to Council for any future excavations deeper than 2.5 m below ground level (bgl). • DO report to the Community Association and Liverpool City Council any gas odours noticed within or outside the buildings. • DO report to the Community Association and Liverpool City Council any breach of the building slab, pavements or Site capping materials that you observe. • DO report to the Community Association and Liverpool City Council any signs of breakage of the gas relief pipes within and adjacent to the buildings. • DO report to the Community Association and Liverpool City Council any signs of building settlement or building distress that you observe beyond industry standards (e.g., The NSW Guide to Standards and Tolerances 2017 prepared by NSW Fair Trading)¹ including pavement cracking, dishing or cavitation. • DO report to the Community Association and Liverpool City Council any damage to gas risers or roof top ventilators. • DO report to the Community Association and Liverpool City Council any breaches of Site capping or unauthorised excavations or erosion which exposes underlying wastes. • DO arrange for covering of any exposed waste resulting from excavation or erosion of cover.

1

http://www.fairtrading.nsw.gov.au/biz_res/ftweb/pdfs/Tenants_and_home_owners/NSW_Guide_to_Standards_and_Tolerances.pdf

Table E2: Summary of Control Actions for Council under this LTEMP for Roads and Public Open Spaces Excluding Buildings with Gas Mitigations (Do's and Don'ts)

<p style="text-align: center;">Actions that should <u>not</u> be undertaken by Council:</p>	<p style="text-align: center;">Actions which should be undertaken by Council:</p>
<ul style="list-style-type: none"> • DO NOT undertake excavations in excess of 2.5 m within any part of the assets without seeking prior approval from the relevant department within Liverpool City Council. • DO NOT ignore gas odours or unidentified odours, DO report such odours immediately to the Community Association and the relevant department within Liverpool City Council. • In the event that an authorised excavation is undertaken DO NOT ignite naked lights or cause sparks. • DO NOT handle (without relevant PPE) or ingest any soils or wastes materials sourced from below a depth of 2.5 m that may become exposed at the surface for any reason. • DO NOT burn any materials on site. Gas-fired BBQ and above-ground charcoal BBQ is acceptable. • DO NOT use groundwater pumped from beneath the Site for any purpose (groundwater pumping / abstraction is prohibited). 	<ul style="list-style-type: none"> • Council is responsible for having the LTEMP recorded on Council's asset management system • Contractors engaged by Council who are to undertake work having the potential to disturb the cap must: <ul style="list-style-type: none"> o be provided with a copy of this LTEMP prior to the commencement of their work; o comply with the requirements of this LTEMP; and o notify Council and the Community Association without delay if they become aware of any defects to the cap. • DO ensure that stormwater drainage is well ventilated to atmosphere to prevent the potential build-up of landfill gas in drains and pits. • DO report to the relevant department within Liverpool City Council any gas odours noticed within stormwater infrastructure. • DO report to the Community Association and the relevant department within Liverpool City Council any breach of the Site capping materials that you observe. • DO report to Liverpool City Council any signs of pavement settlement / distress that you observe including cracking, dishing or cavitation. • DO report to the Community Association and the relevant department within Liverpool City Council any breaches of Site capping or unauthorised excavations or erosion which exposes underlying wastes. • DO arrange for covering of any exposed waste resulting from excavation or erosion of cover.

Table E3: Summary of Control Actions for Contractors under this LTEMP for Works Potentially Impacting the Integrity of the Cap or Landfill Gas Mitigation System (Do's and Don'ts)

Actions that should <u>not</u> be undertaken by Contractors:	Actions which should be undertaken by Contractors:
<ul style="list-style-type: none"> • DO NOT undertake excavations in excess of 2.5 m within the site without prior approval from Liverpool City Council. • DO NOT undertake excavations in excess of 2.5 m without appropriate controls to handle potentially contaminated soils that may be encountered below the cap. • DO NOT undertake any renovation work without development consent that involves: <ul style="list-style-type: none"> o Disturbing the ground floor home or garage slab (e.g., concrete cutting, coring or similar). o Modifying or damaging / blocking the gas mitigation pipework (manifolds, inlets, risers or turbine ventilators). 	<ul style="list-style-type: none"> • Ensure that all works are undertaken in accordance with the requirements of this LTEMP, the Site Audit Statement (SAS) conditions, relevant Standards and NSW EPA endorsed guidelines. • Ensure that any works involving a new (or replacement) concrete slab on ground has been designed in accordance with relevant guidelines and standards for building on gas-affected land (refer to Section 9). • Ensure that you are suitably qualified, licensed and experienced to undertake any work at the Site that has the potential to disturb the cap or the landfill gas mitigation system. • Ensure that all maintenance works on buried services follow standard 'confined space work' protocols, given the potential presence of landfill gas (methane and carbon dioxide) in the subsurface. • Ensure that relevant PPE is used for works involving temporary breaching of the cap. • DO reinstate the cap following any works that partially or fully breach the cap.

Further details on the rationale behind the 'do's and don'ts' outlined in Tables E1, E2 and E3 (above), are provided in the body of this report.

This LTEMP has been prepared with reference to NSW EPA endorsed guidelines and practice notes, including NSW EPA *Guidelines for Consultants Reporting on Contaminated Land* (NSW EPA, 2020) and NSW EPA *Preparing Environmental Management Plans for Contaminated Land* (NSW EPA, 2022). It is envisaged that Council will manage any long term responsibilities that may be associated with roads and public open spaces and that the Community Association will manage any long term responsibilities that may be associated with the housing lots, Community Facility and parks as Community association property. The "LTEMP Responsibility Plan" (i.e., Mirvac Drawing No. 2-11, Appendix A) outlines the two areas of responsibility.

Diligent implementation of this LTEMP should ensure the long term viability of the contaminated soil, soil gas and groundwater management system via the overall remediation strategy of the physical barrier (cap) and landfill gas mitigation systems.

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Appendix A: About this Report

Drawings

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146 Newbridge Road, Moorebank NSW

Long Term Environmental Management Plan

Georges Cove Residential Development

146 Newbridge Road, Moorebank

1. Purpose

This Long Term Environmental Management Plan (LTEMP) has been prepared by Douglas Partners Pty Ltd (DP) for the Georges Cove Residential Development located at 146 Newbridge Road, Moorebank, which is legally defined as Lot 2 in DP1246745 and covers 8.399 ha (the 'Site'). The location and boundary of the Site is shown by DP Drawing 1 in Appendix A.

The Site is mainly used for medium density residential housing and community land managed under a Community Title Scheme, with this land collectively referred to as "Houses and Community Title Land". The other parts of the Site consist of Council owned road reserves, drainage reserves and open space / parks collectively referred to as "Council Land". The layout of these two types of land is shown by Mirvac Drawing No. 2-11 in Appendix A.

The purpose of this LTEMP is to provide a framework for the ongoing passive management of on-site remediation measures that were designed and constructed so that contamination underlying the cap (minimum thickness 2.5 m) does not adversely impact the currently approved land use. The (post-construction) LTEMP includes, among other things:

- Procedures for the management and maintenance of the cap and landfill gas mitigation systems;
- Procedures for scenarios where the capping or landfill gas mitigation systems need to be penetrated and reinstated;
- Restrictions on land use; and
- Responsibilities for implementation of the LTEMP.

Normal day to day operation of the Site does not trigger the implementation of this LTEMP. Normal gardening activities (e.g., lawn watering or cutting, shrub planting) that do not significantly disturb the physical barrier system in any way can be undertaken without triggering the implementation of the LTEMP. The gas mitigations incorporated into the building have the same design life as the building and should not require routine maintenance.

This LTEMP is triggered through works that disturb or penetrate the physical barrier (including disturbing of surface coverings, excavating into soils and accessing buried services). The management requirements for such works are outlined in the Section 5.3.

This LTEMP also is triggered through illegal development works or accidental damage (e.g., house fire) that damages a component of the gas mitigation system in a house e.g., breaching the slab or tearing the sub-slab gas proof membrane or seizing-up of the wind-driven turbine ventilator. The management requirements for such works are outlined in the Section 6.3.

In addition, this LTEMP is triggered through works involving the drilling of groundwater abstraction or monitoring wells (abstraction wells are prohibited under this LTEMP). The management requirements for such works are outlined in the Section 7.3.

All services are confined to the upper ENM portion of cap with the exception of certain segments of stormwater and sewer lines, confirmed by survey during construction, shown on Beveridge Williams & Co Pty Ltd (BW), formerly John M. Daly & Associates Pty Ltd (JMD), Drawings 14005FP4 Sheets 1 and 2, Appendix A. These deeper services were over-excavated and backfilled / encapsulated within ENM at depths below the surrounding ENM cap (refer to depths indicated on Sheets 1 and 2).

The overall purpose and objectives of this LTEMP is to set out the measures necessary for the maintenance of environmental mitigation measures for soil, soil gas and groundwater throughout the tenure of proposed land use and provide a means of managing the remaining contamination on the Site within the context of the proposed residential land use.

A pre-remediation site plan and locality map is shown on DP Drawing 1, Appendix A.

2. Administration and Implementation

2.1 Community Association

The Community Association Committee is established under the Community Land Management Act 2021, with the following officers: Secretary, Treasurer and Chairperson. A Community Manager will be appointed by Mirvac to oversee the management of this process. The bylaws and details of operation are captured within the Community Management Statement, also noting that:

- Mirvac (the developer) will be on the Committee until the development is completed.
- Mirvac will be represented for 2 years after the registration of the first plan.

2.2 Stakeholders

The key stakeholders identified with respect to this LTEMP are as follows:

- Benedict Industries Pty Ltd (former land owner);
- Mirvac Homes (NSW) Pty Ltd (Mircvac) (the developer);
- Community Association (body corporate) on behalf of the individual home owners and Community Facilities of the Community Title scheme;
- Liverpool City Council;
- Community Groups;
- Built asset owners:
 - o Sydney Water;
 - o Endeavour Energy;
 - o NBN; and

- o Jemena.

2.3 Responsibility and Enforceability

The administration and implementation of the LTEMP shall be the responsibility of:

- The Community Association as it pertains to the residential land owned by land owners or the Community Association at the Site; and
- Liverpool City Council as it pertains to Council owned road reserves, drainage reserves and open space / parks at the Site

Provisions under the LTEMP must be passed to the Community Association (body corporate) on behalf of successive landholders in their capacity as members of the Community Association (body corporate) via normal land sales documentation and planning documentation. Accordingly, the existence of the LTEMP will be recorded within the Community Management Statement on the Community title estate and on a covenant registered on the title to land under Section 88B of the Conveyancing Act 1919 for each lot within the Site.

It shall be the responsibility of the Community Manager (as part of the Community Title estate) to make the existence of this LTEMP known to all site owners. The existence of this LTEMP must also be made known to all prospective purchasers. The onus is on the owners ensure that occupants (owners or renters) comply with the Community Management Statement / LTEMP.

This LTEMP is to remain in force for the foreseeable future. This is because, while landfill gas concentrations should continue to decrease over time, contaminated soil remains buried under a cap that requires ongoing management.

2.4 Recording of the LTEMP

The LTEMP will be recorded on the Section 10.7 Planning Certificate for all properties located within the Site. Mirvac is responsible for having the LTEMP recorded on the NSW Dial-Before-You-Dig database. Council is responsible for having the LTEMP recorded on Council's asset management system.

The LTEMP forms part of the Community Management Statement (i.e. a key document relating to the Community Association).

2.5 Document Control and Revisions

The LTEMP has been prepared in accordance with EPA guidance and Development Consent DA-24/2017 issued by Liverpool City Council dated 24 June 2020.

The LTEMP is a Controlled Document and management of the document will be undertaken within the Community Association and Liverpool City Council's document management system. The LTEMP will continue in perpetuity.

Reviewing the LTEMP in light of any new environmental information resulting from events, incidents or monitoring must be done by a qualified Environmental Consultant on an annual basis. Any revisions made to the LTEMP by the Environmental Consultant must comply with current EPA guidance and must be approved by a Site Auditor and Liverpool City Council.

Any updated version of the LTEMP (and any subsequent revisions) must be provided to all relevant land holders / owner / occupiers within the Site by the Community Association (see Section 2.3). The Community Association will have the contact details of all residents and will communicate with them generally via email. The LTEMP forms part of the Community Management Statement, and as such, any updates will be provided to all owners by the Community Manager.

2.6 Community Consultation

The developer, Mirvac, or their delegated representative has managed all community and stakeholder engagement during the development phase of the project.

The Community Association and Liverpool City Council are to maintain feedback through an ongoing community consultation mechanism. A delegated representative of the Community Association and Liverpool City Council is to perform the role of community consultation post-occupation of houses, public roads and parks within the development. Landholder feedback may be in relation to any aspect of this LTEMP such as:

- Proposed or unintentional / uncontrolled breaches of the physical barrier; or
- Updating of the LTEMP in light of any new environmental information resulting from events, incidents or monitoring.

Any landholder feedback is to be directed to the Community Association and Liverpool City Council. Landholder feedback is also to be obtained via meetings (Community Management Statement By Law 16 Meetings).

3. Background

3.1 Site Identification

Site Address	146 Newbridge Road, Moorebank, NSW 2170
Legal Description	Lot 2 in Deposited Plan 1246745
Coordinates	NW: 311787.62,6243764.21 NE: 311991.71,6243778.26 E: 312081.92,6243693.96 SE: 311927.38,6243410.75 SW: 311807.59,6243379.70
Site Owner	Tanlane Pty Ltd, I 006 922 998
Local Government Area	Liverpool
Consent Authority	Liverpool City Council
Site Zoning (current)	R3 - Medium Density Residential
Site Zoning (future)	R3 - Medium Density Residential

A Site plan and locality map are included in DP Drawing 1 in Appendix A. A survey plan depicting individual lots (following subdivision) is "LTEMP Responsibility Plan" (i.e., Mirvac Drawing No. 2-11, Appendix A).

3.2 Historical Land Use

Large scale filling and dredging activity occurred at the Site between 1991 and 2000. The wider Site operated under two NSW EPA licences issued under the POEO Act. Scheduled activities at the Site included:

- Crushing, grinding or separating; land-based extractive activity; and water-based extractive activity;
- Storage / transfer / separation of various waste streams;
- Importation of excavated natural material (ENM) (predominantly sandstone tunnel spoil) and potential acid sulphate soil (PASS) for backfilling sand quarry (according to the Site owner, only minor quantities of PASS was ever accepted at the Site);
- Dredging activities;
- Landfilling activities; and
- Recovery, storage and processing (non-thermal treatment) of general waste including ENM; general solid waste (non-putrescible); general or specific exempted waste; wood waste; waste; paper or cardboard; gyprock; glass; building and demolition waste; asphalt waste (including asphalt resulting from road construction and waterproofing works); and waste tyres.

A large number of geotechnical and environmental (contamination) investigations were conducted at the Site between 1999 and 2019. The investigations have generally confirmed the presence of fill containing a component of construction and demolition waste of varying thickness of up to 11.5 m at the southern central portion of the Site. Localised pockets of chemical and asbestos contamination in the fill remain at the Site below an engineered physical barrier (minimum 2.5 m thick cap, refer to plan for cap depth based on the design finished surface level JMD Drawing 14005FP5 Sheet 1, Appendix A).

A program of ground improvement and remediation work commenced in 2015. The objective of this work was to provide a stable platform on which the residential development could be constructed, reduce landfill gas emissions to acceptable levels, and provide a secure cover over the fill layer. In summary, site remediation involved:

- Soil - containment of the impacted soil (fill) on Site beneath an engineered physical barrier (cap) coupled with the selective excavation and removal of hotspots from buried fill;
- Landfill gas - selective removal of unacceptable landfill gas sources and installation of engineered landfill gas mitigation measures for each proposed structure (e.g., venting and gas resistant membranes beneath concrete slabs) in addition to passive gas ventilation at all boundaries. Selective removal had the added benefit of removing some waste from deep fill areas impacting groundwater quality;
- Groundwater and surface water - monitoring of the Georges Cove Marina basin and Georges River water quality during remediation and construction has demonstrated that groundwater impacts are not occurring at the nearest sensitive receptors (i.e., the marina basin and the Georges River);
- General:
 - o Removal of hazardous building materials from former building areas; and
 - o Removal of buried services that contained asbestos / wastes.

The reports prepared by environmental consultants on the investigation and remediation of the Site were independently reviewed and assessed as part of a statutory site audit, with the results of the audit documented in site audit reports listed in Section 15, with copies of these reports also provided to Council and NSW EPA.

3.3 Identification of Contamination

3.3.1 Soil Contamination

Fill encountered at the Site during DP's site investigations comprised sand, clay, silty clay, clayey sand, sandy clay, crushed sandstone, gravel, crushed glass (fine sand to silt particle size). Anthropogenic materials (typically construction and demolition waste including concrete, timber, glass, brick, asphalt, steel, plastic, terracotta and cotton / fabric) were observed throughout the fill at the majority of boreholes consistent with the known history of burial of demolition waste at the Site. Bonded asbestos containing material (ACM) and fibrous asbestos and asbestos fines (FA and AF) has also been detected sporadically (generally trace level) in the fill. Assuming an average thickness of fill at the Site of 4.0 m, the total quantity of historical fill would be 360,000 m³.

Residual chemical contamination at the Site includes (but is not limited to) some metals (e.g., lead and zinc), total recoverable hydrocarbons (TRH) (likely traces of weathered hydraulic oils or diesel), polycyclic aromatic hydrocarbons (PAH), organochlorine pesticides (OCP) and asbestos (fragments of bonded asbestos sheeting, fibrous asbestos and asbestos fines).

3.3.2 Landfill Gas Contamination

Landfill gas is composed of a mixture of hundreds of different gases. By volume, landfill gas typically contains 45% to 60% methane and 40% to 60% carbon dioxide. Landfill gas also includes small amounts of nitrogen, oxygen, ammonia, sulfides, hydrogen, carbon monoxide, and non-methane organic compounds (NMOCs) such as trichloroethylene, benzene, and vinyl chloride (ASTDR, 2001).

Extensive landfill gas monitoring across the Site over an extended period of time in excess of six years has indicated a risk of the migration of landfill gas into structures was present at the Site such that landfill gas mitigation measures were required to be incorporated into the building design / construction. With reference to NSW EPA guidelines and international guidelines on which the NSW EPA guidelines are based, the monitoring suggests that the Site is a 'characteristic situation' 3 (CS3) which is in the 'moderate risk' category. On this basis, building design measure(s) or system element(s) were incorporated into the building design / construction to achieve a score consistent with what is required based on the CS of 3 (i.e., 4.5 points).

Further information on landfill gas can be obtained at the following links:

- [NSW EPA](#), statutory guideline on [hazardous ground gases](#)
- USEPA, [Basic Information about Landfill Gas](#)

3.3.3 Groundwater Contamination

The timber and other general waste in the fill is currently leaching contaminants such as dissolved metals (in particular, zinc), degradable by-products (e.g., ammonia and nutrients), OCP (assuming discarded containers of OCP are present) and total dissolved solids (TDS). Concentrations of ammonia, nutrients and zinc in surface water bodies (being dredge pond and Georges River surface water) adjacent to the Site were, however, lower than concentrations in the groundwater.

3.4 Current / Future Land Use

The Site has been developed for medium density residential housing with access to soil (Residential A). Houses and Community Title land are part of the Community Title scheme, with Council owned roads reserves, drainage reserves and open spaces / parks (Council land). The "LTEMP Responsibility Plan" (i.e., Mirvac Drawing No. 2-11, Appendix A) outlines these two areas of responsibility. The plan also shows the general site layout comprising roads, individual lots, the 'pocket park' and the community facility that will include a swimming pool.

4. On-Site Remediation Measures

4.1 Remediation of Soil Contamination (Physical Barrier)

Capping and containment of contaminated soil was the most suitable remediation option for the Site and is in line with NSW EPA's remediation hierarchy and with their waste minimisation policy. This section describes the physical barrier ('clean soil' cap).

A minimum 2.5 m thick engineered cap (typically 3.0 m, with a tolerance of not less than 2.5 m in individual housing lots) comprising a 'clean soil' cap has been placed across the Site. The 3 m thick engineered cap consists of 1.0 m of Site derived fill which met remediation acceptance criteria (RAC) for soil, overlain by 2.0 m (1.5 m minimum) of imported ENM fill (crushed sandstone).

The upper surface of the 3 m thick engineered cap is defined as the underside level of the house ground slab. A basic cross-section of the configuration of the upper 3 m of soil (cap) is shown in Figure 1, below.

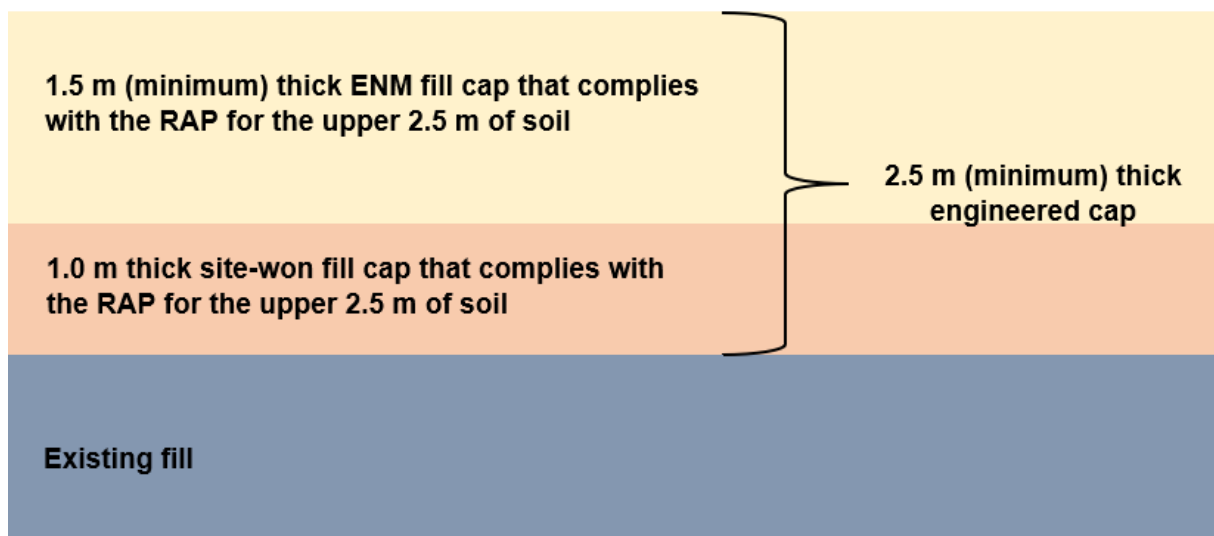


Figure 1: Configuration of the Upper ~3 m of Soil with Underlying 'Existing Fill'

The following drawing included in Appendix A, shows the typical details of general cap depth, location of house slab and benching of the Site at the individual lot scale:

- Drawing 14005E15 Typical House Benching Section Showing Cut and Fill within the Capping Layer.

An as-constructed cap thickness plan generated by the project surveyors, BW, is included as JMD Drawing 14005FP5 Sheet 1, Appendix A. The construction of the physical barrier system (cap) has been documented in the Stage 2 Earthworks validation report (DP, 2021j) and its addendum report (yet to be issued at the date of this report), with all geotechnical aspects being documented by the project geotechnical engineers JK Geotechnics Pty Limited (JK) (JK, 2021b) and its addendum report(s).

The physical barrier system prevents unplanned or incidental human exposure to contaminated soil (i.e., via direct contact, inhalation and ingestion) during regular, day-to-day operations of the Site. Imported and Site-derived 'clean' materials (i.e., materials validated as being suitable for a residential land use) have been used as part of the physical barrier and, therefore, materials used for the physical barrier do not pose a health risk to site users.

Landscaping works must be founded on the surface of the cap comprising plant species with root depths of up to 1.5 m, i.e., establishing within the ENM tunnel spoil fill (maximum 2.5 m in order to avoid any future cap-breach scenario).

The capping system has generally been designed such that it:

- Maximises the long-term stability of the capping and / or containment system(s) and any proposed structures above it (from an engineering perspective) and, where applicable;
- Minimises the potential for leachate formation and/or volatilisation;
- Does not include the erection of structures on the capped and / or contained area that may result in a risk of harm to public health or the environment (e.g., structures which penetrate the cap such as deep basements); and
- Recommends a notification mechanism to ensure that the capped and / or contained areas are protected from any unintentional or uncontrolled disturbance that could breach the integrity of the physical barrier (i.e., refer to Section 5).

As a general principle, contamination at the Site has been remediated to meet the appropriate clean-up criteria. Clean-up criteria for contaminated soils at depth may differ from the criteria for shallow soils due to differences in exposure opportunities. The inhalation of contaminants and the need to protect groundwater has been considered in the design of the overall Site remediation measures.

4.2 Landfill Gas Mitigations

A landfill gas mitigation system has been incorporated into each house and above ground structure within Houses and Community Title Land. Each system has been separately designed for each structure to account for variations in the size and geometry of building footprints and roof layouts. However, the system design includes the following common features from the base up:

- Compacted subgrade to engineers' specification (with sand bed, if required by Monarflex (installation contractor));
- 1000 mm wide sections of 12 mm geocomposite gas ventilation layer (labelled GS1) at 2000 mm centres to be terminated within 100 mm diameter PVC manifold. The manifold connection to have an airtight seal. The unterminated geocomposite layers ends to be sealed airtight;
- Monarflex® RAC gas barrier layer 0.8 mm thick (labelled GS2) to Monarflex / GMS specification installed to best practice and standards;
- Geotextile protection layer (labelled GS3) to be laid over the top of RAC gas barrier layer;
- High impact vapour barrier to National Construction Code compliance (labelled GS4);
- The RAC gas barrier (GS2) and the geotextile protection layer (GS3) to be turned up inside slab formwork during pouring of slab and then laid flat after slab formwork was removed;

- 80 mm diameter PVC inlet pipe to be connect to manifold with the inlet to be placed in landscape areas and the inlet covered with vermin-proof mesh. A 20 mm diameter hole needed to be drilled in the bottom of the vent pipe near its connection to the manifold at its lowest point to allow water / condensation to drain from the manifold / vent pipes [NB: design modification included a drain at the exhaust pipe connected to stormwater to allow water / condensation to drain from the manifold / vent pipes];
- 80 mm diameter PVC exhaust pipe to connect to manifold with outlet to be extended above roofline and connected to a wind activated turbine ventilator;
- Slab thickness 100 mm with normal 32 Mpa concrete (N32);
- Edge beams 300 mm wide x 300 mm (deep below slab);
- Internal ribs 110 mm wide x 300 mm (deep below slab); and
- Widened ribs 300 mm wide x 300 mm (deep below slab).

The construction of the gas mitigation measures has been documented by the installation contractor (Monarflex) and third-party construction quality assurance (CQA) inspections were undertaken by DP at certain hold points on a minimum percentage of installations, as specified in DP (2022c). Post-construction performance monitoring of the pipework was also completed by DP.

Figures 2, 3, 4, 5, 6 and 7, below, depict a typical gas drainage layer (2), welded membrane (3) geotextile protection layer (4), concrete slab (5 and 6) and wind-driven turbine ventilator (7) which have been installed at the Site. Mirvac Design Drawing No. 9-63 in Appendix A depicts the general design in cross section:

- Turbine ventilator (wind-driven) on roofs and inlets; as connected to
- Exhaust pipe / inlet pipe and concrete slab with underlying vapour barrier (GS4) geotextile protection layer (GS3), Monarflex® RAC gas barrier (GS2), drainage geocomposite (GS1), manifold and stormwater pit.



Figure 2: Gas drainage layer



Figure 3: Welded membrane



Figure 4: Geotextile protection layer



Figure 5: Concrete slab (steel reinforcement and waffle-pods placed over the geotextile, pre-concrete pour)



Figure 6: Concrete slab



Figure 7: Turbine ventilator (wind-driven) connected to under-slab drainage layer

In addition to the above, a gas interception trench has been installed along the eastern boundary of the Site. The trench allows passive ventilation of gases (if any), on this boundary to the atmosphere. The trench is located within the last metre of properties adjacent (running parallel) to the fence line.

4.3 Remediation of Groundwater Contamination (Low Permeability Cap)

The primary groundwater remediation measure at the Georges Cove Residential Site was the placement / construction of the low permeability cap across the Site surface (refer to Section 4.1) in addition to selective excavation and screening of deep fill to remove leachate generating items from that fill such as timber and scrap metal. The objective of the low permeability cap was to promote stable and / or improved groundwater conditions emanating from the Site which has occurred following completion of excavation / screening and construction of the cap.

5. Protection of the Physical Barrier (Cap) / Management of Intrusive Works

5.1 Introduction

Normal day to day operation of the Site does not trigger the implementation of this LTEMP. Normal gardening activities (e.g., lawn watering or cutting, shrub planting) that do not significantly disturb the physical barrier system in any way can be undertaken without triggering the implementation of the LTEMP.

This LTEMP is triggered through works that disturb or penetrate the physical barrier (including disturbing of surface coverings, excavating into soils and accessing buried services). The management requirements for such works are outlined in the Section 5.3.

All services are confined to the upper ENM portion of the cap with the exception of those detailed in the deepened trench plans (Appendix A).

5.2 Potential Exposure Pathways

Workers involved in disturbing soil, if contaminated, could be exposed to the contaminants of concern (e.g., PAH or asbestos) by:

- Direct contact through the skin (i.e., by handling the soil without the appropriate personal protective equipment);
- Inhalation of dust generated from the soil (either during excavation, or subsequent storage or handling);
- Ingestion of soil or groundwater through poor hygiene practices (i.e., eating or drinking during work activities, not washing hands before eating, etc.);
- Inhalation of airborne asbestos fibres; and
- Possible secondary exposure from contaminated equipment or clothing via pathways such as those identified above.

Measures to minimise exposure include the use of appropriate personal protective equipment (PPE) and good hygiene (e.g., washing hands prior to eating and upon completion of work).

Planning and review of any intrusive works involving exposure and/or disturbance of soil and implementation of appropriate health and safety measures will minimise the potential for worker contact with contaminated materials through the above listed pathways.

5.3 Control Measures

The Community Association and Liverpool City Council, as key stakeholders of the overall Georges Cove Residential Site, are to ensure that:

- The Consent Authority must not permit any development at the Site that could result in damage to the cap below a depth of 2.5 m below ground level (bgl), unless such works have been designed

to mitigate contamination risks and will restore the integrity of the cap as part of the development work;

- Any proponent seeking works involving future excavations deeper than 2.5 m bgl within the Site must apply for development consent; and
- The Community Association arrange for an annual inspection of the Site by an environmental consultant / geotechnical engineer to confirm that the overall integrity of the cap has not been compromised and that the capping system remains functional and complies with the requirements of the LTEMP and is to provide the report to Council (refer also to the inspection required under Section 10).

The cap / physical barrier depth is outlined in as-constructed cap thickness plan generated by the project surveyors, BW, i.e., JMD Drawing 14005FP5 Sheet 1, Appendix A) and has a minimum depth of 2.5 m bgl. Default positions for works at the Site are:

- No permanent open excavations;
- No temporary excavations (e.g., for planting of shrubs) in excess of 0.5 m depth;
- No works to occur that penetrates or disturbs the physical barrier beyond a depth of 2.5 m bgl (i.e., beyond the base of the physical barrier);
- Always reinstate the cap / physical barrier to the original surface level immediately following any temporary excavations or works with the same materials, or lower permeability materials (e.g. concrete);
- Any works to occur below a depth of 2.5 m bgl (i.e., below the base of the physical barrier **must** have development consent from the Consent Authority (i.e., Liverpool City Council) (refer to details below); and
- **Under no circumstances can works involving the breach of the house or garage concrete floor slab(s) occur, as this will permanently damage the gas mitigations.**

Where intrusive works (at non-concrete floor slab areas) cannot be avoided (e.g., for the maintenance of buried services), the following procedure is to be incorporated into the work undertaken:

- Works must have development consent from the Consent Authority (i.e., Liverpool City Council);
- The designated responsible person(s) / Consent Authority (as appropriate) is to review the proposed works and the requirements of this LTEMP and determine the management and reinstatement protocols to be applied to the works;
- During the planning process, the proposed works are to consider the feasibility and approach to works given the presence of contaminated fill below a depth of 2.5 m bgl;
- Appropriate work health and safety measures (e.g., safe work method statements) for the proposed works below a depth of 2.5 m bgl are to be developed;
- During excavation below a depth of 2.5 m bgl, the physical barrier materials are to be stockpiled separately from fill that is excavated from beneath the barrier. Fill from beneath the barrier is to be placed on a plastic sheet within the work area and lightly wetted or covered with plastic to prevent generation of dust. All stockpiles are to be either reinstated or removed from Site on the same day as excavation. If they need to remain on site overnight for any reason the stockpile must be securely fenced and covered;

- Where possible, fill from beneath the physical barrier is to be reinstated at a depth that is below the physical barrier. However, if disposal of excess fill is required, the waste material is to be classified for off-site disposal purposes. At the time of preparing this LTEMP, the relevant guidelines for waste disposal were the NSW EPA (2014) *Waste Classification Guidelines*;
- The physical barrier is to be reinstated under standard geotechnical controls as per the appropriate physical barrier system design (see Section 4.1). New capping material is required where cross-contamination has occurred with the material below the barrier; and
- The designated person(s) responsible for implementation of this LTEMP is to inspect the area to check that the physical barrier has been adequately reinstated and record the works undertaken in the maintenance log. The date, time, description of works, location of works undertaken, and any required follow ups (i.e., further inspections) are to be recorded in the maintenance log.

Where excavation beneath the physical barrier system is proposed (i.e., below a depth of 2.5 m bgl), a competent qualified Environmental Consultant is to be engaged to monitor and verify the management and reinstatement works undertaken in accordance with this LTEMP. The remediation works (mitigation measures) may need to be followed up with landfill gas monitoring to confirm the adequacy of the reinstatement, if required, and as determined by the Environmental Consultant.

The potential exposure (dermal contact, ingestion and inhalation) to workers should be minimised. Measures to minimise exposure include the use of appropriate personal protective equipment (PPE) and good hygiene (e.g., washing hands prior to eating and upon completion of work).

5.4 Disposal of Excess Soil

Spoil that is not returned to the original excavation, or is suspected of being contaminated, must be appropriately managed. This may entail assessment and classification prior to off-site disposal to a licensed landfill facility. If material is to be disposed to landfill, the assessment and classification and subsequent disposal must be in accordance with the applicable NSW EPA waste regulations and the NSW EPA (2014) *Waste Classification Guidelines. Part 1: Classifying Waste*.

Provisions for temporary storage of the excess spoil in an environmentally responsible manner prior to disposal must be undertaken. This should include measures such as:

- Placement of material on a sealed or plastic lined surface away from drainage lines, watercourses or stormwater drains;
- Construction of sediment retention features around stockpiled materials;
- Covering of stockpiled materials; and
- Dust suppression.

5.5 Rectification of Disturbances / Defects.

The following procedures must be followed when disturbances / defects to the cap are found:

- The physical barrier is to be reinstated under standard geotechnical controls as per the appropriate physical barrier system design (see Section 4.1);

- Backfilling of excavation(s) must be done using similar materials (i.e., crushed sandstone or lower permeability material for the ENM / sandstone portion of the cap; or clayey material for the site-won portion of the cap);
- Works must be documented by the Environmental Consultant that also undertakes annual inspections in their annual report (Section 10); and
- The designated person(s) responsible for implementation of this LTEMP is to inspect the area to check that the physical barrier has been adequately reinstated and record the works undertaken in the maintenance log. The date, time, description of works, location of works undertaken, and any required follow ups (i.e., further inspections) are to be recorded in the maintenance log.

5.6 Unexpected Finds Protocols for Asbestos-Containing Materials.

In addition to the procedure listed in Section 5.3, if suspected asbestos-containing material (ACM) is encountered in the fill (beneath the physical barrier) during excavation works, the following protocol is to be applied:

- Upon discovery of suspected ACM in soil, the manager of the work site is to be notified and the affected area is to be isolated and secured by installing warning signs and a temporary barricade (e.g. marker tape) around the area to prevent anyone from accidentally disturbing materials and generating airborne asbestos fibres;
- To minimise the potential release of asbestos fibres into the air, keep the soil damp (but not flooded) and / or cover the area with plastic sheeting;
- The designated person(s) responsible for implementation of this LTEMP is to be notified of the unexpected find; and
- An Occupational Hygienist is to be engaged to inspect the suspected ACM and provide specialist advice on how to manage the situation. Depending on the nature of the works and ACM present, the Occupational Hygienist is to determine requirements for air monitoring, asbestos removal and PPE so that the work can be completed.

It is noted asbestos contaminated soil can remain beneath the physical barrier. The designated person(s) responsible for implementation of this LTEMP is to keep a record of the location of the ACM impacted soil in the maintenance log for future reference.

It is noted that only a Class A asbestos removal licence holder is permitted to conduct asbestos related work that involves friable asbestos. SafeWork NSW must be notified at least five days in advance of any asbestos removal work. Where friable asbestos is present, only a licenced asbestos assessor may undertake air monitoring and risk assessments and issue a clearance certificate for removal work.

6. Protection of Landfill Gas Mitigations

6.1 Introduction

Normal day to day operation of the Site does not trigger the implementation of this LTEMP. The gas mitigations incorporated into the building have the same design life as the building and should not require routine maintenance, with the exception of the wind-driven turbine ventilators fitted to the roof of each home and garage.

This LTEMP is triggered through illegal development works or accidental damage (e.g. house fire) that damages a component of the gas mitigation system e.g. breaching the slab or tearing the sub-slab gas proof membrane or seizing-up of the wind-driven turbine ventilator. The management requirements for such works are outlined in the Section 6.3.

6.2 Potential Exposure Pathways

Residents could be exposed to landfill gas by the migration of gases from a landfill waste mass into enclosed spaces within buildings and homes such that a risk of fire or explosion (methane) or asphyxiation (carbon dioxide) may occur. The possibility of this scenario occurring is remote, however, the potential consequence may be acute. Moreover, the gas mitigation measures installed within each building should eliminate the risk of such an event from occurring.

6.3 Control Measures

The control measure in place to prevent damage to the existing landfill gas mitigation measures is that the Consent Authority must not permit any development at the Site that would result in damage to the existing gas protection measures. The land owners / occupiers must ensure that the inlet and outlet vents are not covered or damaged. The sub-surface perimeter manifolds must not be damaged. If the wind-driven turbine ventilator is observed to be seized-up, the land owner must arrange for its immediate replacement via the Community Association.

Any new structures that are enclosed spaces in contact with the ground in which landfill gas could potentially accumulate must not be permitted unless the new works involve building design measure(s) or system element(s) incorporated into the building design / construction to achieve a score consistent with what is required based on the CS of 3 (i.e., 4.5 points) as a condition of consent.

The control measure in place for the maintenance of the landfill gas interception trench located along the eastern boundary is for no planting of trees or shrubs within the easement (i.e., 1.0 m from the rear / backyard boundary fence). Placement of permanent planter boxes or similar items must be kept at least 1.0 m away from the turf-covered landfill gas interception trench in order to maintain the ability of the gases (if any) to vent to atmosphere.

The Community Association is to arrange for an annual inspection of the Georges Cove Residential Site by an Environmental Consultant to confirm that all wind-driven turbine ventilators fitted to the roof of each home / garage remain functional / rotating (e.g., survey by drone-mounted camera on a day with moderate wind speeds) and comply with the requirements of the LTEMP. Any turbine ventilators found to have seized-up must be replaced by the Community Association under direction by the

Environmental Consultant. The annual inspection by the Environmental Consultant must also include a visual check that no unauthorised building or construction work has occurred to a structure having the potential to impact the integrity of the cap or a landfill gas mitigation system.

A report must be provided to Council summarising the results of the survey and documenting any turbine ventilator replacements. The survey must also involve checking that the interception trench remains clear of objects. Any obstructions that require clearances from the trench alignment and / or any obvious illegal development must be reported to the Community Association and Liverpool City Council for action.

Given the potential presence of landfill gas in the subsurface at the Site, maintenance works on buried services must follow standard 'confined space work' protocols, i.e., Safe Work Australia (2019) *Confined Spaces, Code of Practice*, or its successor.

6.4 Rectification of Disturbances / Defects.

The following procedures must be followed when disturbances / defects to the landfill gas mitigation system are found:

- The mitigation system element(s) is to be reinstated under the direction and supervision of a suitably qualified Environmental Consultant experienced with design of landfill gas mitigation systems and be completed / constructed by Contractor(s) experienced with the construction thereof²;
- Any rectification works must be sufficient to accommodate a CS3 under NSW EPA (2020), as per the existing installations;
- Works must be documented by the Environmental Consultant in a report which is to be provided to Council; and
- The designated person(s) responsible for implementation of this LTEMP is to inspect the area to check that the rectification works have been adequately completed and record the works undertaken in the maintenance log. The date, time, description of works, location of works undertaken, and any required follow ups (i.e., further inspections) are to be recorded in the maintenance log.

² The generic design for landfill gas mitigations beneath homes / garages is summarised in Section 4.2. The specialist contractor that installed the membranes at the Site was Monarflex: <https://www.monarflex.com/>. Mirvac Design Drawing No. 9-63 in Appendix A depicts the general design in cross section.

7. Restrictions on Groundwater Abstraction

7.1 Introduction

Normal day to day operation of the Site does not trigger the implementation of this LTEMP. This LTEMP is triggered through works involving the drilling of groundwater abstraction wells. The management requirements for such works are outlined in the Section 7.3.

7.2 Potential Exposure Pathways

Residents that install groundwater abstraction wells to source groundwater for drinking water (highly unlikely) or irrigation could be exposed to the contaminants present in groundwater by:

- Direct contact through the skin (i.e., by handling the groundwater without the appropriate personal protective equipment);
- Ingestion of groundwater (e.g., drinking water); and
- Inhalation of aerosols from groundwater spray, such as irrigation of extracted groundwater.

Planning and review of any intrusive works involving exposure and / or disturbance of groundwater, and implementation of appropriate health and safety measures, will minimise the potential for worker contact with contaminated materials through the above listed pathways.

7.3 Control Measures

Abstraction of groundwater at the Site for any purpose must not be undertaken by any stakeholder including individual house owners of Community Title scheme lots.

8. Contractors

The following types of contractor work pose a potential risk to the integrity of the cap or performance of a landfill gas mitigation system:

- Maintenance of stormwater and sewer alignments, as shown on JMD Drawings 14005FP4 Sheets 1 and 2, Appendix A, including the construction of any new services / deep services;
- Any works involving excavation into the cap; and
- Any works that involve cutting / sawing or drilling concrete slabs of any house / garage, excluding open-air car ports and outdoor paving / concrete (external to the building).

This type of contractor is defined as a “Special Contractor” under this LTEMP. Special Contractors must:

- Be suitably qualified, licensed and experienced to undertake work at the Site having the potential to disturb the cap or the landfill gas mitigation system;
- Comply with the requirements of the LTEMP;

- Only commence work at the Site after they had received and reviewed a copy of the LTEMP; and
- Notify Council and the Community Association without delay if they become aware of any defects to the cap.

9. New Developments

The procedures / protocols that need to be followed when a new development is proposed at the Site having the potential to damage the cap or a landfill gas mitigation system are defined under the Community Statement as By Law 2 - Building Works and Alterations. In summary, and proposed new development must:

- Seek necessary approvals;
- Submit plans and specifications;
- Obtain decisions from the Association Committee, noting the Committee must not approve an application to carry out Works, if the proposed Works:
 - o Conflict with or do not comply with the LTEMP; and
 - o Impact the gas mitigation measures on any Lot, Community Property or Subsidiary Body Property.

Construction of new homes and / or garages (demolition and re-build) may involve construction of footings / foundations that has the potential to disturb the cap, and this must be considered in the plans and specifications (i.e., the cap must not be breached and any footings must not create a preferential pathway for landfill gas). Construction of new home and / or garage must incorporate necessary landfill gas mitigation system to a CS3 under NSW EPA (2020), or its successor.³

The procedures / protocols that need to be followed for any proposed paving and concreting are defined under the Community Statement as By Law 3 - External Fixtures (Section 3.9).

10. Inspections and Monitoring

An inspection and monitoring program of the cap and landfill gas mitigation systems is to be undertaken while the LTEMP remains in force. The program is to be undertaken by a suitably qualified Environmental Consultant experienced in the closure and redevelopment of former landfill sites generating landfill gas. The Environmental Consultant is also to meet the NSW EPA requirements for a certified contaminated land consultant as specified on their website.

The physical barrier and landfill gas remediation acceptance criteria (RAC) that need to be met are:

- A physical barrier (clean soil cap) of not less than 2.5 m must be in place; and

³ Unless assessed by a suitably qualified Environmental Consultant as otherwise under the framework in NSW EPA (2020), or its successor. The assessment must be approved by a Site Auditor and Liverpool City Council.

- Each house / garage landfill gas mitigation system must be functioning as the design intended (i.e., wind-driven turbine ventilators must be operational and connected to the manifolds).

The Mirvac Geotechnical Engineer (JK Geotechnics) with input from the Mirvac Structural Engineer (Secta Consulting Engineers Pty Ltd) prepared a “Consolidation Contingency Plan” (Section 11) for mitigating potential impacts to the landfill gas mitigation system, house foundations and buried services caused by ground consolidation. The Consolidation Contingency Plan outlines the geotechnical RAC that need to be met and these are:

- A settlement at a monitoring location greater than 30 mm measured during the 12 month period that commenced prior to the construction of house slabs in the area; and
- A differential settlement between adjacent settlement pins greater than 20 mm measured during the 12 month period that commenced prior to the construction of the house slabs in the area.

The scope of work is to include:

- Inspections by the Environmental Consultant of the Site, the exterior condition of structures and landfill gas vents installed on structures are to be undertaken annually and at other times where there is a report of potential damage to the cap or landfill gas mitigation system;
- Annual monitoring by the Geotechnical Consultant of the 14 settlement pins used to monitor the consolidation and stability of the final ground surface at the locations shown in a drawing to be included in Appendix B. Settlement monitoring may cease after 5 years if settlements remain below the RAC;
- Review by the Environmental Consultant of the landfill gas monitoring conducted at locations where damage was suspected or known to have occurred to the cap or a landfill gas mitigation system;
- Review by the Environmental Consultant of records kept by the Community Association and Council regarding the implementation of the LTEMP;
- An assessment by the Environmental Consultant of the integrity of the cap and landfill gas mitigation systems;
- An assessment by the Environmental (landfill gas) and Geotechnical (settlement) Consultant of compliance with the LTEMP; and
- Producing an annual inspection and monitoring report in accordance with NSW EPA guidance.

The corrective actions that need to be undertaken when the physical barrier or a landfill gas monitoring criterion is exceeded are:

- Repair / reinstate the damaged area of capping;
- Repair the damaged system element(s) of the landfill gas mitigations. This is envisaged to occur from time to time and predominantly involve the replacement of any seized-up wind-driven turbine ventilators; and
- Implement the contingency plan (Section 11) if any subsequent assessment indicates that the conditions exceed a CS3 under NSW EPA (2020).

The corrective actions that need to be undertaken when the settlement criterion is exceeded is to implement the contingency plan (Section 11).

Council must be notified in the event that a monitoring criterion is exceeded.

11. Contingency Plan

The contingency plan for exceedances of the landfill gas criterion of CS3 is to:

- Implement landfill gas pressure-relief mitigations. Mitigations are to be designed by an Environmental Consultant and could include:
 - o Installation of passive vertical ventilation well(s) (potentially disguised as light poles) at the area(s) of concern; and / or
 - o Installation of active vertical ventilation well(s) (potentially disguised as light poles), driven by an intrinsically safe blower, at the area(s) of concern; or
- Converting existing passive mitigation systems to active (i.e., aided by a blower to enhance sub-slab gas extraction rates). The design of any upgrade must be by an Environmental Consultant experienced with this type of work and the design must be approved by Council and a Site Auditor.

A standalone contingency plan for geotechnical issues has been prepared by the project Geotechnical Engineers JK Geotechnics. The plan is included in Appendix B.

12. Summary of General Control Actions for Land Owners

A summary of general control actions for landholders (do's and don'ts) is presented in the Executive Summary Table E1 of this LTEMP. The Executive Summary is provided as a pragmatic quick reference guide for landholders in order to assist with their maintaining compliance with this LTEMP. Land owners must make a copy of this LTEMP available to anybody occupying (e.g., renting) their property.

A development application for any house extensions or redevelopment must be submitted to, and approved by, Liverpool City Council such that Council can ensure that necessary gas mitigations and geotechnical considerations are included as part of any proposed extensions.

13. Summary of General Control Actions for Council

Council is responsible for roads and public open spaces. The road infrastructure will all be situated within the ENM portion of the cap and no gas mitigation systems are required beneath roads or footpath pavements as these are not 'enclosed' structures. Likewise, public open spaces will also be situated within the ENM portion of the cap. These assets essentially sit on the cap.

The exception would be stormwater infrastructure in road corridors and the gross pollutant traps (GPTs) in the park. Provided stormwater infrastructure (including any replacement infrastructure) is designed to be well ventilated to atmosphere, the risk of landfill gas build-up would be minimised. The

location of stormwater infrastructure and its position within the cap is in the deepened trench plans (Appendix A). Stormwater infrastructure has grated drains at regular intervals that will provide ventilation / connection to atmosphere, however, standard 'confined space' protocols must apply for maintenance work etc.

Table E2 provides a summary of general control actions for Council (do's and don'ts) in relation to roads and public open spaces (excluding buildings with gas mitigations). Table E3 provides a summary of control actions for contractors for works potentially impacting the integrity of the cap or landfill gas mitigation system. The Executive Summary is provided as a pragmatic quick reference guide for Council in order to assist with its maintaining compliance with this LTEMP.

The summary of control actions in Table E1 (do's and don'ts) provided in the Executive Summary primarily relate to built structures with enclosed spaces. The current public open space (park) design does not involve any built structures (other than drainage). If a structure such as ablution blocks that are not well ventilated to atmosphere (i.e., susceptible to gas build-up) is built by Council at a future date, the do's and don'ts relevant to built structures in Table E1 would also be relevant to these Council assets. The control actions associated with the protection of gas proof membranes are only applicable to built structures with enclosed spaces that warrant such membranes.

14. Conclusions

This LTEMP has been prepared with reference to NSW EPA endorsed guidelines and practice notes. Individual stakeholders (i.e. individual house owners of Community Title scheme blocks making up the Community Association and Council) are responsible for the implementation of the LTEMP on their own sites. Diligent implementation of this LTEMP should ensure the long term viability of the management controls in place via the overall remediation strategy of the physical barrier (cap) and landfill gas mitigation systems. This LTEMP is subject to a review and update (if necessary) mechanism on an annual basis by a suitably qualified Environmental Consultant and proposed changes must be approved by a Site Auditor and Liverpool City Council.

15. References

BSI 8485 (2015) Code of Practice for Design of Protective Measures for Ground Gases

CIRIA (2007) C665 Assessing Risks Posed by Hazardous Ground Gases to Buildings

CIRIA (2014) C735 Good Practice on the Testing and Verification of Protection Systems for Buildings against Hazardous Ground Gases

DP. (2021). Report on Stage 2 Validation Assessment, Proposed Residential Development, 146 Newbridge Road, Moorebank [ref: 7159.09.R.057.Rev1, dated 6 December 2021]

DUAP NSW EPA (1998) State Environmental Planning Policy No. 55 (SEPP 55)

JK. (2021a). Report to Benedict Industries on Geotechnical Assessment of Remediation Earthworks, 146 Newbridge Road, Moorebank, NSW [ref: 29657ZN5 rpt1 rev3 dated 30 November 2021] [report updated to include Stage 2 earthworks]

NEPC (2013) National Environment Protection (Assessment of Site Contamination) Measure 1999 amended 2013

NSW EPA (2016) Environmental Guidelines: Solid Waste Landfills [Second Edition 2016]

NSW EPA (2017) Guidelines for the NSW Site Auditor Scheme (3rd Edition)

NSW EPA (2020) Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases

NSW EPA (2020) Guidelines for Consultants Reporting on Contaminated Land

NSW EPA (2022) Preparing Environmental Management Plans for Contaminated Land

NSW EPA (2014a) Waste Classification Guidelines, Part 1: Classifying Waste

NSW EPA (2014b) Waste Classification Guidelines Part 2: Immobilisation of Waste
NSW Fair Trading (2017) New South Wales Guide to Standards and Tolerances 2017

Safe Work Australia (2019) Confined Spaces, Code of Practice

Swane IC (23 January 2018) 'Site Audit Report 264B by Dr Ian Swane, Remediation Strategy for Proposed Residential Development with Community Title at 146 Newbridge Road, Moorebank NSW 2170' (includes site audit statement 264B)

Swane IC (6 January 2022) "Site Audit Report 264C by Dr Ian Swane, Stages 1 & 2 Remediation Work for Early Release Area at Proposed Georges Cove Residential Development, 146 Newbridge Road, Moorebank NSW 2170" (includes site audit statement 264C)

Swane IC (8 March 2022) "Site Audit Report 264D by Dr Ian Swane, Stages 3 & 4 Remediation Work for Early Release Area at Proposed Georges Cove Residential Development, 146 Newbridge Road, Moorebank NSW 2170" (includes site audit statement 264D)

Swane IC (30 May 2022) "Site Audit Report 264E by Dr Ian Swane, Stages 1 & 2 Remediation Work for Sites 5, 6 & 11 at Proposed Georges Cove Residential Development, 146 Newbridge Road, Moorebank NSW 2170" (includes site audit statement 264E)

16. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 146 Newbridge Road, Moorebank in accordance with DP's proposal 71459.16.P.001.Rev0 dated 1 September 2022 and acceptance received from Ernest Dupere of Benedict Industries Pty Ltd. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Benedict Industries Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Asbestos has previously been detected by observation or by laboratory analysis at the site, either on the surface of the site, or in filling materials at the test locations sampled and analysed. Building demolition materials, such as concrete, brick, tile, timber, plastic, are ubiquitous throughout the fill at the site, and these are considered as indicative of the possible presence of hazardous building materials (HBM), including asbestos. It is therefore considered possible that HBM, including asbestos, may be during bulk earthworks associated with the proposed development, and hence no warranty can be given that asbestos is not present.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards associated with future design aspects relevant to our input to the project, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the environmental components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About this Report

Drawings

Site Plan

Mirvac Responsibility Plan

Trench Deepening Plan

Cap Thickness Plan

House Benching Plan

Cross Section of Gas Mitigation (Typical)

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

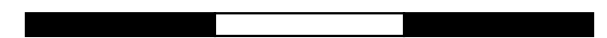
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Legend

 The Site (Lot 2 Deposited Plan 1246745)

0 50 100 150 m



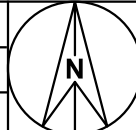
Notes:

1. Basemap from metromap.com.au dated 13/06/2022



TITLE: Site Plan
Long Term Environmental Management Plan
 146 Newbridge Road, Moorebank, NSW

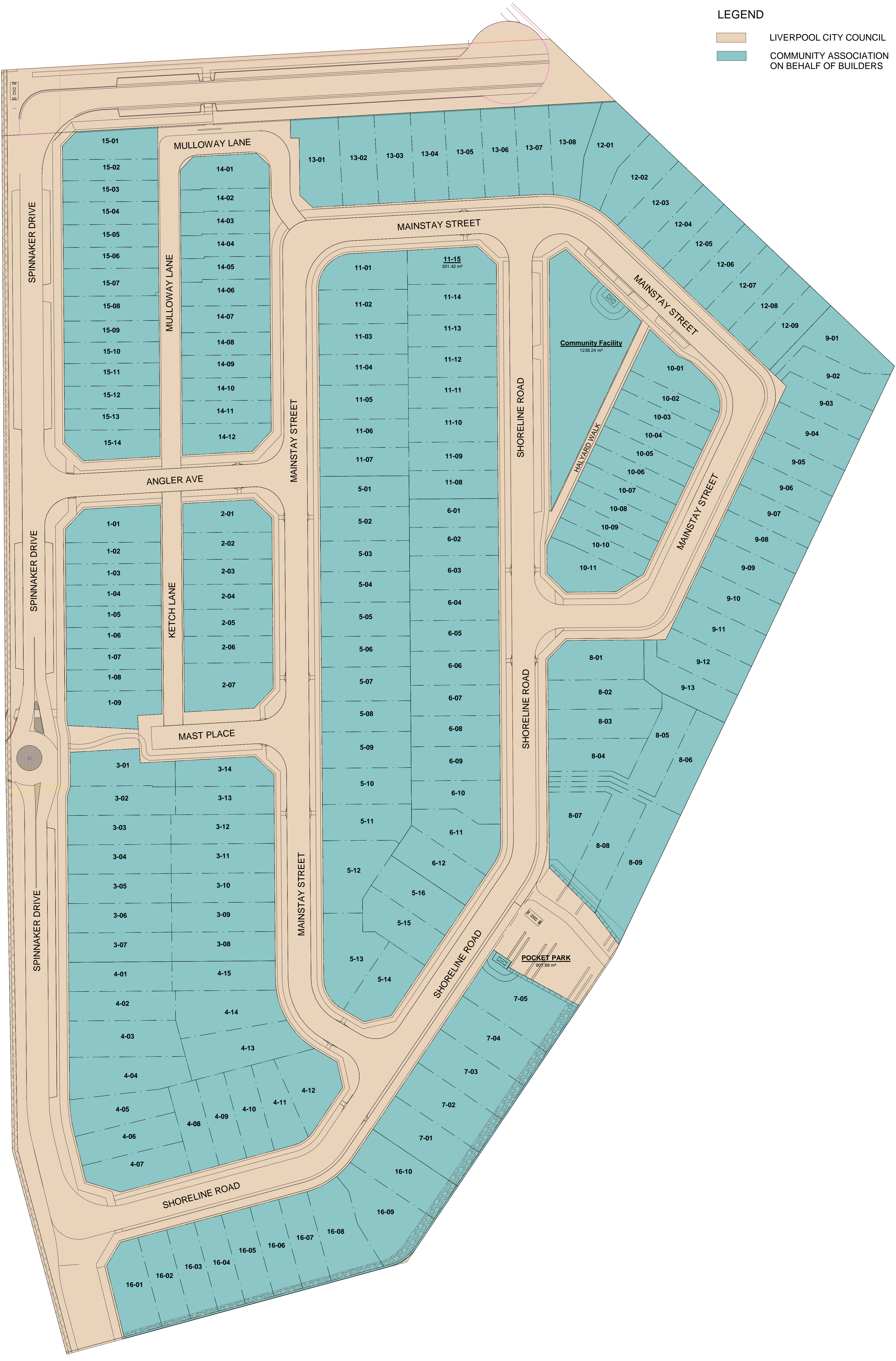
CLIENT: Benedict Industries Pty Ltd
 OFFICE: Sydney DRAWN BY: JJH
 SCALE: 1:2000 @ A3 DATE: 14.09.2022



PROJECT No: 71459.14
 DRAWING No: 1
 REVISION: 1

LEGEND

- LIVERPOOL CITY COUNCIL
- COMMUNITY ASSOCIATION ON BEHALF OF BUILDERS



Date	Rev	Issued For Information
2021.10.13	A	ISSUED FOR INFORMATION

Amendment

Project: GEORGES COVE RESIDENCES
MOOREBANK

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 Mirvac Design Pty Ltd
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NEWBRIDGE ROAD

BRICKMAKERS DRIVE

B6 ZONE

LOT 6
DP1065574

PROPOSED STAGE 1
BOUNDARY

LOT 2
DP602988

PT 310
DP1118048

LOT 309
DP1118048

PT 310
DP1118048

PT 200
DP1117280

LOT 6
DP1065574

PROPOSED STAGE 1
BOUNDARY

LOT 201
DP1117280

LOCAL DEEPENING FOR THE POOL
LOCATED IN THE COMMUNITY FACILITY

FOR THE DURATION OF THE STAGE 2 EARTHWORKS PROGRAMME (VENM CAPPING PORTION), BENEDICTS USED A DGPS THAT HAD BEEN CALIBRATED WITH THE SERVICES DEEPENING DESIGN SURFACE PROVIDED TO BENEDICTS TO GUIDE THEIR EARTHWORKS TO ACHIEVE THE SURFACE THAT WAS SUBJECT TO THE BMD HANDOVER. THIS IS A SNAPSHOT OF WORKS COMPLETED AS OF THE 27th APRIL 2021. ALL SURVEY WAS COMPLETED BY JMD.

IN ADDITION TO THIS, GLENMORE PARK PLUMBING COMPLETED THE CAP DEEPENING FOR THE TRUNK SEWER WORKS. THIS WAS NOT SURVEYED BY JMD BUT WAS COMPLETED AT THE SAME TIME THE SEWER TRUNK MAIN WAS CONSTRUCTED. MODELLING OF THE TRUNK SEWER SHOWN IN THIS PLAN SHOWS THE DEEPENING BASED ON DESIGN LEVELS BEING 1.5m BELOW THE INVERT OF THE SEWER.

- 1) THESE NOTES & LEGEND FORM PART OF THE PLAN AND SURVEY AND MUST REMAIN WITH THE PLAN IF ANY REPRODUCTION IN WHOLE OR PART.
- 2) THE SURVEY INFORMATION SHOWN HERE WERE PREPARED FOR A SPECIFIC PURPOSE FOR THE CLIENT SHOWN. THE INFORMATION IS NOT TO BE USED FOR ANY OTHER PURPOSE OR BY ANYONE NOT AUTHORISED BY THIS CLIENT.
- 3) IF THIS PLAN HAS BEEN PROVIDED IN ELECTRONIC FORMAT, BE ADVISED THAT THE POSITION OF SOME DETAIL IS SHOWN DIAGRAMMATICALLY ONLY, IN ORDER TO PROVIDE CLARITY ON THE HARD COPY PLAN. SOME TEXT AND LIFESTYLES MAY BE SHOWN IN INCORRECT POSITIONS OR DIFFERENTLY TO THAT INTENDED, AS YOU MAY BE VIEWING THE DRAWING IN AN INCOMPATIBLE PROGRAM OR VERSION. THE HARD COPY PLAN IS TO BE USED TO CHECK TEXT AND LIFESTYLES.
- 4) THIS PLAN HAS BEEN PREPARED FOR HARD COPY (OR PDF) FORMAT ONLY AND IF PROVIDED IN CAD FORMAT ALL DIMENSIONS HEREON TAKE PRECEDENCE OVER ANY INTERROGATION OF LINEWORKS IN THE CAD FILE.

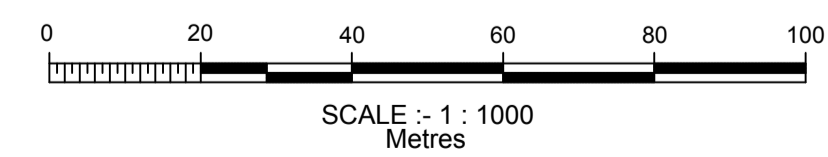
Height Table	
Elevation	Colour
-12.00 to -6.00	Dark Purple
-6.00 to -5.00	Dark Blue
-5.00 to -4.00	Blue
-4.00 to -3.00	Light Blue
-3.00 to -2.75	Cyan
-2.75 to -2.50	Green
-2.50 to -2.25	Yellow-Green
-2.25 to -2.00	Yellow
-2.00 to -1.50	Orange
-1.50 to -1.25	Red-Orange
-1.25 to -1.00	Red
-1.00 to -0.75	Dark Red
-0.75 to -0.50	Brown
-0.50 to -0.25	Dark Brown
-0.25 to 0.00	Black
0.00 to 0.25	White

GREATER THAN THE IDEAL 2m VENM THICKNESS

WITHIN 500mm OF THE IDEAL 2m VENM THICKNESS

LEVEL MORE THAN 500mm LOWER THAN THE IDEAL 2m VENM THICKNESS

LEGEND	
	DENOTES PADDOCK AREAS
	DENOTES HOLES LEFT FOR SPOIL CREATED DURING THE CIVIL & BUILDING PROCESS
	DENOTES WESTERN RETAINING WALL REINFORCEMENT BLOCK
	DENOTES PROPOSED STORMWATER DRAINAGE PIT & PIPE
	DENOTES PROPOSED SEWER STRUCTURE & PIPE



GEORGES RIVER

FUTURE MARINA

Issue	App	Date	Description
C	S.G.	12-08-2021	UPDATED PER CLIENT COMMENTS & SHEET NUMBERS CHANGED
B	S.G.	15-07-2021	AMENDED TO INCLUDE THE SRA & FSL DESIGN
A	S.G.	23-04-2021	ISSUED FOR DISCUSSION

Client: BENEDICT INDUSTRIES	Datum: AHD
Designed by: S.G.	Origin of Levels: SSM 49623 RL 3.31
Date of Drawing: 23-04-2021	Date of Survey: VARIOUS
Ratio (A1): 1:1000	



John M. Daly & Associates PTY LTD
A.B.N. 88051977989
Surveying
Engineering
Project Management
Licensed Water Service Co ordinators
32 Iolanthe Street
P.O. BOX 25
CAMPBELLTOWN N.S.W. 2560
PH. (02) 4625 5055
FAX (02) 4628 2013
email: admin@jmd.com.au

Project:	LOT 70 IN DP1254895 - NEWBRIDGE ROAD, MOOREBANK COVE	Sheet 1 of 7 sheets
	PLAN SHOWING TRENCH DEEPENING COMPLETED BY BENEDICTS AND / OR GPPD PRIOR TO VENM FILLING WORKS	Ref: 14005FP4
Locality: MOOREBANK	L.G.A.: LIVERPOOL	CAD Ref: S:\J085\14\14005\LMK-ENG\CAPPING 2\STAGE 2 CAP - C&F

The ratio shown on this plan relates to the original plan, produced by JMD only. Any photocopying or printing from digital files provided (particularly PDF files) may significantly alter the ratio of the plan.

NEWBRIDGE ROAD

B6 ZONE

BRICKMAKERS DRIVE

LOT 6
DP1065574

PROPOSED STAGE 1
BOUNDARY

LOT 2
DP602988

PT 310
DP1118048

LOT 309
DP1118048

PT 310
DP1118048

PT 200
DP1117280

LOT 6
DP1065574

PROPOSED STAGE 1
BOUNDARY

LOT 201
DP1117280

TRENCH WIDENING (ORIGINAL
SERVICES DEEPENING
COMPLETED BY BENEDICTS)

TRENCH DEEPENING
COMPLETED BY BMD

300mm TRENCH WIDENING
(ORIGINAL SERVICES DEEPENING
COMPLETED BY BENEDICTS)

FUTURE MARINA

GEORGES RIVER

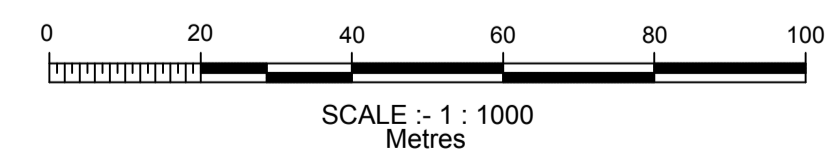
FOR THE DURATION OF THE STAGE 2 EARTHWORKS PROGRAMME (CIVIL WORKS PORTION), BMD WORKED TOWARDS DESIGN LEVELS BASED ON THE CURRENTLY APPROVED DRAWINGS.

THIS IS A SNAPSHOT OF WORKS COMPLETED AS OF THE 16th AUGUST 2021 BASED ON DATA PROVIDED BY BMD & REVIEWED BY JMD.

- 1) THESE NOTES & LEGEND FORM PART OF THE PLAN AND SURVEY AND MUST REMAIN WITH THE PLAN IF ANY REPRODUCTION IN WHOLE OR PART.
- 2) THE SURVEY INFORMATION SHOWN HERE WERE PREPARED FOR A SPECIFIC PURPOSE FOR THE CLIENT SHOWN. THE INFORMATION IS NOT TO BE USED FOR ANY OTHER PURPOSE OR BY ANYONE NOT AUTHORISED BY THIS CLIENT.
- 3) IF THIS PLAN HAS BEEN PROVIDED IN ELECTRONIC FORMAT, BE ADVISED THAT THE POSITION OF SOME DETAIL IS SHOWN DIAGRAMMATICALLY ONLY, IN ORDER TO PROVIDE CLARITY ON THE HARD COPY PLAN. SOME TEXT AND LIFESTYLES MAY BE SHOWN IN INCORRECT POSITIONS OR DIFFERENTLY TO THAT INTENDED, AS YOU MAY BE VIEWING THE DRAWING IN AN INCOMPATIBLE PROGRAM OR VERSION. THE HARD COPY PLAN IS TO BE USED TO CHECK TEXT AND LIFESTYLES.
- 4) THIS PLAN HAS BEEN PREPARED FOR HARD COPY (OR PDF) FORMAT ONLY AND IF PROVIDED IN CAD FORMAT ALL DIMENSIONS HEREON TAKE PRECEDENCE OVER ANY INTERROGATION OF LINEWORKS IN THE CAD FILE.

LEGEND

- DENOTES PADDOCK AREAS
- DENOTES HOLES LEFT FOR SPOIL CREATED DURING THE CIVIL & BUILDING PROCESS
- DENOTES WESTERN RETAINING WALL REINFORCEMENT BLOCK
- DENOTES DEEPENING OF VENM CAP FOR THE SERVICES BY BMD (CIVIL CONTRACTOR) BY A MAX. 150mm (BEDDING)
- DENOTES DEEPENING OF VENM CAP FOR THE SERVICES BY BMD (CIVIL CONTRACTOR) BY A MAX. 500mm (INCLUDES A 250mm COMPACTED VENM CAP UNDER THE SERVICES)
- DENOTES DEEPENING OR WIDENING OF VENM CAP FOR THE SERVICES BY BMD (CIVIL CONTRACTOR) BY A MIN. 1m (INCLUDES A 1m COMPACTED VENM CAP UNDER THE SERVICES)
- DENOTES PROPOSED STORMWATER DRAINAGE PIT & PIPE
- DENOTES PROPOSED SEWER STRUCTURE & PIPE



Issue	App	Date	Description
C	S.G.	12-08-2021	UPDATED PER CLIENT COMMENTS & SHEET NUMBERS CHANGED
B	S.G.	15-07-2021	AMENDED TO INCLUDE THE SRA & FSL DESIGN
A	S.G.	23-04-2021	ISSUED FOR DISCUSSION

Client: BENEDICT INDUSTRIES	Datum: AHD
Designed by: S.G.	Origin of Levels: SSM 49623 RL 3.31
Date of Drawing: 23-04-2021	Date of Survey: VARIOUS
Ratio (A1): 1:1000	



John M. Daly & Associates PTY LTD
A.B.N. 88051977989
Surveying
Engineering
Project Management
Licensed Water Service Co ordinators

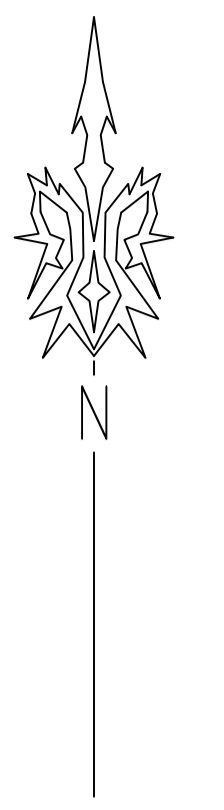
32 Iolanthe Street
P.O. BOX 25
CAMPBELLTOWN N.S.W. 2560
PH. (02) 4625 5055
FAX (02) 4628 2013
email: admin@jmd.com.au

Project: LOT 70 IN DP1254895 - NEWBRIDGE ROAD, MOOREBANK COVE	Sheet 2 of 7 sheets
PLAN SHOWING APPROXIMATE LOCATION OF LOCAL DEEPENING OF SERVICES INTO THE ZERO+1m PORTION OF THE CAP COMPLETED BY BMD DURING CIVIL WORKS	Ref: 14005FP4
Locality: MOOREBANK	L.G.A.: LIVERPOOL
CAD Ref: S:\J085\14\14005\LMK-ENG\CAPPING 2\STAGE 2 CAP - C&F	

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NEWBRIDGE ROAD

BRICKMAKERS DRIVE



LOT 1
DP1246745

B6 ZONE

PT LOT 2
DP(UNREG)

COMMUNITY TITLE
SCHEME
BOUNDARY

LOT 2
DP602988

PT LOT 3
DP(UNREG)

DRAINAGE CHANNEL
DEDICATED TO COUNCIL

APPROXIMATE WIDTH OF
WESTERN RETAINING WALL

LOT 309
DP1118048

PROMONTORY WAY
(ROAD NO.7)

PT LOT 3
DP(UNREG)

PT 200
DP1117280

DRAINAGE CHANNEL
DEDICATED TO COUNCIL

PT LOT 2
DP(UNREG)

COMMUNITY TITLE
SCHEME
BOUNDARY

LOT 3
DP1246745

FUTURE MARINA

LOT 201
DP1117280

SPINNAKER DRIVE (ROAD NO.1)

MULLOWAY LANE (ROAD NO.12)

ANGLER AVENUE
(ROAD NO.9)

KETCH LANE (ROAD NO.11)

MAST PLACE
(ROAD NO.4)

MAINSTAY STREET (ROAD NO.3)

MAINSTAY STREET
(ROAD NO.3)

SHORELINE ROAD (ROAD NO.2)

SHORELINE ROAD (ROAD NO.2)

COMMUNITY TITLE
SCHEME
BOUNDARY

GEORGES RIVER

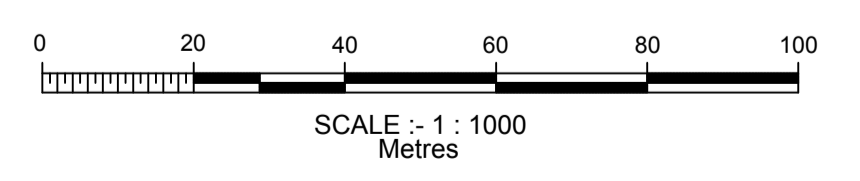
BASED ON DESIGN LEVELS, THE
AREA IN BLUE (WHICH HASN'T
BEEN CONSTRUCTED YET) WILL
BE A MINIMUM OF 2.5m THICK

GREATER THAN 2.5m THICK CAP

LESS THAN 2.5m THICK CAP

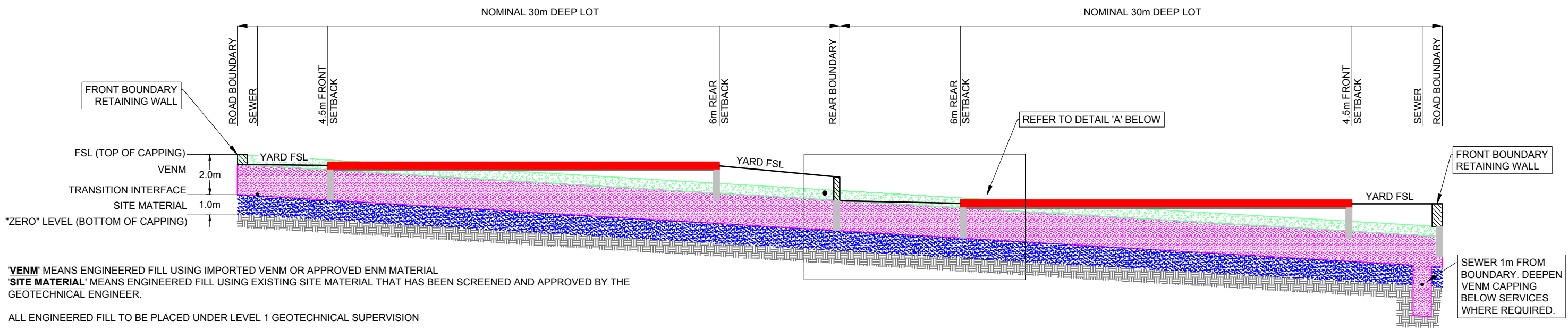
Height Table for Zero-FSL Depth	
Elevation	Colour
-12.00 to -7.00	Dark Red
-7.00 to -6.00	Red
-6.00 to -5.00	Orange-Red
-5.00 to -4.00	Orange
-4.00 to -3.75	Red-Orange
-3.75 to -3.50	Orange
-3.50 to -3.25	Yellow-Orange
-3.25 to -3.00	Yellow
-3.00 to -2.50	Light Green
-2.50 to -2.25	Green
-2.25 to -2.00	Light Blue
-2.00 to -1.75	Blue

THIS IS AN ESTIMATE OF THE SANDSTONE THICKNESS BETWEEN THE SURVEYED ZERO LEVEL (BOTTOM OF THE CAP) & THE DESIGN FINISHED SURFACE LEVEL.



Issue	App	Date	Description	Client: BENEDICT INDUSTRIES	Datum : AHD		John M. Daly & Associates PTY LTD A.B.N. 88051977989 Surveying Engineering Project Management Licensed Water Service Co ordinators 32 Iolanthe Street P.O. BOX 25 CAMPBELLTOWN N.S.W. 2560 PH. (02) 4625 5055 FAX (02) 4628 2013 email: admin@jmd.com.au	Project : LOT 70 IN DP1254895 - NEWBRIDGE ROAD, MOOREBANK COVE COMPARISON BETWEEN THE SURVEYED SURFACE OF THE ZERO LEVEL (BOTTOM OF THE CAP) TO THE DESIGN FINISHED SURFACE Locality : MOOREBANK L.G.A. : LIVERPOOL CAD Ref: S:\JOBS\14\14005\LMK-ENG\CAPPING 3\ZERO_FSL	Sheet 1 of 2 sheets Ref: 14005FPPS
			Designed by : S.G.	Origin of Levels : SSM 49623 RL 3.31					
			Date of Drawing : 21-09-2021	Date of Survey : VARIOUS					
B	S.G.	13/10/2021	MINOR AMENDMENTS TO NOTES & PLAN	Ratio (A1) : 1:1000					
A	S.G.	21-09-2021	ISSUED FOR INCLUSION IN THE LTEMP						

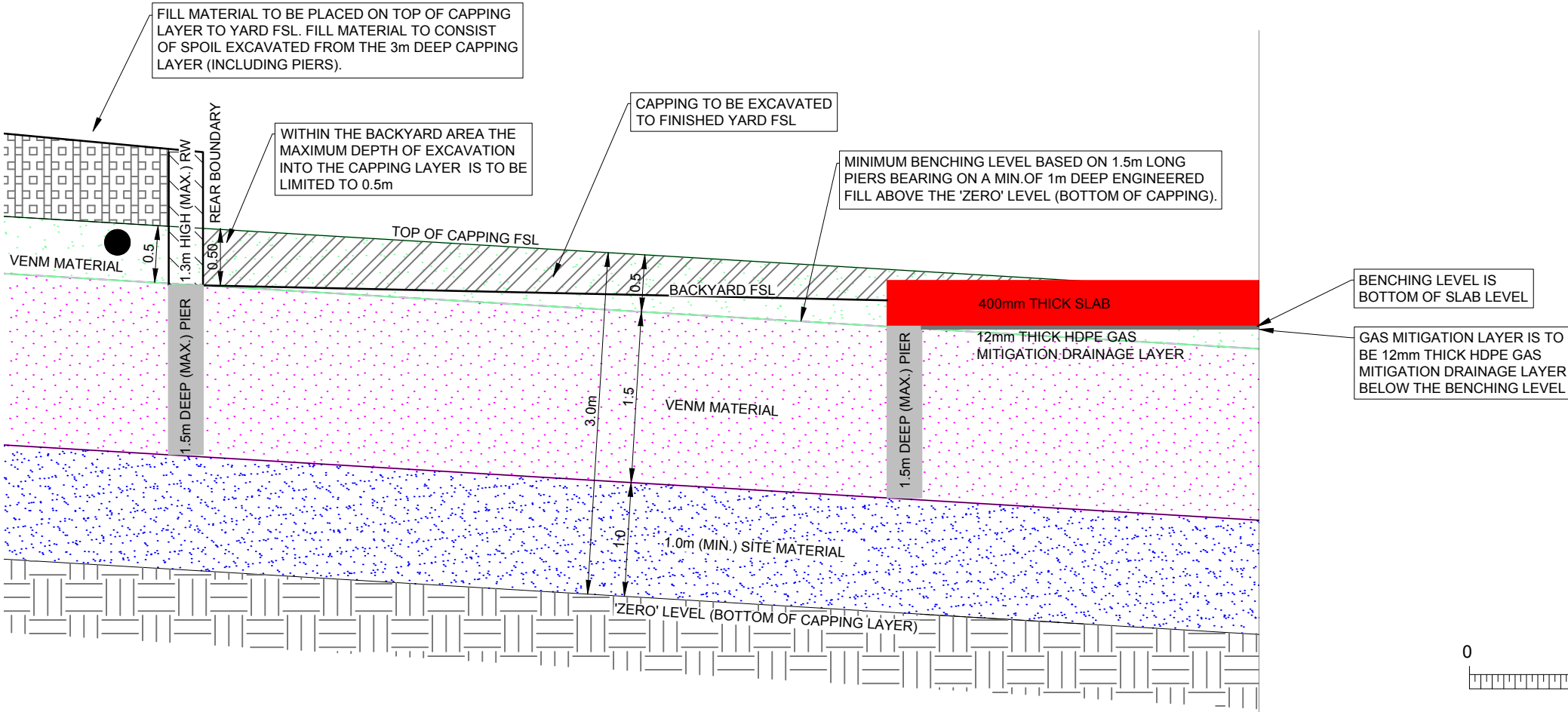
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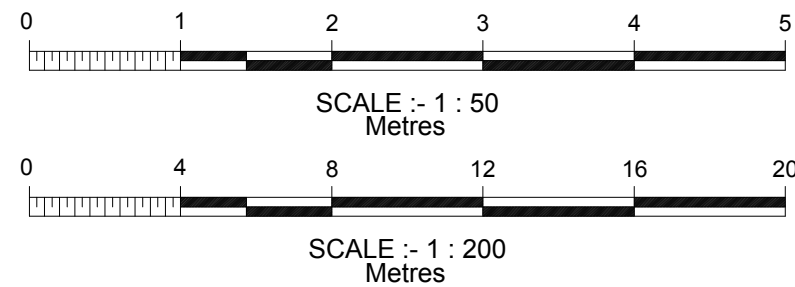
'VENM' MEANS ENGINEERED FILL USING IMPORTED VENM OR APPROVED ENM MATERIAL
 'SITE MATERIAL' MEANS ENGINEERED FILL USING EXISTING SITE MATERIAL THAT HAS BEEN SCREENED AND APPROVED BY THE GEOTECHNICAL ENGINEER.

ALL ENGINEERED FILL TO BE PLACED UNDER LEVEL 1 GEOTECHNICAL SUPERVISION

TYPICAL HOUSE BENCHING SECTION
 SHOWING CUT AND FILL WITHIN THE CAPPING LAYER
 RATIO 1:200



DETAIL A - PIER, CUT AND FILL DETAILS
 RATIO 1:50



- E 14-09-2021 DRAINAGE LAYER AMENDED PER DESIGN REPORT
- D 09-08-2021 DRAINAGE LAYER AMENDED & SERVICES DEEPEENING HAS BEEN ILLUSTRATED
- C 15-02-2019 MINOR AMENDMENTS TO CAPPING LAYER THICKNESS
- B 13-03-2017 MINOR AMENDMENTS TO NOTES, SERVICES ADDED
- A 09-03-2017 ORIGINAL ISSUE FOR COMMENT

Client: MIRVAC HOMES (NSW) PTY LTD.	Ratio (A3) : 1:200 & 1:50		John M. Daly & Associates PTY LTD A.B.N. 88051977989	Project : MOOREBANK COVE - NEWBRIDGE ROAD, MOOREBANK	Sheet 1 of 1 sheets	
Origin of Levels : N/A	Date of Survey :		Surveying Engineering Project Management Licensed Water Service Co ordinators	TYPICAL HOUSE BENCHING SECTION SHOWING CUT AND FILL WITHIN THE CAPPING LAYER		Ref: 14005E15
Datum : AHD	Designed By : S.G.		32 Iolanthe Street P.O. BOX 25 CAMPBELLTOWN N.S.W. 2560			PH. (02) 4625 5055 FAX (02) 4628 2013 email: admin@jmd.com.au
	Approved : T.H.					

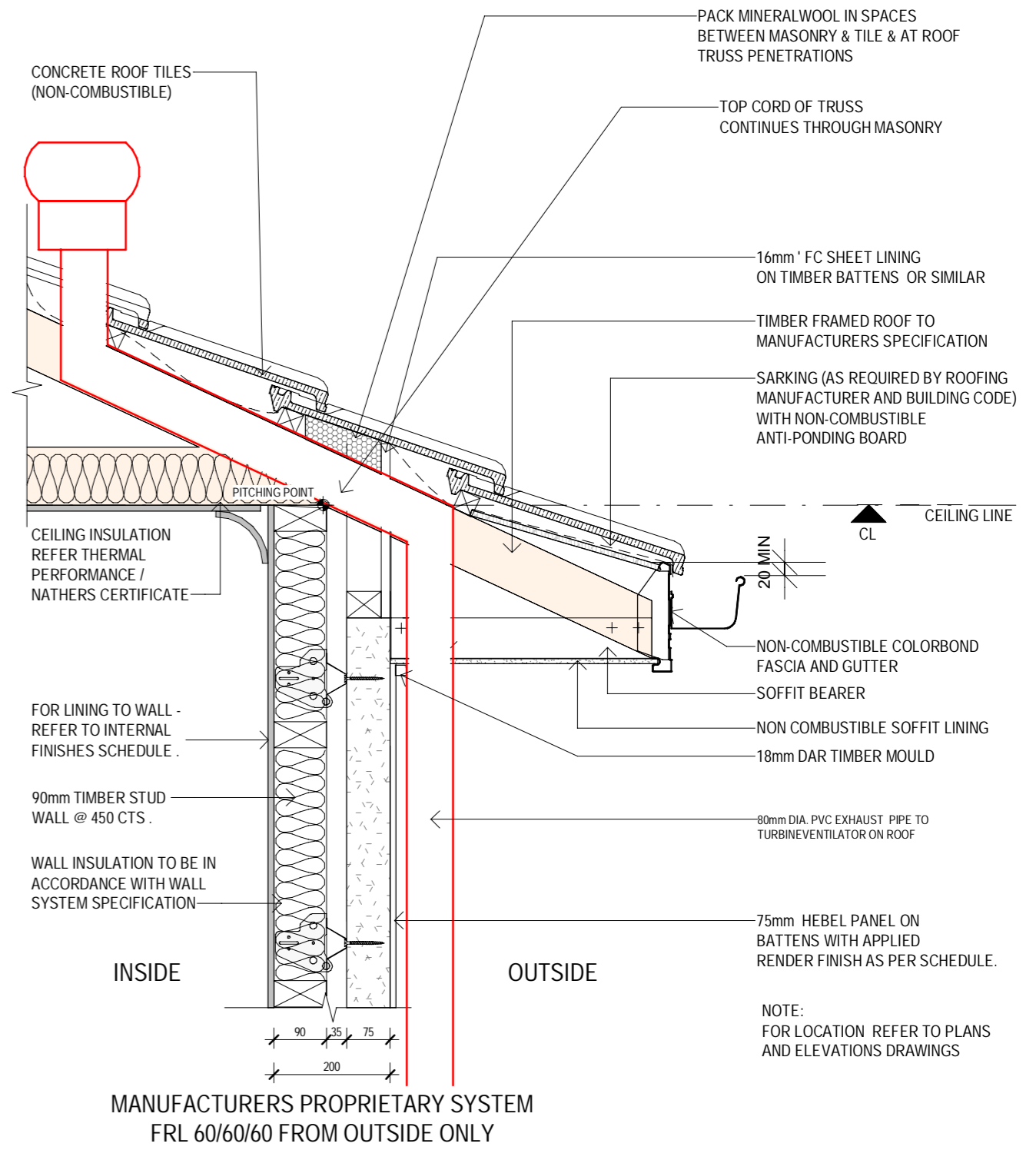
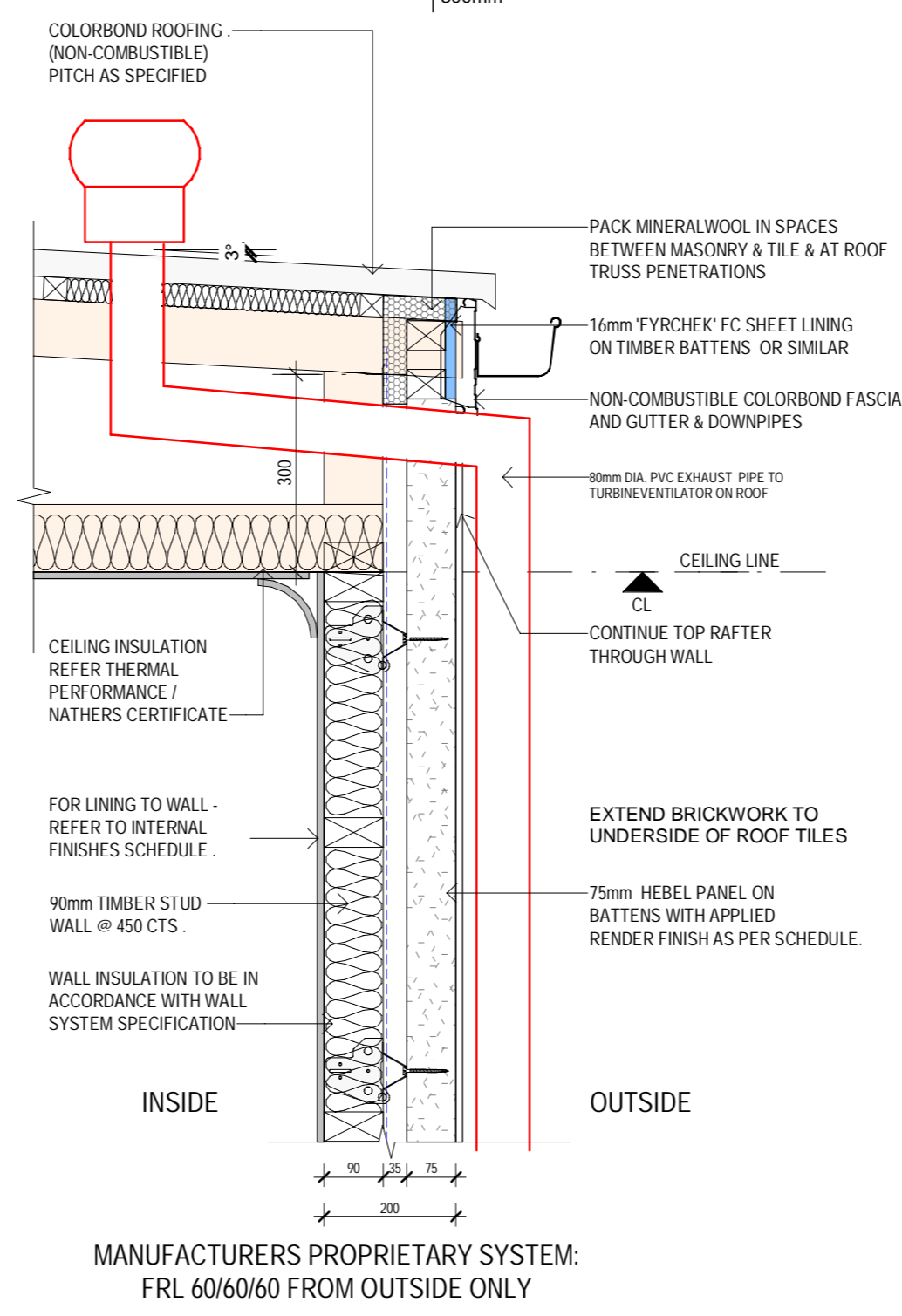
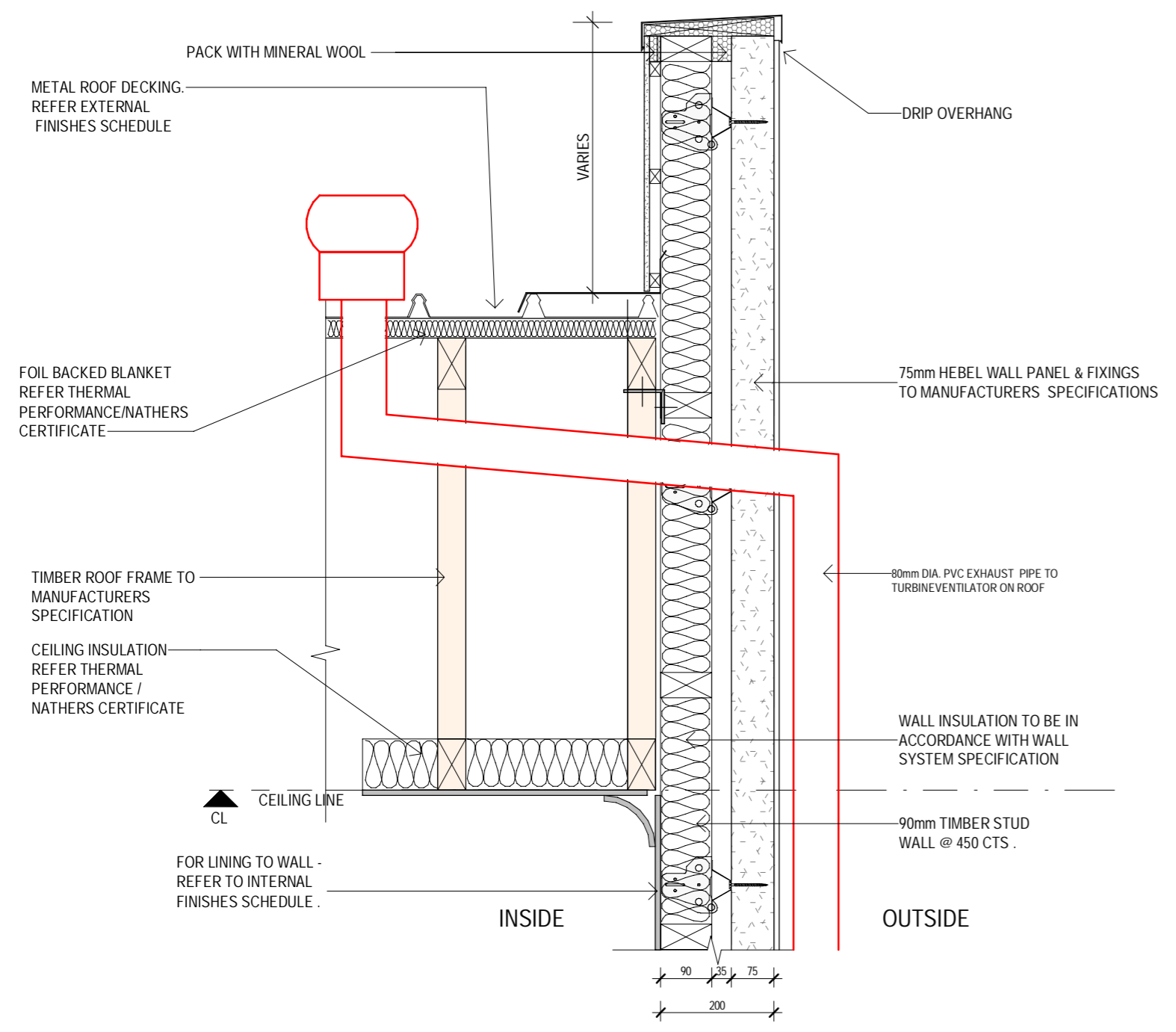
The ratio shown on this plan relates to the original plan, produced by JMD only. Any photocopying or printing from digital files provided (particularly PDF files) may significantly alter the ratio of the plan.

0mm

100mm

200mm

300mm



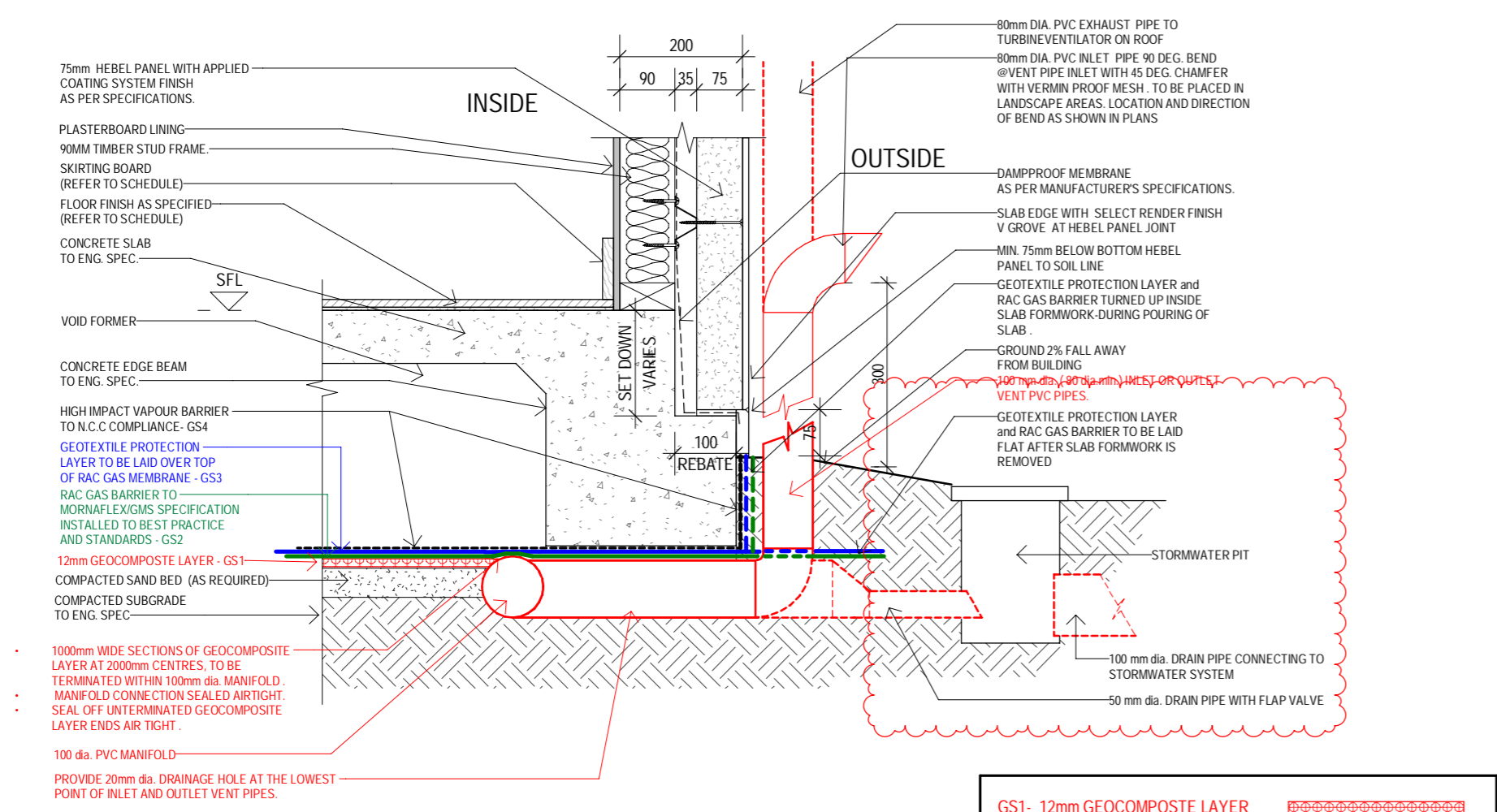
2 METAL ROOF- PARAPET
Scale 1:10

3 METAL ROOF- ZERO EAVE
Scale 1:10

4 TILE ROOF EAVES
Scale 1:10

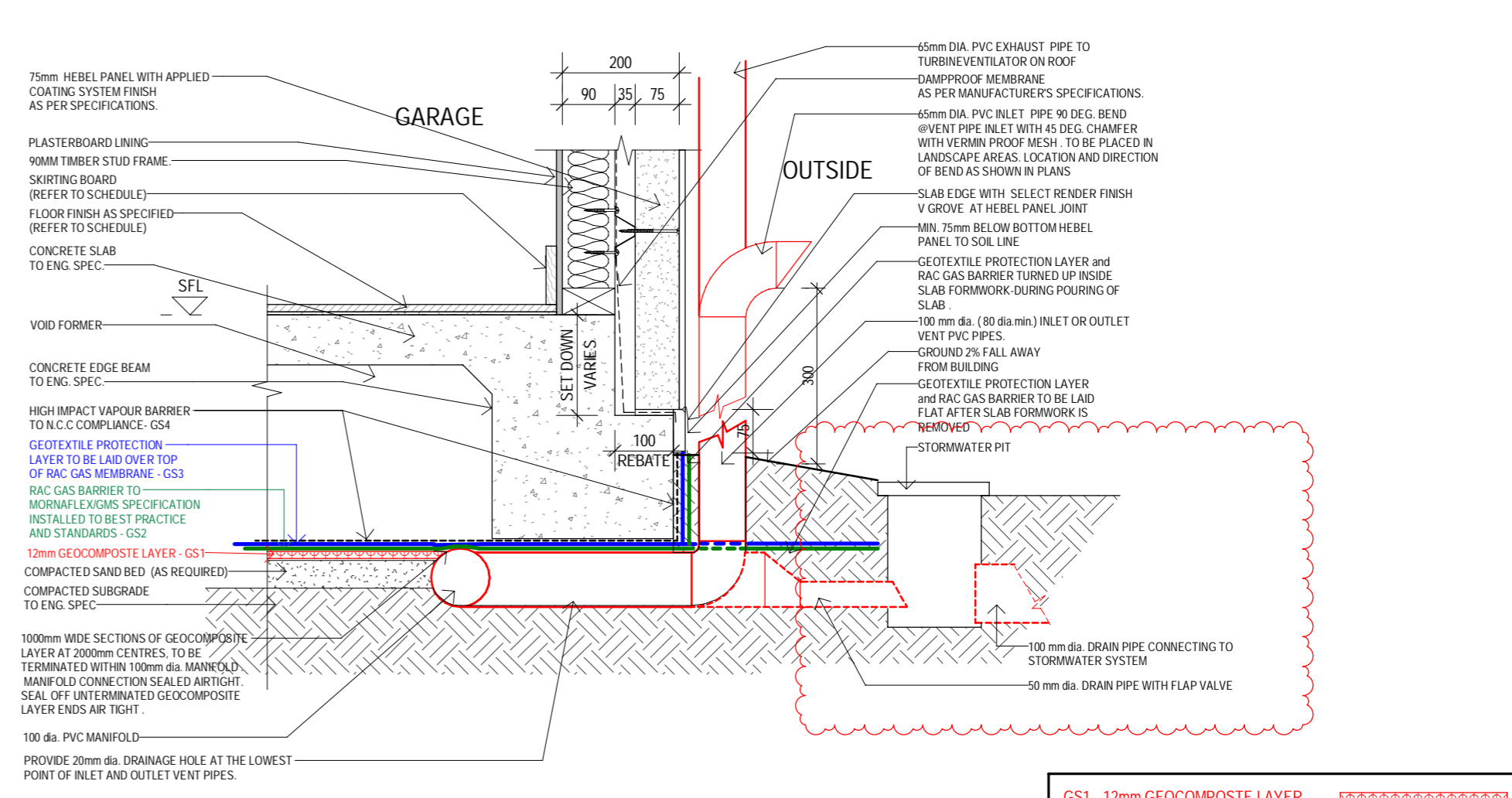
200mm

300mm



1 TYPICAL EDGE BEAM-GAS MITIGATION LAYERS
Scale 1:10

G1- 12mm GEOCOMPOSITE LAYER	
G2- RAC GAS BARRIER LAYER	
G3- GEOTEXTILE PROTECTION LAYER	
G4- HIGH IMPACT VAPOUR BARRIER	



5 DETACHED GARAGE EDGE BEAM-GAS MITIGATION LAYERS
Scale 1:10

G1- 12mm GEOCOMPOSITE LAYER	
G2- RAC GAS BARRIER LAYER	
G3- GEOTEXTILE PROTECTION LAYER	
G4- HIGH IMPACT VAPOUR BARRIER	

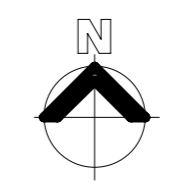
Date	Rev	Amendment
13.10.21	1	ISSUE FOR GAS MITIGATION DETAIL REVIEW
29.11.21	2	ISSUE FOR GAS MITIGATION DETAIL REVIEW
17.01.22	3	ISSUE FOR CONSTRUCTION- GAS MITIGATION DETAILS UPDATED
23.03.22	4	GAS MITIGATION DRAINAGE DETAIL UPDATED

Project:
GEORGES COVE RESIDENCES
BRICKMAKERS DR. MOOREBANK

House Type:

MIRVAC DESIGN
Level 28/200 George St
Sydney NSW 2000
T:02 9660 8000

mirvac



Title:
GAS MITIGATION DETAILS

Drawn: AF
Approved: AF
Job Number: 7.790.99999 Date: OCT 21
Lot Number: Drawing no: 9-63 Rev: 4
Scale @ A2: 1:10

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Mirvac Design Nominated / Responsible Architects
Diana Saracino, Anita Niemi, Michael Wiener, David Hirst, Prampong Sitabandh, Andrew La
<https://www.mirvacdesign.com/nominated-architects>

Appendix B

JK Geotechnics (2022) Geotechnical Opinion,
Consolidation Contingency Plan,
146 Newbridge Road, Moorebank NSW

Mirvac

Attention: Ben de Montemas

Email: ben.demontemas@mirvac.com

**GEOTECHNICAL OPINION
CONSOLIDATION CONTINGENCY PLAN
146 NEWBRIDGE ROAD, MOOREBANK, NSW**

From an email dated 7 February 2022, we understand that as a part of the Auditor's approval, a Consolidation Contingency Plan is required, addressing the following:

- 8. The Mirvac Structural Engineer is to prepare a ground consolidation contingency plan that is to be approved by the SA within four weeks from the date of this SAS. The plan is to outline a strategy for mitigating potential impacts to the LFG mitigation system, house foundations and buried services caused by ground consolidation. The contingency plan is to be implemented by Mirvac if settlements are measured that exceed one of the following trigger levels:**
- a) A settlement at a monitoring location greater than 30 mm measured during the 12 month period that commenced prior to the construction of house slabs in the area; and**
 - b) A differential settlement between adjacent settlement pins greater than 20mm measured during the 12 month period that commenced prior to the construction of house slabs in the area.**

In response to the above, we note that as detailed in our letter (Ref: 29657ZN5 let5 rev3) dated 11 January 2022, we recommended a AS2870-2011 Class H2 site classification be adopted for design of the slabs/footings for the proposed houses. However, the upper at least 1.5m of the soil profile below subgrade level is crushed sandstone VENM which is not reactive to moisture content change, i.e. no shrink-swell movements are expected to occur. Instead, the recommended site classification is intended to reflect potential long term differential movement (consolidation/settlement) of the deep landfill present below the site.

For a Class H2 site, surface shrink-swell movements of up to 60mm to 75mm would normally be expected, and a footing/slab system design for a Class H2 site would be sufficient stiff to withstand such movements. As such, we consider a slab/footing system suitable for a Class H2 site would be suitable to accommodate possible long term differential movement of the deep landfill, present below the site.





As a measure to address possible future movements, we suggest the following:

1. Settlement monitoring of the already installed SSM's be completed in accordance with the procedure detailed in our previous letter Ref: 29657ZN5 let8 dated 17 December 2022 and as agreed by all relevant parties.
2. On completion of each house, including any floor coverings, a level survey of the floor slab be completed (e.g. using a water level) to establish a 'baseline' for each house. This would not necessarily need to be linked to AHD as it would be to assess possible future differential movement of the slab itself and not movement relative to any external point.
3. Should any of the triggers noted above be exceeded, a follow up level survey of house slabs in the vicinity of the recorded triggers should be completed to establish if there has been any differential movement of the house slab.
4. Should any differential movement of house slabs occur to the extent that the tilt of the slab exceed allowable limits, as detailed in the BCA, injection grouting, e.g. using an expansive epoxy product or pressurised cementitious grout could be completed to 'relevel' the affected slabs.

Should you require any further information regarding the above, please do not hesitate to contact the undersigned.

Yours faithfully
For and on behalf of
JK GEOTECHNICS

A handwritten signature in black ink, appearing to read 'N. Smith'.

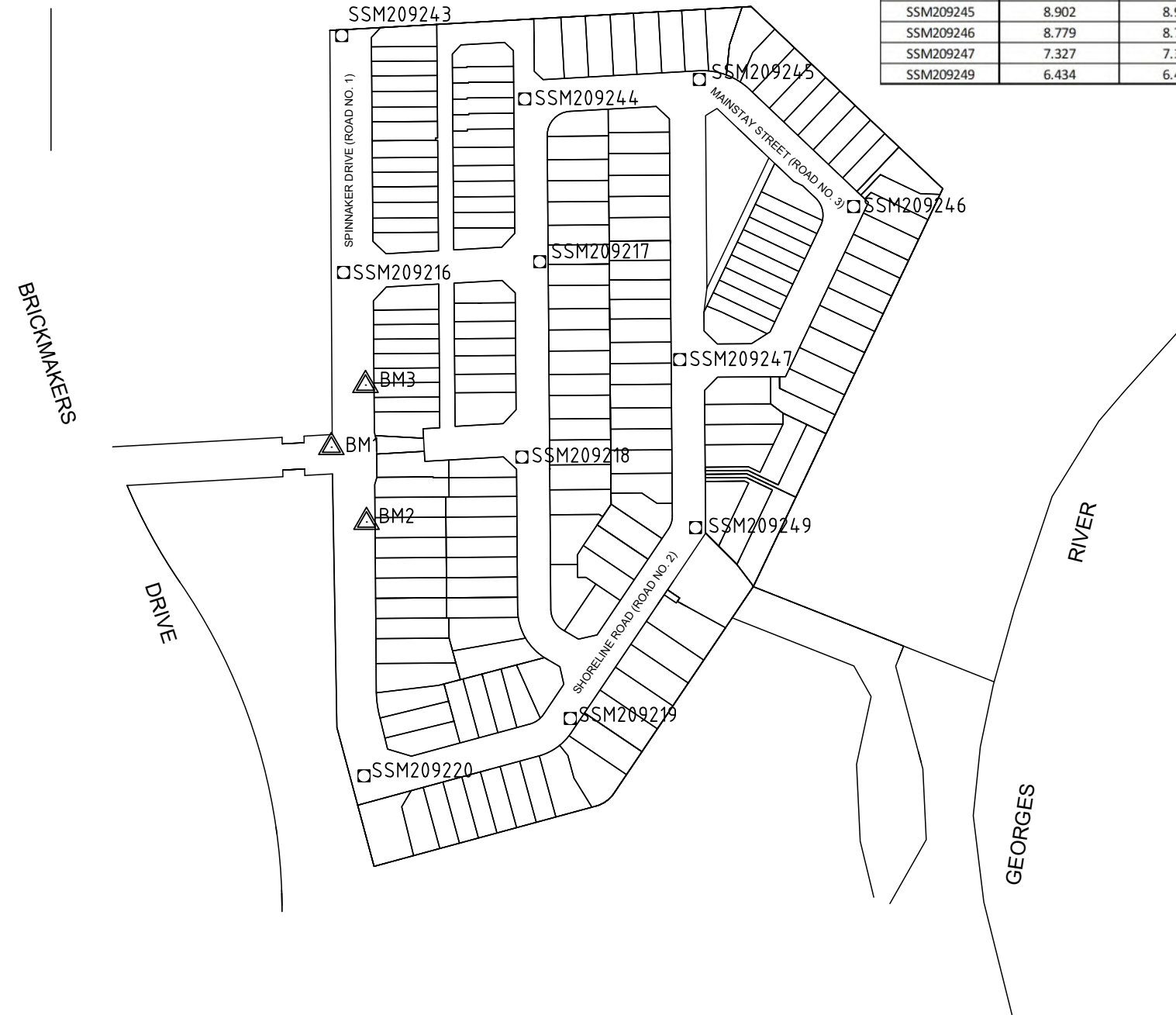
Nicholas Smith
Senior Associate | Geotechnical Engineer



MGA
SCIMS

Schedule of Surveyed Levels

Benchmark	RL (at 17/12/2021)	RL (at 21/01/2022)	RL (at 21/02/2022)	RL (at 22/03/2022)	RL (at 20/04/2022)	RL (at 19/05/2022)	RL(at21/06/2022)	RL(at25/07/2022)	RL(at23-08-2022)	Difference to initial survey (in mm)
BM1 (On bridge)	9.925	9.925	9.925	9.925	9.925	9.925	9.925	9.925	9.925	0.000
BM2	10.274	10.274	10.273	10.272	10.273	10.273	10.271	10.270	10.269	-0.005
BM3	9.456	9.457	9.455	9.455	9.457	9.452	9.457	9.457	9.456	0.000
SSM209216	8.018	8.018	8.017	8.018	8.020	8.016	8.019	8.020	8.019	0.001
SSM209217	8.766	8.766	8.764	8.766	8.764	8.766	8.768	8.768	8.767	0.001
SSM209218	8.321	8.321	8.319	8.319	8.318	8.319	8.321	8.322	8.321	0.000
SSM209219	7.436	7.437	7.434	7.435	7.438	7.436	7.436	7.437	7.436	0.000
SSM209220	8.375	8.373	8.370	8.367	8.369	8.366	8.364	8.363	8.361	-0.014
SSM209243	7.841	7.840	7.838	7.839	7.842	7.838	7.840	7.842	7.841	0.000
SSM209244	9.283	9.283	9.280	9.282	9.285	9.283	9.284	9.285	9.284	0.001
SSM209245	8.902	8.901	8.898	8.899	8.903	8.901	8.902	8.902	8.902	0.000
SSM209246	8.779	8.778	8.776	8.775	8.780	8.777	8.777	8.778	8.778	-0.001
SSM209247	7.327	7.327	7.325	7.324	7.329	7.326	7.326	7.327	7.327	0.000
SSM209249	6.434	6.435	6.433	6.433	6.437	6.435	6.435	6.436	6.435	0.001



I ~ ADDED NEW SET OF LEVELS 31-08-2022
H ~ ADDED NEW SET OF LEVELS 01-08-2022

VER	BY	AMENDMENTS	DATE
A	~	ORIGINAL ISSUE	13-01-2022
B	~	ADDED NEW SET OF LEVELS	24-01-2022
C	~	ADDED NEW SET OF LEVELS	22-02-2022
D	~	ADDED NEW SET OF LEVELS	23-03-2022
E	~	ADDED NEW SET OF LEVELS	28-04-2022
F	~	ADDED NEW SET OF LEVELS	25-05-2022
G	~	ADDED NEW SET OF LEVELS	23-06-2022



Beveridge Williams
Registered Surveyors
Land Development
Consultants

(02) 46255055 www.beveridgewilliams.com.au

CLIENT:
MIRVAC

DETAILS:

**PLAN OF BENCHMARK LEVEL
MONITORING
AT MOOREBANK COVE**

NOT TO
SCALE

SHEET SIZE
A3

SURVEYOR:	BC
DRAWN:	AS
CHECKED:	BC
SURVEY DATE:	N/A
CAD REFERENCE:	14005 MON

SHEET 1 OF 1

PROJECT No.
14005

DRAWING REF.
14005 MON

VERSION |

DATE 21 FEBRUARY 2022
Secta Reference: STR4225

ATTN: Ben de Montemas

STRUCTURAL STATEMENT
Geotechnical Consideration

Address: 146 NEWBRIDGE ROAD, MOOREBANK NSW
Superintendent: MIRVAC HOMES
Structural Document: SC_19308 - Residential Dwelling Slab/Footings

The structural engineering design for the above mentioned works was carried out by Secta Consulting Engineers. We certify that this design was in accordance with normal engineering practice and relevant Australian Standards.

Relevant (current edition) standards include but are not limited to:

1. AS1170:0&1 – Structural design actions;
2. AS 3600 – Concrete Structures;
3. AS2870 – Residential Slabs and Footings;

We confirm that the designs as nominated above have been prepared in conjunction with Geotechnical recommendations and findings as detailed in JKGeotechnics letter Ref: 29657ZN5 dated 11 January 2022.

Based on the above, we confirm the following:

1. **Adopted slab/footing designs are a minimum of Class “H2” as defined in AS2870-2011;**
2. **Adopted slab/footings expected to withstand movements of up to 60mm-75mm;**

In addition to the above, we have been made aware that a Consolidation Contingency Plan has been requested by the Auditor to form part of the overall approval. We further understand that a copy of JKGeotechnics letter Ref: 29657ZN5 let10 dated 16 February 2022 has been issued satisfying the Contingency Topics.

We confirm that the minimum “H2” slab/footing requirements as set out in The Consolidation Contingency Plan has been implemented in our design.

We additionally confirm that periodic inspections of the works during construction will be required to ensure the works generally conform to the intent of the design as conveyed by our structural engineering drawings.

This certificate shall not be construed as relieving any other party of their responsibilities or contractual obligations.

Yours sincerely



Sharief Abdelfattah
Senior Structural Engineer
MIEAUST CPENG NPER (structural/civil)
APEC Engineer IntPE(Aus)
NSW Fair Trading Accredited Certifier (structural/civil)
for Secta Consulting Engineers