



Environmental Services

Specialising in:

Acid Sulfate Soils
Contaminated Site Assessment
Air Quality Investigations

Remediation Advice and Design
Groundwater Management
Facility Maintenance

ABN 36 835 856 256

Environmental Site Management Plan For Proposed Dwellings

at

**Lot 9002 Longford Road,
Beaconsfield WA**

PREPARED FOR:

Lot 9002 Longford Road Pty Ltd

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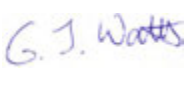
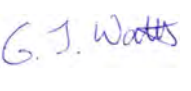

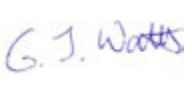
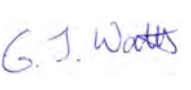

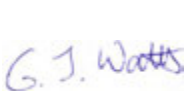
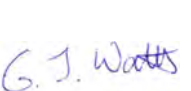
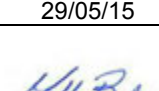
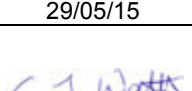
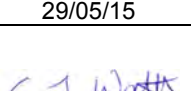



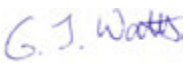
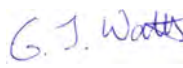

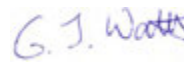
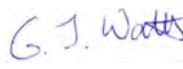

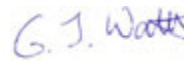
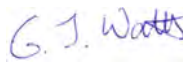

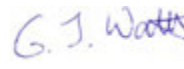
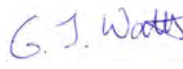


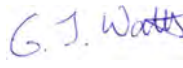


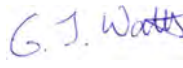


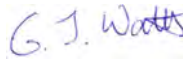


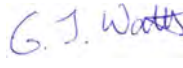


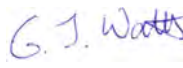
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EXECUTIVE SUMMARY

MDW Environmental Services (MDWES) was instructed by Lot 9002 Longford Road Pty Ltd (the Client) to develop an Environmental Site Management Plan (ESMP) for the management and installation of passive ground gas and membrane measures during the construction of each of the proposed new dwellings on Site. The Site is located at Lot 9002 Longford Road, Beaconsfield, Western Australia.

The Site proposal allows for the development of 35 (total) residential subdivision lots. The areas of the subdivided lots range between 216m² to 526m². The development does not include the Public Access Way (PAW) located on site. Each of the residential Lots requires a membrane installation and passive ventilation measures.

The parameters and data that were recorded during each of the nine monitoring visits were in accordance (CIRIA guidelines). The results observed fluctuated between CS1 and CS2 however during the final ninth visit CS3 was recorded which came at a period of low pressure and high precipitation which created elevated concentrations. Therefore, based on the CIRIA guidelines a “worst case scenario” should be adopted. Therefore, the site was classified as CS3 over all for the monitoring program. Therefore, ground gas protection measures were adopted for this Site.

The Site contains twenty-one (21) ground gas monitoring wells (LGMW) which were utilised for the ground gas monitoring program. Once the ground gas monitoring program has been certified complete and there is no further requirement to monitor the site (DER/DoH confirmed). The wells will be decommissioned prior to any construction taking place on site and the developing of any lot.

This ESMP has been written to provide installation details and requirements for ground gas protection measures during construction at the foundation stage for **all** new dwellings on the subject Site. The land/home owner must select from the options A or B presented in this report and must be followed in accordance with this management plan and supporting documents.

Installation and sign off is required by the appropriate persons nominated within this document to ensure that the protection measures have been installed in line with the manufacturer’s specifications. This management plan should be read in conjunction with the design and installation guides which provide the requirements for the nominated installation companies who are **Merit Lining Systems** or **CETCO**.

Summary of Option A: The installation options will be conducted/supplied by the following contractor in the following stages.

Passive Ventilation Option A	
Passive Ventilation Supplier	Products can be obtained from Builder Supplies/Supplier
Passive Ventilation Installer	The contracted builder/earth worker
Product	Granular fill (blue-metal 5-20mm) to be laid >300mm below ground slab (foundation). However, the greatest pore space should be adopted into the design to allow free flow of air. The permeability of the material should be at least 0.16m/s. 100mmØ slotted pipe drain to be installed within the upper parts of the granular fill material. The pipes should be continuous and should vent above the gravel sumps located at the end of the slab. The sumps should extend 0.5m from the slab and approximately 0.5m in width.
Sign Off	Contracted Builder / Engineer / Architect.

Membrane Option A	
Membrane Supplier	Maccaferri - Perth Office - Geofabrics Australia, 44 Christable Way, Lansdale, WA, 6065
Membrane Installer	Merit Lining Systems - Merit Lining Systems, 43 Kirwan Street, Floreat, WA, 6014
Product	Puraflex Membrane
Specification	0.45mm with dimensions of 2.1m x 50m. Conventional thermal weld equipment will be used (hot air/wedge) to seal the membrane.
Protection	Below Membrane - 2-6mm of blinding (rolled builders sand) or Needle punched Geofabric.
Sign Off	Rob Ronzon – Merit Lining Systems or Certified Engineer <i>The membrane will be installed as per the design and product specifications, Sign off will only be allowed if all criteria are met.</i>

Summary of Option B: The installation options will be conducted/supplied by the following contractor in the following stages.

Passive Ventilation Option B	
Passive Ventilation Supplier	CETCO
Passive Ventilation Installer	CETCO
Product	Drain Cel™ (50mm) overlaid with Ultrashield G-1000 Geotextile.
Protection	Below Drain Cel – Silting Layer to prevent blockages (Light Gauge Geotextile). Above Drain Cel - membrane – Ultrashield G-1000 Geotextile.
Sign Off	Mike Novak or Thomas Felauer – CETCO or Certified Engineer <i>The Drain Cel™ will be installed as per the design and product specifications, Sign off will only be allowed if all criteria are met.</i>
Membrane Option B	
Membrane Supplier	CETCO - 50 Crowle Street, Geelong, VIC, 3215
Membrane Installer	CETCO - 50 Crowle Street, Geelong, VIC, 3215.
Product	VI-20 with liquid boot
Specification	0.50mm 3.5m x 45m this will be sealed using liquid boot.
Protection	Above membrane – Ultrashield G-1000 Geotextile.
Sign Off	Mike Novak or Thomas Felauer – CETCO or Certified Engineer <i>The membrane will be installed as per the design and product specifications, Sign off will only be allowed if all criteria are met.</i>

NB: CETCO operate and work in Perth Metro Area

The gas drains/ventilation inlets and outlets should periscope up out of the sumps to ventilate. The periscope vents should be fixed to the building and terminate approximately 250mm above ground level with mushroom hats (Granular fill only). For aesthetic reasons, should the home owner wish to hide the vents, then the periscope should extend beyond the roof line. Either option should not be removed, covered or altered in any way after the construction (applicable to granular fill or CETCO Drain Cel Design). To assist with gas movement, cowls should be fitted to the periscope vents/outlets which extend beyond the roof line this will allow for greater passive ventilation to be drawn up the vertical exhaust and will also reduce debris, foliage from blocking of the vent.

Consideration should be given to the placement of garden beds, pavers, hardstand and driveways up to the building to allow for the sumps to be located.

The installation of the membrane (option A or B) will be completed by a competent, professional person the nominated company to complete this is Merit Lining Systems/CETCO. The selected company will provide final inspection and certificate sign off on each Lot installation.

The validation certificate is required from Merit Lining Systems (MLS) (option A) or CETCO (C) (option B) for their respective installations to demonstrate the products have been installed as per the manufacturer's specification.

An engineer's certificate from Robert Ronzon from Merit Lining Systems (option A) or Mike Novak/Thomas Felauer from CETCO (option B) is required. The engineers certificate is to sign off that the installation is compliant with engineering requirements. The certification is to be presented to all relevant stakeholders, which include:

- The Home Owner.
- The Client (9002 Longford Road Pty, Ltd).
- Environmental Consultant (MDWES).
- Environmental Auditor (AEA).
- Government - Department of Environment Regulation (DER), Department of Health (DoH).
- The City of Fremantle – Building Code Inspection Department.

Once the membrane has been certificated and "sign-off" has been completed no further alteration can be made to the membrane, structure and integrity there of. If alterations (retro fitting) are required then further validation/certification is required to ensure that the membrane is performing proficiently by the installer (Merit Lining Systems / CETCO).

In the future if the owner wishes to extend or redevelop the property then the measures outlined in this management plan must be adhered to and carried out on any remodeling or construction. Therefore, a membrane and passive ventilation as per the design specification must be incorporated in any redesign to the building footprint. (Selection from options A or B).

1 INTRODUCTION

1.1 General

MDW Environmental Services (MDWES) was instructed by Lot 9002 Longford Road Pty Ltd (the Client) to develop an Environmental Site Management Plan (ESMP) for the management for each of the proposed new residential dwellings proposed at Lot 9002 Longford Road, Beaconsfield, Western Australia, as illustrated in Figure 1 & 2. This ESMP has been written for the land owner/developer to install required ground gas protection measures upon the Site based on investigation data and published assessment criteria.

This ESMP has been written to provide installation details and requirements for ground gas protection measures during construction at the foundation stage for all new dwellings on the subject Site. This revised ESMP now presents two construction options:

- **Merit Lining Systems – Granular fill and Puraflex membrane.**
- &
- **CECTO – Draincel™ & VI-20 membrane**

The landowner/developer is required to select one construction option from the nominated installers to be compliant with required protection measures. These options need to be incorporated into the development design by the contracted builder/engineer or architect.

Each installer option and design must be followed in accordance with this management plan and supporting documents. Installation and signed off is required by the appropriate persons nominated within this document to ensure that the protection measures have been installed in line with the manufactures specifications.

This management plan should be read in conjunction with the design and installation guides which provide the requirements for the nominated installation companies.

- *Merit Lining Systems/Maccaferri – (Appendix A).*
- *CETCO – (Appendix B).*

This management plan should be provided to the installation company for compliance with proposed measures for each option. In addition, this management plan also details the environmental responsibilities and requirements to the Lot owner within the Longford Road development in terms of ground gas mitigation measures.

The investigations and conclusions drawn to date have been conducted in accordance with CIRIA Guidelines (CIRIA) – “*Assessing Risk Posed by Hazards Ground Gasses to Buildings*” (2007) and “*The Guidelines for the Assessment and Management of Sites impacted by Hazardous Ground Gases*” (NSW, EPA, 2012). Additional reference is also drawn from the Building Research Establishment (BRE) report 212 (1991), for the construction of passive ground gas systems. These documents are in line with published DER guidelines for the “*Assessment and Management of Contaminated Sites – Contaminated Sites Guidelines*” (2014).

1.2 Form of Development

The Site proposal allows for the development of 35 (total) residential subdivision lots. The areas of the subdivided lots range between 216m² to 526m² (Figure 3). The development does not include the Public Access Way (PAW) located on site.

Based on the monitoring data there is a requirement to develop remedial measures into the foundation construction for each of the dwellings proposed on the Lots. These measures comprise a passive ground gas system (membrane) and passive under slab ventilation to mitigate the risk to the end user (dwelling occupants). The construction options for the land owner are presented in this management plan and must be decided upon prior to construction.

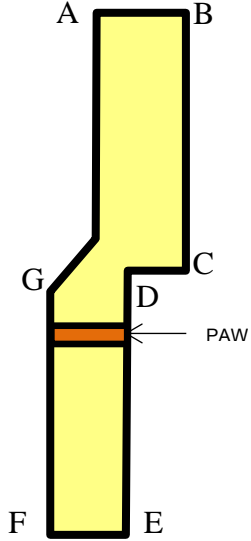
1.3 Site Identification

Site identification details are summarised in Table A below, with Table B detailing the Site boundary coordinates. The Site location is shown on figures 1, 2 and 3

Table A: Site Identification

Site Name:	Beaconsfield
Site Location:	Lot 9002 Longford Road, Beaconsfield, WA
Certificate of Title: (Volume / Folio)	Subject to Dealing (most recent CoT 2588/243)
Site Area:	Approximately 10,027m ²
Site Owner:	Lot 9002 Longford Road Pty Ltd
Local Government:	City of Fremantle
Planning Scheme:	No 4 (District Scheme)
Proposed Zoning:	The site has been rezoned Residential (R35) and superseding Development Plan 19.
Locality Map:	See Figure 1, 2 and 3

Table B: Site Boundary UTM Coordinates

Site	Co-Ordinates		
	Boundary	Eastings	Northings
	A	0383352	6451365
	B	0383363	6451364
	C	0383339	6451174
	D	0383367	6451175
	E	0383340	6450993
	F	0383315	6450994
G	0383317	6451177	

2 SITE CLASSIFICATION

The Site has been classified by the DER under the Contaminated Site Act (2003) as "Remediated Restricted use".

The following memorials on title will be applicable to each Lot on the development Site.

2.1 Ground Water Abstraction

Ground water abstraction of the underlying aquifer is prohibited on each of the development Lots. This includes and not limited to ground water bores used for reticulation or irrigation within a Lot and/or groundwater abstraction for human consumption.

2.2 Excavations

Excavations or intrusive works are limited to the top 1.25m of soil cover. Excavations below this level will require an additional management plan due to the environmental nature and potential contamination of the underlying soils.

There is a distinct horizon between the required 1.25m of clean soil cover and the underlying inert landfill material. This should be observed at all times during any intrusive ground works. This is applicable to but not limited to the following examples:

- Gardening.
- Underground Service Installations.
- Repairs and Maintenance.

2.3 Ground Gas

Ground Gas has been monitored and assessed as part of the program of investigative works on the subject Site. In conclusion residual ground gas is present on site and protective measures have been adopted and are presented in this management plan. All dwellings planned for construction must adhere to the building requirements stipulated in this management plan and the options presented.

3 BACKGROUND

Potential contaminants can have a wide range of consequences for both human health and the environment. This is dependant upon the type of contaminant, the media it is in and its interaction with other substances. Some contaminants may be inert, while others may be mobile, nuisance or impacting. As part of the ground gas monitoring program the following parameters were reported to determine the potential for human health risks.

The parameters and data that were recorded during each of the nine monitoring visits were: flow rate; barometric pressure; differential pressure; temperature and current weather conditions at each LGMW Monitoring well (see Figure 4).

Each of the LGMW's were sampled for a minimum of 300 seconds (5 minutes) or until stable readings were measured (which ever was greater). The following gas concentrations were continuously measured at each LGMW across the Site:

- Methane (CH₄).
- Carbon Dioxide (CO₂).
- Carbon Monoxide (CO).
- Oxygen (O₂).
- Hydrogen Sulfide (H₂S).
- Volatile Organic Compounds (VOC).
- Lower Explosive Limit (LEL).

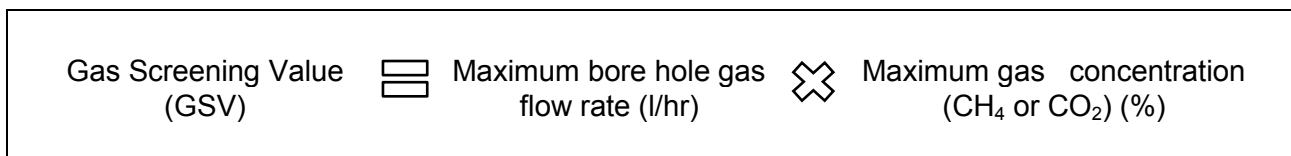
Ground gas can enter buildings through voids and gaps around service pipes, construction joints and wall cavities. Ground gas can accumulate within voids created by settlement beneath the floor slabs, within drains and soak wells that may be constructed on a site.

The force driving ground gas ingress is principally the positive pressure arising from the conditions under the floor slab which is generated due to the slightly negative pressure relative to atmosphere. There in, exists as a result a stack effect, in that, warm indoor air is less dense than the outdoor air.

3.1 Ground Gas Analysis

The assessment criteria adopted by the DER for ground gases has been taken from the UK CIRIA guidelines for the investigations of a Site and NSW Guidelines for assessing site impacted by ground gas. For the purpose of the investigations undertaken on Site the CIRIA guidelines were adopted which assesses the concentration and gas flow rate to determine the risk posed by a gassing site. The determined risk is communicated by the use of a "traffic light system" to identify the risk level.

The first step is to determine the Gas Screening Value (GSV) this is achieved by multiplying the maximum borehole flow rate by the gas concentration of methane or carbon dioxide. A visual representation of this calculation is below.



Determination of the GSV enables the association of a characteristic situation (risk level) and determination of the types and levels of gas protection required. Table C details the assessment levels and GSV values.

Table C: Determining Characteristic Situation (CS) of the Site

Characteristic Situation (CIRIA R149)	Comparable Classification DETR <i>et al</i> (1999)	Risk Classification	Gas Screening Value (GSV) (CH ₄ or CO ₂) L/hr threshold	Additional Factors	Typical Source of Generation
CS1	A	Very Low	<0.07	Typical Methane around 1% and/or Carbon Dioxide around 5%. Otherwise consider increasing to "CS2"	Natural Soils with low organic content "typical Made Ground"
CS2	B	Low Risk	<0.7	Bore air flow rate not to exceed 70l/hr, otherwise consider increasing to "CS3"	Natural high peat/organic content "Typical Made Ground"
CS3	C	Moderate Risk	<3.5	-	Old Landfill, Inert waste mine working flooded
CS4	D	Moderate to High Risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine-working susceptible to flooding, completed landfill (WMP 268 Criteria)
CS5	E	High Risk	<70	-	Mine working Unflooded inactive with shallow workings near surface.
CS6	F	Very High Risk	>70	-	Recent Landfill Site

Sourced from CIRIA guidelines: CIRIA C665, Table 8.5 - p88.

4 SUMMARY OF GROUND GAS RESULTS

The ground gas monitoring program undertaken by MDWES was across nine (9) ground gas sampling events in a six (6) month period. Each ground gas event obtained data at each of the twenty (21) LGMW's for potential ground gas emissions. A summary of the results and classification for each of the monitoring visits is presented in the following table D.

4.1 Ground Gas Sampling Classification

On each of the visits (9) MDWES presented a summary of the calculated classification for each of the individual LGMW's for methane and carbon dioxide (CIRIA Classification Criteria). The results observed fluctuated between CS1 and CS2 across the monitoring program. However, during the final ninth visit CS3 was recorded. Based on the CIRIA guidelines a "worst case scenario" should be adopted under these conditions. Therefore, the site was classified as CS3 over all for the monitoring program and CS3 ground gas protection measures should be adopted.

Table D: Ground Gas Monitoring Visit Classification Summary

	Event# 1		Event# 2		Event# 3		Event# 4		Event# 5		Event# 6		Event# 7		Event# 8		Event# 9	
	CH ₄	CO ₂	CH ₄	CO ₂	CH ₄	CO ₂	CH ₄	CO ₂	CH ₄	CO ₂	CH ₄	CO ₂	CH ₄	CO ₂	CH ₄	CO ₂	CH ₄	CO ₂
LGMW1	CS2	CS2	CS1	CS2	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS2	CS1	CS1	CS1	CS1
LGMW2	CS2	CS2	CS1	CS1	CS2	CS2	CS1	CS1	CS2	CS2	CS2	CS2	CS1	CS1	CS1	CS1	CS2	CS2
LGMW3	CS2	CS2	CS2	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS2	CS2	CS2	CS2	CS1	CS1	CS2	CS3
LGMW4	CS2	CS2	CS1	CS1	CS2	CS2	CS1	CS2	CS1	CS2	CS2	CS2	CS1	CS2	CS1	CS1	CS2	CS3
LGMW5	CS1	CS2	CS2	CS2	CS1	CS2	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS2	CS3
LGMW6	CS1	CS1	CS1	CS1	CS1	CS1	CS2	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
LGMW7	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS2	CS1	CS2	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS2
LGMW8	CS1	CS2	CS1	CS1	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
LGMW9	CS1	CS2	CS1	CS1	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
LGMW10	CS1	CS1	CS1	CS1	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
LGMW11	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
LGMW12	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
LGMW13	CS1	CS1	CS1	CS2	CS1	CS1	CS2	CS2	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
LGMW14	CS1	CS2	CS1	CS2	CS1	CS2	CS1	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS2
LGMW15	CS1	CS1	CS1	CS1	CS1	CS1	CS2	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
BHB01	CS2	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
BHA02	CS1	CS1	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS1	CS2	CS1	CS1
SB1	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS1	CS2	CS2	CS2
SB2	CS1	CS1	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2	CS2
BHB03	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS2	CS2	CS1	CS1	CS2
BHA06	CS1	CS1	CS2	CS2	CS1	CS1	CS2	CS2	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1	CS1
Event Classification	CS2		CS2		CS2		CS2		CS2		CS2		CS2		CS2		CS3	

4.2 VOC and Hydrogen Sulfide Assessment

The ground gas monitoring program (visits 1-9) which is detailed section 4.1 included a ground gas assessment for volatile organic compounds (VOCs) and Hydrogen Sulfide which were identified as being of potential contaminants of concern. The field results detailed on Table E below present the findings of said investigation which highlight that hydrocarbon and hydrogen sulfide was present in concentrations particularly in the southern portion of the site (LGMW13 to LGMW15 inclusive).

Based on the monitoring results (Table E) further investigation was recommended, which was completed via sampling with laboratory evacuated canisters on each of the on site wells (LGMW1 to LGMW15) this provided a more accurate result data set under laboratory conditions. The results of the laboratory analysis found that slightly elevated concentrations of VOC compounds and Hydrogen Sulfide were present on Site particular LGMW14. To ensure the health and protection of the residents for the development it was concluded that gas protection measures proposed would be sufficient to protect the end user based on the laboratory data and concentrations recorded. It was also stated that the specification of the membrane should ensure that it is resistant to VOCs and hydrogen sulfide gases.

Table E: Summary of Maximum Concentrations of Hydrogen Sulfide and Volatile Organic Compounds

	Event# 1		Event# 2		Event# 3		Event# 4		Event# 5		Event# 6		Event# 7		Event# 8		Event# 9	
	H ₂ S	VOC	H ₂ S	VOC	H ₂ S	VOC	H ₂ S	VOC	H ₂ S	VOC	H ₂ S	VOC	H ₂ S	VOC	H ₂ S	VOC	H ₂ S	VOC
LGMW1	0.0	0.380	0.0	61.8	0.0	0.800	0.0	1.40	0.0	0.000	0.0	0.813	0.0	0.000	0.0	0.253	0.0	2.2
LGMW2	0.0	0.990	0.0	117	0.0	1.40	0.0	1.10	0.0	0.500	0.0	0.100	0.0	0.000	0.0	0.749	0.0	0.000
LGMW3	10	0.530	100	1.00	0.0	0.500	0.0	0.600	0.0	0.000	0.0	0.000	0.0	0.232	0.0	0.000	0.0	0.000
LGMW4	0.0	0.040	0.0	243	0.0	0.400	0.0	1.20	0.0	0.400	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
LGMW5	10	0.030	0.0	98.2	0.0	0.700	0.0	1.10	0.0	0.000	0.0	0.000	0.0	0.147	0.0	0.253	0.0	0.000
LGMW6	10	0.030	10	8.00	0.0	0.400	0.0	0.000	10	0.000	0.0	0.300	0.0	1.99	0.0	0.000	0.0	0.000
LGMW7	0.0	0.590	0.0	112	0.0	1.60	0.0	2.00	0.0	0.900	0.0	0.600	0.0	1.40	0.0	0.60	0.0	30.4
LGMW8	10	0.510	0.0	214	0.0	1.00	0.0	0.700	0.0	0.700	0.0	0.400	0.0	0.295	0.0	0.485	0.0	0.000
LGMW9	10	0.030	0.0	38.6	0.0	2.10	0.0	1.00	0.0	0.100	0.0	2.20	0.0	1.05	0.0	1.76	0.0	0.000
LGMW10	10	0.430	0.0	33.8	0.0	2.70	0.0	2.70	0.0	0.300	0.0	1.90	0.0	1.61	0.0	1.43	0.0	0.000
LGMW11	0.0	0.330	0.0	29.6	0.0	4.20	0.0	0.800	0.0	0.300	0.0	1.30	0.0	0.189	0.0	0.009	0.0	0.000
LGMW12	10	2.01	10	9.20	0.0	4.20	10	3.300	10	2.20	10	4.70	10	4.50	0.0	4.41	0.0	0.000
LGMW13	10	1.11	10	14.6	20	1.10	10	1.10	10	1.00	10	1.40	10	0.886	0.0	0.644	0.0	0.000
LGMW14	420	48.9	530	68.0	160	28.5	1030	84.1	7110	88.4	230	50.9	150	38.7	1380	133	850	31.6
LGMW15	10	1.29	20	4.60	10	0.700	30	1.40	20	1.00	20	0.700	40	1.77	20.0	2.98	30	0.000
BHB01	10	0.030	10	206	0.0	1.30	0.0	0.300	0.0	0.000	0.0	0.100	0.0	0.000	0.0	0.000	0.0	11.6
BHA02	10	0.030	10	105	10	0.000	10	0.000	10	0.000	10	0.000	10	0.147	0.0	0.601	0.0	0.000
SB1	10	0.095	10	0.000	10	0.000	0.0	0.000	0.0	0.000	0.0	0.000	10	0.000	0.0	0.009	0.0	0.000
SB2	0.0	0.030	10	84.4	0.0	0.000	0.0	0.000	10	0.000	0.0	0.000	0.0	0.000	0.0	0.080	0.0	0.000
BHB03	0.0	0.030	10	93.0	10	0.100	0.0	0.800	10	0.000	0.0	0.000	0.0	0.000	0.0	0.009	0.0	17.7
BHA06	10	1.22	10	161	0.0	1.90	10	0.000	10	0.000	0.0	0.500	10	0.000	0.0	0.000	0.0	63.0

Note:

1. Highlighted Hydrogen Sulfide results indicate concentrations above 10ppm.
2. Highlighted total VOC concentration are considered elevated.

At the request of the Department of Health (DoH) and Department of Environment Regulation (DER) a third investigation was required around location LGMW14 specifically designed for assessing Hydrogen Sulfide concentrations. The investigation included the installation of additional monitoring wells around LGMW14 (LGMW16a 16b and 16c at prescribed depths within the capping soils and landfill horizon). Each of the four wells were sampled twice (x2) over a 14 day period and were sampled via laboratory evacuated canisters again for comparison.

The laboratory results of visit 1 highlighted that hydrogen sulfide concentrations were below the laboratory's limit of reporting (ppmv 0.05/0.08mg/m³) within LGMW16a, LGMW16b and LGMW16c. Concentrations within LGMW14 were slightly above the limit of reporting (ppmv 0.05/0.08mg/kg³) indicating a presence, however, the concentration of hydrogen sulfide was below the assessment criteria (WHO 15-30mg/m³).

The laboratory results of visit 2 highlighted that hydrogen sulfide concentrations were below the laboratory limit of reporting (ppmv 0.05/0.08mg/m³) for LGMW16 a, LGMW16b and LGMW16c. Furthermore, concentrations reported within LGMW14 were noted above the limit of reporting and did exceed the adopted assessment criteria (WHO 15-30mg/m³).

The investigation around LGMW14 also included an assessment at "surface" to determine the health risks of hydrogen sulfide which may be present at the interface between the superficial soils and future residents. The surface assessment was completed via "flux box" assessment at four (4) locations around LGMW14. Results collected during the flux box testing indicated that the ground gas flux (rate of emission) was very low/negligible at all test locations indicating a flux rate equal to the lower detection level of the test method (0.001 mg/m² /second).

The conclusions of each of the phases of investigation works for ground gas identified that ground gas protection measures were required in accordance with CIRIA guidelines to a CS3 level (ground gas membrane + ventilated void). In addition it was stated that the ground gas membrane was to be resistant to VOCs and hydrogen sulfide, (identified) which would significantly reduce the risks to the end user (the residents) and would be negligible.

5 CIRIA CLASSIFICATION & PROTECTION REQUIREMENTS

The results of the 9 ground gas monitoring visits have classified the site as being at a CS3 level. Therefore, the construction design should incorporate the ground gas protective measures set out in table E below for a CS3 classification (highlighted grey).

A CS3 classification requires a passively ventilated sub floor space and a ground gas protection membrane installed. This report details the options for the ground gas protection systems, each option is compliant with the specification outlined in the CIRIA guidelines in that a passive ventilated area and gas protection membrane is constructed within the foundation design by the property owner.

Table F: Determining Characteristic Situation (CS) of the Site

Characteristic Situation (CIRIA R149)	Risk Classification	Number of Levels of Gas Protection Measures	Scope of Ground Gas Protection Measures
CS1	Very Low	None	No Special Precautions
CS2	Low Risk	2	a. Reinforced concrete cast in situ floor slab (raft) with at least 1200 gauge DMP. or b. Passive venting System installed below precast raft. <i>All joints and penetrations to be sealed.</i>
CS3	Moderate Risk	2	All type of floor slab. All joints and penetrations sealed into the building. Proprietary gas resistant membrane. And Passively ventilated underfloor sub-space or positively pressurised underfloor sub-space.
CS4	Moderate to High Risk	3	All type of floor slab. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor sub-space or positively pressured underfloor sub space, over site capping and or blinding and in-ground venting layer.
CS5	High Risk	4	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary Gas Resistant membrane and ventilated or positively pressurised underfloor sub-space, over site capping and in-ground venting layer and in ground venting wells and or barriers.
CS6	Very High Risk	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design.

Sourced from CIRIA guidelines: CIRIA C665, Table 8.6 – p90.

6 CURRENT GROUND GAS MONITORING WELL NETWORK

The Site contains twenty-one (21) ground gas monitoring wells (LGMW) which were utilised for the ground gas monitoring program. Once the ground gas monitoring program has been certified complete and there is no further requirement to monitor the site the wells will need decommissioning. The DER/DoH confirmed in writing on February 2016 that the monitoring program was complete to their satisfaction and no further monitoring was required.

Note: At the time of writing v10 of this ESMP (April 2016) the five monitoring wells had been decommissioned on Lots 72, 73 and 74 LGMW14, LGMW15 and LGMW16 (a/b/c) (04/04/16). This will be followed up with a decommissioning report which will be presented to the Auditor for environmental endorsement to clear the Lots for construction.

All the monitoring wells will require decommissioning prior to any construction taking place on site and the development of any Lot. Decommissioning should be in accordance with Edition 3 of the Minimum Construction Guidelines for Water Bores in Australia (National Water Commission 2012). The following is applicable for the decommissioning of wells on the project Site.

6.1.1 De-Commissioning Objectives

The following objectives apply for the decommissioning of the wells.

- Remove the hazard of an open hole.
- Prevent the monitoring well acting as a conduit for contamination to migrate to lower soil horizons and or potentially the underlying ground water table.
- Prevents a conduit for ground gas to migrate to the surface and potential ingress into new proposed dwellings.
- To document and demonstrate the well has been decommissioned in accordance with industry standards (NWC 2012).

6.1.2 Monitoring Well De-Commissioning Process

1. Remove the concrete and head (riser) casing from the well exposing the 25mmØ UPVC installation.
2. During the monitoring program groundwater was not recorded within any of the wells. However, prior to filling, the wells will be dipped and any water encountered will be pumped and removed from the well.
3. The monitoring well should then be grouted with clean, inert, non polluting material and allowed to cure hard. Material used for grouting should be in the form of a bentonite slurry mix or concrete slurry to plug the well. Due to the diameter of the well a wet/liquid mix will be required to ensure encapsulation.
4. Sufficient time should be given to allow the slurry/grout to cure hard.
5. Excavation of the soils around the well should follow. Soils should be removed to the base of the current capping soils on site (approximately 1.25mbgl) to the horizon of the underlain landfill material.
6. The grouted monitoring well should then be cut (terminated) at the landfill horizon approximately 1.25mbgl.
7. Once the well has been terminated at the landfill horizon, the excavated capping sands should be placed back on top to provide the required 1.25m of cover. If an additional volume is required to return back to ground level then clean, verified soils should be used.
8. Decommissioning of the monitoring well should be undertaken by a professional person. This well decommissioning methodology should be verified and endorsed by the environmental auditor prior to being undertaken.
9. Documentation and records should be presented to demonstrate the wells have been decommissioned in accordance with industry standards.

7 PROPOSED PROTECTION MEASURES & REQUIREMENTS

The ground gas results collected for the nine (9) visits over a 6 month period have shown the site to be characterised as being CS3 for ground gas protection measures (section 3, 4 & 5). Therefore, based on the results of the monitoring and as long as the following protection measures are adopted, the proposed site development should be able to proceed and would be suitable for the proposed residential development.

The CIRIA guidelines and BRE 212 (1991) present recommendations for ground gas protection which requires a passive ventilation system and gas proof membrane to comply with a CS3 classification. To comply with ground gas protection measures under the current classification of CS3 this ESMP presents the recommended protection measures which should be employed during construction of residential dwellings:

MDWES states that as the environmental consultant the design proposals are in line with current regulatory guidelines. We also recommend that the design parameters are forwarded and presented to the building company, civil engineer and/or architect to ensure that the proposals do not undermine the integrity of the foundation and structure of the proposed dwelling.

Given complexities on Site a higher level of detail is required with regards to the management plan of which this report is part. In particular this relates to the inclusion of products and services providers noted herein. Whilst we (MDWES) do not necessarily endorse these products or companies, we acknowledge they have instrumental in our ability to prepare this ESMP (Merit Lining Systems & CETCO).

This being said, similar products and providers are available on the market and can be sought if desired. However, we cannot provide comment as to the effectiveness at this stage if used in your development. We should note that a product change or alteration from the designs being proposed needs to be with good reason and any change will require an evaluation as to the suitability for use on the development. Any change or alteration of protection measures will require endorsement before use, which may ultimately cause an unforeseen delay in construction until approval is obtained as to the suitability on the alternate product being suggested.

This ESMP presents product and construction options which are required for the installation of a ground gas protection system for each dwelling (passive ventilation system + gas proof membrane). The nominated contractor(s) need to be employed by the owner/land developer to be compliant with environmental requirements in terms of gas protection measures. This report should be supplied to the builder, engineer and/or architect to assist in the design process.

It is recommended that the landowner/developer or assigned contractor for dwelling liaises with the nominated suppliers/installers within this report to ensure that the product(s) best works for you and your design. Once chosen the supplier/installer will provide the required sign-off and supporting documents to certificate the installation for the landowner to certify completion and compliance. A brief summary of the installers are presented in Table G & H below:

Table G: Protection Measures - OPTION A

Element	Construction Details	By Whom
Stage 1	Granular fill (blue-metal) to be laid >300mm below ground slab (foundation). 100mmØ slotted pipe drain to be installed within the upper parts of the granular fill material. Requires >300mm of current capping soils to be removed prior to installing of passive ventilation system (This also allows for the membrane)	Builder or Assigned contractor to construct
Stage 2	Installation of Puraflex membrane (0.45mm) with hot weld seals which is overlain with a blinding layer of fine builder sand which is 2-6mm thick for protection.	Merit Lining Systems /Maccaferri

NB: The passive ventilation layer for the granular option requires inlet and outlet pipes to allow air to flow under the structure. Full details and requirements for ventilation pipes are presented in this report.

NB: Membrane is to be installed below the concrete slab or block and beam structural design as per architectural drawings. The builder/architect/engineer should ensure this is apparent on plans or drawings produced for the property.

Table H: Protection Measures - OPTION B

Element	Construction Details	By Whom
Stage 1	50mm (depth) interlocking Drain Cel™ installed across the footprint of the dwelling up to 1m of the internal facing wall. An “Ultrashield” G-1000 geotextile will be placed over the drain cell as a protection measure. Requires approximately 55mm of current capping soils to be removed prior to installing of passive ventilation system (This also allows for the membrane)	CETCO to install Drain Cel™ <i>Ground Preparation is required by Builder or Assigned contractor. This should be in consultation with CETCO as to requirements.</i>
Stage 2	Installation of VI-20 membrane (0.5mm) with Liquid boot sprayed seams (1.5mm). Membrane is overlain with “Ultrashield” G-1000 geotextile for protection	CETCO

NB: The passive ventilation layer for the draincel option requires inlet and outlet pipes to allow air to flow under the structure. Full details and requirements for ventilation pipes are presented in this report.

NB: Membrane is to be installed below the concrete slab or block and beam structural design as per architectural drawings. The builder/architect/engineer should ensure this is apparent on plans or drawings produced for the property.

8 OTHER ITEMS

8.1 Selection Process

The nominated membrane products and passive ventilation systems have been vetted, modelled and selected in accordance with current building and guidelines standards. The suppliers and installers presented in this ESMP have been selected, nominated and endorsed through a rigorous process to demonstrate that they are competent for the installation on each of the dwellings at the Longford Road development.

8.2 Chartered Engineer Validation

To validate the installation a chartered engineer is required to supply an “**engineer’s certificate**” to deem the installation fit for use. The use of another chartered engineer can be used providing that they have the credentials to supply a certificate of compliance for the installation. The use of another chartered engineer is at the discretion of the homeowner/builder.

The “**certificate of compliance**” should be passed onto the nominated stakeholders and building control department or the building control officer as part of the development sign-off for the foundation completion phase.

8.3 Using Other Suppliers/Installers/Products

If the builder or homeowner does not agree with the preferred suppliers recommended within this report, then they are within their rights to seek alternate solutions and products. However, a detailed justification and rationale for changing this ESMP **will** be required. This may include reports, drawings and supporting documents which will need to be reviewed and assessed to deem compliance with environmental standards and to assure there are no short/long term human health exposure risks.

All revisions and new information will require a full review before endorsement by the Stakeholders (Developer, Environmental Consultant, Environmental Auditor, DER and DoH) and to ensure compliance with current gas protection and construction guidelines (CIRIA C665 and BS8485). As discussed, any changes to this document should also consider the suitability for environmental and human health.

It should be noted that changes made from the scope presented in this ESMP will be at the homeowners cost. In addition presenting alternative suppliers, products or installers could result in delaying construction of the dwelling until endorsement has been provided.

The following sections outline the contractor and product options (A & B) to comply with the required ground gas protection measures.

Gas Protection Measures - OPTION A

9 PASSIVE VENTILATION GRANULAR (OPTION A)

The CS3 classification which is applicable to this site requires design for passive ground gas mitigation measures. The installation of a granular passive ventilation system is required on each of the properties Longford Road Site if this option is chosen, prior to the installation of the gas protection membrane.

9.1 Passive Ventilation - Granular Fill with Pipe work

Under the floor slab a >300mm granular layer is to be incorporated into the foundation design with a passive venting system (See figures 5). The following design parameters should be adopted when constructing the granular layer for passive ventilation. The current capping soils are to be excavated to required depths to incorporate the construction of this passive system. The passive system needs to be constructed prior to installation of the Puraflex gas proof membrane.

It is recommended that the construction the granular passive ventilation is installed by the contracted builder or earthworks company to ensure compliance. Prior to the start of construction capping material will need to be excavated to allow for passive ventilation system to be installed. The capping soils on site have been tested and classified as Class I soils, upon excavation the following design points should be followed:

1. Depth of granular fill should be >300mm.
2. The granular layer should be placed in compacted layers of no more than 150mm thickness.
3. Voids for granular fill are not to extend into the underlying landfill (1.25m below ground surface level). A tolerable allowance of >300mm (maximum 750mm) should be allowed between the underside of the foundations to the landfill horizon for the granular fill.
4. Granular material used should be blue metal or similar (5mm-20mm or greater) of aggregate material to ensure sufficient pore space between aggregate to allow for passive flow. Granular material should also be very low in fines. The permeability of the material should be at least 0.16m/s.
5. A blinding layer should be placed on top of the granular fill comprising clean builder's sand 2mm to 6mm to protect the membrane which would be overlain.
6. Gas drains are to be formed within the granular layer. The gas drain are to have a minimum diameter of 100mm, it should be machine slotted with a smooth internal surface.
7. The gas drains are to be formed from slotted pipe with machined slots between 2-6mm.
8. Gas drains pipe to have a minimum 10% and maximum 15% open area (slots).
9. Gas Drains to be formed from continuous lengths of pipe.
10. The gas drains are to be installed to avoid short circuiting of venting of the underside of the slab. i.e.: gas drains that emerge on one side of the slab should not extend such that they emerge on the opposite side of the slab (see figure 5 for layout).
11. The gas drains should be laid at approximate 1.25m centres with each drain inlet/outlet to exit around the slab and periscope upwards to ground level (see fig 5 for example).
12. Gas drains should extend from the edge of the slab and periscope upwards within a sump with dimensions of approximately 0.5m x 0.5m (this is applicable for each of the sumps).
13. Limited paving, garden beds and drive way should be allowed up to the building, but should not cover the ventilation sumps.
14. Gas drains on the opposite side should be completed by the use of a periscope vent which can comprise the following:
 - Vent is terminated at 250mm above ground with a mushroom cap. Such that the outlet will remain free from obstruction and attached to the building.

- If for aesthetic reasons if the previous option is not viable, the home owner can extend the periscope up to the roof line. The vent should be fitted within a cowl to allow air to be drawn up the vertical and vent at the roof line.
15. The inlet/outlet vents should provide a minimum of 1500mm² (0.0015m²) vent area per metre length of wall on both sides of the long side of the building
 16. During the pouring of the concrete floor slab it is imperative that concrete does not fall or set between the aggregate as this could restrict passive venting (*this should be prevented through the installation of the blinding sand, see #5*).
 17. The passive ventilation system is to be signed off by a professional person (engineer) to ensure the passive system has been installed correctly in accordance with the management plan.

It should be noted that it is prohibited to remove, cover or alter the gas drain granular layer extensions (sumps) and periscope vents in any way after construction.

9.2 Gravel Fill – Construction/Engineer Sign Off

Upon construction completion of the Gravel Fill and pipe network system the builder/engineer will sign off and certificate that the passive ventilation system has been completed in accordance with design parameters set out within this report. Upon sign-off of the passive system, the installation of the membrane can begin.

10 GROUND GAS MEMBRANE MERIT LINING SYSTEMS (OPTION A)

Upon construction of the passive system (granular fill) the ground gas membrane should be installed. Please read the Maccaferri Report which includes the "Design Details & Installation Guide" of a Puraflex Membrane design (Appendix A).

Upon engaging **MERIT LINING SYSTEMS** they will comply with the requirements of this ESMP and supporting documents and provide a certificate of installation and sign-off for the landowner to certify completion.

10.1 Nominated Membrane Installer

The nominated company for installing the membrane for Option A is Merit Lining Systems.

The nominated construction/building company developing each Lot on the Beaconsfield Site needs to provide the footprint and design of the dwelling to Merit Lining System so that the membrane geometry can be designed and installation can be arranged.

Perth office

Merit Lining Systems,
43 Kirwan Street,
Floreat,
WA, 6014

Ph: 08 9383 7510

<http://www.merit-linings.com.au/>

Contact: Robert Ronzon

10.2 Nominated Membrane Supplier

The installer will obtain the membrane from the following supplier Maccaferri.

Head office

Maccaferri Australia PTY LTD
22 Powers Road
Seven Hills, NSW, 2147

Ph: 02 8825 6300

<http://www.maccaferri.com.au/>

Perth Office

Geofabrics Australia
44 Christable Way
Lansdale, WA, 6065

Ph: 08 6305 0561

10.3 Nominated Membrane Product

The design proposal recommends a ground gas protective scheme for the proposed dwelling to consist of a low permeability ground gas barrier. This is a propriety gas resistant membrane as part of the CS3 classification requirements as detailed in Table E.

The nominated membrane used for the installation for Option A is a **Puraflex membrane** this will be supplied and installed by Merit Lining Systems.

The Puraflex membrane has been engineered specially for ground gas protection. The Puraflex membrane is a composite material comprising thermal weldable polymer layers on both sides of a chemical resistant core. Whilst the upper and lower polymer layers are UV stabilised, it is recommended that the membrane is only used for covered installations (Ground slab placed on top).

Further installation and design procedures are presented in the appended Puraflex “Design Detail & Installation Guide”. Installation CAD drawings are presented in sections 6.7.8 to 6.7.12 of the Maccaferri installation guide, attached in Appendix A.

Key Features

- Exceptional chemical resistance to harmful gases, industrial chemicals and hydrocarbons.
- Long-term durability.
- Good mechanical properties including tensile, tear and burst strength, puncture resistance.
- Good environmental stress crack resistance.
- Good welded seam peel and shear performance.
- Flexible to accommodate undulating ground contours.
- Good elasticity to accommodate limited ground movement.
- UV stabilised for added protection during the installation phase.
- High-visibility yellow on upper surface for easy recognition during excavations.

10.4 Nominated Chartered Engineer

To validate the installation of the membrane an independent inspector is required to deem the installation has been performed in accordance with the product specifications and is fit for purpose. A chartered engineer or the engineer from Merit Lining Systems can be used to sign off the installation.

Robert Ronzon

Merit Lining Systems,
43 Kirwan Street,
Floreat,
WA, 6014

10.5 Earth Works Preparation

All surfaces to be covered with the puraflex membrane shall be smooth and free from foreign and organic material, sharp objects or debris of any kind. The subgrade shall perform a firm, unyielding foundation with no sharp changes or abrupt break in the grade. No standing water will be present on the Lot prior to installation.

It is the responsibility of the builder and/or the installer to ensure the ground conditions are optimal and in line with the Puraflex design specifications prior to membrane installation.

10.6 Protection of Gas Proof Membrane

To minimise the risk of puncture, the Puraflex membrane should be adequately protected on either side with a suitable needle punched non woven geotextile or a thin layer of fine soft builder’s sand (2mm to 6mm), with no sharps or inclusions.

10.7 Construction Principles – Concrete Slab

The proposed foundations for the development are ground bearing slabs. The Puraflex membrane will be installed underneath the slab prior to the construction of the foundations. During installation it is imperative the membrane is not damaged or torn. Further foundation design details are presented within the Puraflex installation guide (section 6.7).

The design of the foundations needs to be provided to the Merit Lining Systems so the geometry of the membrane can be worked out prior to the installation on site.

10.8 Puraflex Installation Principles – Gas Proof Membrane

The principal consideration for a gas-proof membrane is to provide protection and reduce the permeability of ground gas ingress (no membrane is 100% impermeable). The Puraflex membrane has to withstand the construction process because, once torn or damaged, the membrane ceases to be operate as an effective barrier.

During construction the builder has to maintain the integrity of the membrane whilst the foundations are being constructed. If the membrane is torn or damaged then Merit Lining Systems need to be informed and the membrane has to be fixed/repaired and sign off (again) by Merit Lining Systems to ensure the integrity of the membrane has not been compromised.

Adequate quality control during the laying of the membrane is extremely important. The membrane should be protected either through the use of temporary boarding (smooth, no nails or rough edges) over the whole area, or by the immediate laying blinding sand and floor slab. The manufactures instructions should be followed whilst laying the membrane or the installer's representative should oversee the installation. The membrane specification has a nominal thickness is 0.45mm with dimensions of 2.1m x 50m. Conventional thermal weld equipment will be used (hot air/wedge) to seal the membrane.

The installation of the membrane will be conducted by Merit Lining Systems and are highlighted in section 6.4 of the Maccaferri Report Appendix A.

10.9 Puraflex Installation Principles – Prefabricated Panels

Pre-fabricated panels have the advantage of being installed relatively quickly and cleanly. They should be considered where Site conditions make in-situ welding more difficult or inappropriate. Panels minimise weather – induced delays and reduce on-site welding and can be made to the necessary detail, shape and size and delivered to site folded and rolled ready for deployment.

Preparation and deployment will be in accordance with the membrane specification procedures, with appropriate quality control measures undertaken by the installers.

If the membrane is delivered damaged or not cut to the bespoke footprint of the proposed new dwelling then the membrane is not to be installed and rejected until the problem is resolved.

It is understood the prefabricated panels will be used where possible by Merit Lining Systems. However, it is anticipated that the membrane will be laid and cut on site to the bespoke foot print design. If option 1 is adopted then the building foot print design needs to be presented to Merit Lining Systems prior to on site installation so the geometry of the membrane can be designed. This also includes the anchoring design which will be in line with the Puraflex specifications.

10.10 Construction Principles – Services

Service penetrations through the membrane should be kept to a minimum and to this end services can be directed into the building above the floor slab if design specifications allow. The installation should ensure that all membrane joints, seals and section breaks are sealed into the building, across any cavity walls creating a continuous barrier.

If services have to come through the floor slab the Puraflex design parameters for service ingress should be followed. Merit Lining Systems will comply with the Puraflex design specifications to ensure a continuous membrane barrier.

Inlet services to the dwelling need to be firmly anchored with service temperatures not to exceeding 60°C. Where a service pipe penetrates the membrane a cut hole in the membrane ensuring a tight seal is made without scratching the membrane. Top hats should be installed around penetrations as specified in the Puraflex product installation guide.

The pipe and membrane are flashed together by creating three cut-outs of the membrane material and hot air welded together. All services should be lapped and sealed to ensure a good seal. These points are developed further within the Puraflex installation guide (Section 6.1 to 6.6).

10.11 Puraflex Membrane Installation - Sign Off

The installation of the Puraflex membrane should be completed by a competent, professional person (nominated - Merit Lining Systems). Merit Lining Systems will provide the final inspection and certificate "sign off" of ITP based on the Quality Assurance/Control and check list of the Puraflex specifications. The following highlights some of the design protocols.

1. Each membrane install should be signed off and verified by Merit Lining Systems in accordance with the Puraflex installation guidelines.
 - a. Qualitative Non-destructive testing of the entire membrane surface, seam welds and penetration seals are checked and verified.
 - b. Qualitative Destructive testing of seam welds. Preservation of the integrity of the membrane should be minimised checked and verified.
 - c. Photographs of all penetrations seals and damaged areas should be taken with subsequent repairs.
 - d. Any non-conformances or breaches will be repaired and actioned prior to final sign off of the membrane.
2. To minimise the risk of puncturing, the barrier membrane should be adequately protection with a suitable non-woven geotextile or sand (non sharp) sand is to comprise a thickness of 2mm to 6mm.
3. The underlying soil should be picked and free from sharp protruding objects.
4. Installers should wear protective shoes to ensure that no tear or rip occurs whilst walking and installing the membrane.
5. Separate sheets or breaks should be over-lapped and welded together to ensure continuity, although care should be taken to avoid damaging the membrane during installation.
6. Special pieces/sections can be used for edges and corners to continue the membrane over these awkward areas.
7. The installed membrane should be continuous across the slab. It should continue through the wall and any cavity wall to prevent any potential ground gas accumulating within them.
8. Damage or tears to the membrane during installation should be repaired with immediate effect in accordance with product specifications and signed off before continuing with the screed.

The installation and design guide of Puraflex should be consulted as part of the installation process. Merit Lining Systems will comply with the installation and design document, in depth design speciation's which are provided and attached in Appendix A.

10.12 Puraflex Installation - Engineers Certificate

The installation of the Puraflex membrane by Merit Lining Systems requires an Engineers certificate. This should be completed by an accredited Chartered Engineer. The nominated chartered engineer is Robert Ronzon. The certificate will certify that the membrane has been installed professionally and is fit for use. The certificate of compliance for installation of the membrane should be passed to the building control officer as part of the foundation sign off.

10.13 Validation Certificates

Validation of the membrane installation is required as part of the quality control. Merit Lining Systems will install, validate and “sign-off” on each installation to certificate a Lot.

Merit Lining Systems are to provide quality assurance through an independent inspector who will provide an engineers certificate to verify the installation and materials used are correct.

The validation certificates from the installer and chartered engineer will be presented to all relevant stakeholders to ensure compliance.

- The Home Owner.
- The Client (9002 Longford Road Pty Ltd).
- Environmental Consultant (MDWES).
- Environmental Auditor (AEA).
- Department of Environment Regulation (DER).
- Department of Health (DoH).
- The City of Fremantle – Building Code Inspection Department.

10.14 Membrane Life Span & Warranty

The nominated membrane product (Puraflex) has been reported to have a 100 year life span, with a manufacturer’s warranty of 15 years.

Puraflex is manufactured to ISO 9001 Quality Assurance Standards with batch traceability.

10.15 Design Alterations

Once the Puraflex membrane has been certificated and “sign-off” is complete no further alteration can be made to the membrane structure as it would remove the integrity.

If an alteration (retro fitting) is required then further validation/certification is required to ensure that the membrane is performing proficiently. This should be completed by the nominated installer Merit Lining Systems and signed off accordingly.

Alterations to foundation design and construction need to be approved by a certified engineer or architect prior to installation.

10.16 Further Requirements or Contingencies

In future if the owner wishes to extend or redevelop the property then the measures outlined in this management plan must be adhered to and carried out on any remodeling or construction. Therefore, a membrane and passive ventilation option is required as per the design specification and must be incorporated in any redesign to the building footprint.

There are no contingencies at this stage.

Gas Protection Measures - OPTION B

11 PASSIVE VENTILATION SYSTEM – DRAIN CEL™ (OPTION B)

The CS3 classification which is applicable to this site requires design for passive ground gas mitigation measures. Therefore, a CETCO Drain Cel™ (Flownet) system has been nominated to mitigate this risk. The installation of a passive ventilation system is required on each of the properties Longford Road Site if option B is selected. The Drain Cel™ (Flownet) is a system which has been modelled by CETCO to provide the necessary passive ventilation required, in accordance with ground gas protection measures.

Upon engaging **CETCO** for the Drain Cel™ they will comply with the requirements of this ESMP and supporting documents and provide a certificate of installation and sign-off for the landowner to certify completion.

11.1 Passive Ventilation – CETCO Drain Cel™ (OPTION B)

The proposed product for Option B is called Drain Cel™ which is an open void product using a geocomposite to offer superior performance and provides high air and gas flows to be achieved and is less likely to block or stall via silt and water (CETCO report). It has been calculated that the 50mm Drain Cel™ provides a large void area of >95% producing a greater efficiency in the flow of air through the Cell and should be used if this is the chosen option. The product comes in panel form and is rigid so some ground preparation of the substrate is required so the product can be laid on a flat plane to accommodate the clip mechanism.

1. Sub grade area preparation of a straight and level cut with the removal of up to 55mm of capping soils maybe required prior to installation. *(The cut required should be confirmed with CETCO as to RL depth requirements prior to installation).*
 2. A sub grade silting layer to be installed above the current capping soils to prevent silting/blockages (light gauge geotextile). *(This is to be confirmed with CETCO as to RL depth requirements prior to installation).*
 3. CETCO to install a 50mm interlocking Drain Cel™ placed across the footprint of the dwelling within 1m of the internal face of edge footings.
 4. CETCO to install x2 100mm PVC inlet pipes – SN6 sewer grade, with solvent cement joints, fabricated manifold sleeves with air inlet, air brick/plate, bollard or vent box.
 5. CETCO to install x2 100mm PVC outlet pipes - SN6 sewer grade, with solvent cement joints, fabricated manifold sleeves with air outlet. Outlets to extend to roof level with no more than 2 bends and present 0.5m above gutter or parapet level.
 6. CETCO to install Ultrashield G-1000 geotextile. This is provides a protection layer above the Drain Cel™.
- *The VI-20 ground gas membrane is then laid upon the Ultrashield G-1000 geotextile.*
 - *If this passive system is the preferred option then CETCO should be contacted and consulted during development and design of structural drawings as per their report specifications in Appendix B.*
 - *It should be noted it is prohibited to removed, cover or alter the external vents in any way after construction.*

11.2 Nominated Drain Cel™ Installer

Geelong Head Office

CETCO,
50 Crowle Street,
Geelong,
VIC, 3215

Ph: 03 5278 2555

<http://www.cetco.com/en-us/>

Contact: Mike Novak

Perth Office

(CETCO operate and work in Perth Metro Area)

CETCO Services,
11 Ernest Clark Road,
Canning Vale,
WA, 6155

11.3 Nominated Drain Cel™ Supplier

CETCO will use the following company to supply the Drain Cel product.

Polyfabrics Australia

Polyfabrics Australia Pty Ltd,
144 Northbounre Road
Campbellfield
VIC, 3061

Ph: 03 9305 0300

<http://www.polyfabrics.com.au/>

11.4 Nominated Drain Cel™ Product

The Drain Cel™ creates a permanent non-clogging void between the concrete slab and the soil profile that will not collapse or distort. Drain Cel™ is easy to install and come in panel sizes of 1200x1000mm (which can be cut to size). The Drain Cel™ is durable and is used from 100% recycled polypropylene.

The 50mm void enables a direct flow of air to designated outlets avoiding the risk of ground gas build up and penetration into the property. The large surface and capacity void space (>95%) which enables superior flow efficiency compared to the small voids created by using a gravel system.

The lightweight nature of this product reduces weight on the structure by 98% over a gravel system and provides compressive/ultimate load strength of >225t/m³. CETCO should be contacted with regards to the further information and consult the CETCO report in Appendix B.

11.5 Drain Cel™ - Installation Sign Off

Upon completion and installation of the Drain Cel System CETCO will sign off and certificate that the passive ventilation system has been complete in accordance with the manufacturers specification. Upon sign-off of the passive system, the installation of the CETCO membrane can begin.

11.6 Drain Cel™ - Engineers Sign Off

The installation of the Drain Cel™ by CETCO requires an Engineers certificate. This should be completed by an accredited Engineer. The nominated engineer for CETCO is Mike Novak or Thomas Felauer. The certificate will certify that the Drain Cel™ has been installed professionally and is fit for use. The certificate of compliance for installation of the Drain Cel™ should be passed to the building control officer as part of the foundation sign off.

12 GROUND GAS MEMBRANE CETCO – OPTION B

Upon construction of the passive system (Drain Cel™) the ground gas membrane should be installed. Please read the CETCO Report which includes the “Design Details & Installation Guide” of a VI-20 Membrane design (Appendix B).

Upon engaging **CETCO** they will comply with the requirements of this ESMP and supporting documents and provide a certificate of installation and sign-off for the landowner to certify completion.

12.1 Nominated Membrane Installer

The nominated company for installing the membrane for Option B is CETCO.

The nominated construction/building company developing each Lot on the Beaconsfield Site needs to provide the footprint and design of the dwelling to CETCO so that the membrane geometry can be designed and installation can be arranged.

Geelong Head Office

CETCO,
50 Crowle Street,
Geelong,
VIC, 3215

Ph: 03 5278 2555

<http://www.cetco.com/en-us/>

Contact: Mike Novak

Perth Office

(CETCO operate and work in Perth Metro Area)

CETCO Services,
11 Ernest Clark Road,
Canning Vale,
WA, 6155

12.2 Nominated Membrane Supplier

Geelong Head Office

CETCO,
50 Crowle Street,
Geelong,
VIC, 3215

Ph: 03 5278 2555

<http://www.cetco.com/en-us/>

Contact: Mike Novak

Perth Office

(CETCO operate and work in Perth Metro Area)

CETCO Services,
11 Ernest Clark Road,
Canning Vale,
WA, 6155

12.3 Nominated Membrane Product

The design proposal recommends a ground gas protective scheme for the proposed dwelling to consist of a low permeability ground gas barrier. This is a propriety gas resistant membrane as part of the CS3 classification requirements as detailed in Table E.

The nominated membrane used for the installation for Option 2 is a **VI-20 Geomembrane with Liquid Boot seams** this will be supplied and installed by CETCO.

The VI-20 is a 7-layer co-extruding geomembrane is made using high quality virgin grade polyethanlene and EVOH resins which provide unmatched impact strength as well as superior resistance to VOC, methane and other ground gas vapour. The VI-20 membrane will be used in conjunction with spray application Liquid boot to provide a comprehensive protection barrier.

Liquid boot is a seamless, spray applied water based membrane which provides a barrier against vapour intrusion into structures. Liquid Boot spray application directly penetrates footing, grade beams, pile caps and other irregular surfaces for a fully adhered ground gas barrier system.

Further installation and design procedures are presented in the appended CETCO "Gas Barrier and Mitigation System – Technical Speciation Report". Installation CAD drawings are presented in section C – Construction Drawings of said report. The full technical report is presented in Appendix B.

Benefits VI-20

- Long-term durability for the life of the dwelling.
- Good mechanical properties including tensile, tear and burst strength, puncture resistance.
- Polyethelene layers provide excellent chemical resistance and physical properties.
- EVOH barrier technology provides protection against diffuse chemicals when compared to typical HDPE membranes.
- Manufactures at ISO9001:2008 certificated plant.

Liquid Boot is to be used to seal the VI-20 membrane. Liquid boot provides a seamless, spray applied water based membrane which provides a barrier against vapour instruction.

Benefits Liquid Boot

- Spray application provides excellent sealing of penetrations, eliminating the need to mechanical fastening.
- Seamless, monolithic membrane eliminates seaming-related membrane failures.
- Unique formulation provides superior protection from ground gases and water vapour.
- Fully adhered system reduces the risk of gas migration.
- Protection from identified ground gases including methane gas, VOCs, chlorinated solvents and other contaminants.

Full specification on the VI-20 membrane and Liquid Boot products are presented in Section D (Technical Data sheets) of the CETCO report in Appendix B.

12.4 Nominated Chartered Engineer

To validate the installation of the membrane an independent inspector is required to deem the installation has been performed in accordance with the product specifications and is fit for purpose. A chartered engineer or the engineer from CETCO can be used to sign off the installation of the membrane:

Mike Novak or Thomas Felauer (CETCO)

CETCO,
50 Crowle Street,
Geelong,
VIC, 3215

12.5 Earth Works Preparation

All surfaces to be covered with the VI-20 geomembrane shall be prepared and will smooth and free from foreign and organic material, sharp objects or debris of any kind. The subgrade will be a laid with a silting layer to prevent blockage (light gauge geotextile). No standing water will be present on the Lot prior to installation.

It is the responsibility of the builder and/or the installer to ensure the ground conditions are optimal and in line with the CETCO design specifications prior to membrane installation.

12.6 Protection of Gas Proof Membrane

To minimise the risk of puncture, the VI-20 membrane will be laid within an Ultrashield G-1000 geotextile sandwich. The Ultrashield will be laid above and below the VI-20 membrane by CETCO the installer. The overlying ultra shield will provide the protection for incoming trades. However, construction workers should remain vigilant and aware that that sharp or penetrating tools or debris may impact the integrity of the membrane.

During construction the builder has to maintain the integrity of the membrane whilst the foundations are being constructed. If the membrane is torn or damaged then CETCO, need to be informed and the membrane has to be fixed/repaired and sign off (again) by CETCO to ensure the integrity of the membrane has not been compromised.

The manufactures instructions should be followed whilst laying the membrane or the installer's representative should oversee the installation. The membrane specification has a nominal thickness is 0.50mm with dimensions of 3m x 45m (rolls). To seal the section Liquid Boot will be used to seal the membrane.

The installation of the membrane will be conducted by CETCO and are highlighted in the CETCO report Appendix B.

12.7 Construction Principles – Concrete Slab

The proposed foundations for the development are ground bearing slabs. The VI-20 membrane will be installed underneath the slab prior to the construction of the foundations the VI-20 membrane will be sealed using liquid boot. During installation it is imperative the membrane/seals are not damaged or torn. Further foundation design details are presented within the CETCO report.

The design of the foundations needs to be provided to the CETCO so the geometry of the membrane can be workout prior to the installation on site.

12.8 VI-20 Installation Principles – Gas Proof Membrane

The principal consideration for a gas-proof membrane is to provide protection and reduce the permeability of ground gas ingress (no membrane is 100% impermeable). The VI-20 membrane has to withstand the construction process because, once torn or damaged, the membrane ceases to be operate as an effective barrier. During construction the builder has to maintain the integrity of the membrane whilst the foundations are being constructed. If the membrane is torn or damaged then the installer (CETCO), need to be informed and the membrane has to be fixed and sign off (again) by CETCO to ensure the integrity of the membrane has not been compromised.

Adequate quality control during the laying of the membrane is extremely important. The membrane should be protected either through the use of temporary boarding (smooth, no nails or rough edges) over the whole area, or by the immediate laying of geotextile (Ultrashield) and floor slab. The manufactures instructions should be followed whilst laying the membrane or the installer's representative should oversee the installation. The nominal thickness is 0.5mm with liquid boot used to seal in the membrane around services and ingress areas.

The installation of the membrane (drawings) will be conducted by CETCO and are highlighted in section C of the CETCO report.

12.9 VI-20 Installation Principles

Membrane installation is to be performed across the entirety of the building footprint, including any penetrations as detailed in section C of the CETCO report. The membrane is to be installed in a continuous manner beneath the dwelling.

VI-20 will be rolled out across the floor space, with wrinkles folds and stress points reduced laying the membrane tight in all corners or recesses, with all seam overlaps to be a minimum of 150mm before applying the liquid boot product. All service into the dwellings will be sealed using liquid boot product and completed in accordance with CETCO's design specification for service ingress.

Were footings are present, VI-20 and liquid boot are to be overlapped and sealed a minimum of 75mm over the concrete. Once application is complete and the liquid boot seams have cured the testing should be completed in accordance with CETCO specifications Section 5 of the report. Once signed off the Ultrashield protection layer is rolled out across the footprint of the membrane to avoid trafficable damage.

Preparation and deployment will be in accordance with the membrane specification procedures, with appropriate quality control measures undertaken by the CETCO.

12.10 Construction Principles – Services

Service penetrations through the membrane should be kept to a minimum and to this end services can be directed into the building above the floor slab if design specifications allow. The installation should ensure that all membrane is sealed using Liquid boot by CETCO on the joints, seals and section breaks into the building.

If services have to come through the floor slab the CETCO design parameters for service ingress should be followed. CETCO will comply with the VI-20 and liquid boot design specifications to ensure a continuous membrane barrier.

Inlet services to the dwelling need to be firmly anchored with service temperatures not to exceeding 60°C. Where a service pipe penetrates the membrane a cut hole in the membrane ensuring a tight seal is made without scratching the membrane, liquid boot will be used to seal and ensure a gas tight membrane is present across the footprint of the dwelling. These points are developed further within the CETCO installation guide.

12.11 VI-20 Membrane – Smoke Test Sign Off

Upon installation of the VI-20 membrane and to ensure the design intent of the membrane is met, smoke testing will be completed by CETCO as part of the validation process. The inspection will be performed in accordance with the CETCO “form 2.1” sign off procedure.

12.12 VI-20 Membrane Installation - Sign Off

The installation of the VI-20 membrane and Liquid Boot sealing system should be completed by a competent, professional person (nominated - CETCO). Once the smoke test has been completed and signed off, CETCO will provide the final inspection and certificate “sign off” of ITP based on the Quality Assurance and CETCO control checks

CETCO will sign off in a staged approach.

1. Form 1 – Surface Perpetration
2. Form 2 – Membrane installation
3. Form 2.1 – Smoke test
4. Form 3 – Post application and Pre-concrete inspection

Examples of the sign off forms are presented Section E of the CETCO Report (Appendix B). Each of the sign off completion stages will be accompanied with the following information:

- a. Multipoint conditional sign off for each stage under CETCO sign off forms.
- b. Photographs of all penetrations seals and damaged areas should be taken with subsequent repairs.
- c. Any non-conformances or breaches will be repaired and actioned prior to final sign off of the membrane.

The installation and design guide of CETCO should be consulted as part of the installation process. CETCO will comply with the installation and design document; in depth design specifications are provided within attached document Appendix B.

12.13 VI-20 Installation - Engineers Certificate

The installation of the IV-20 membrane by CETCO requires an Engineers certificate. This should be completed by an accredited Chartered Engineer. The nominated chartered engineer is Mike Novak or Thomas Felauer. The certificate will certify that the membrane has been installed professionally and is fit for use. The certificate of compliance for installation of the membrane should be passed to the building control officer as part of the foundation sign off.

12.14 Validation Certificates

Validation of the membrane installation is required as part of the quality control. CETCO will install, validated and "sign-off" on each installation to certificate a Lot.

CETCO are to provide quality assurance through an independent inspector who will provide an engineers certificate to verify the installation and materials used are correct.

The validation certificates from the installer and chartered engineer will be presented to all relevant stakeholders to ensure compliance.

- The Home Owner.
- The Client (9002 Longford Road Pty Ltd).
- Environmental Consultant (MDWES).
- Environmental Auditor (AEA).
- Department of Environment Regulation (DER).
- Department of Health (DoH).
- The City of Fremantle – Building Code Inspection Department.

12.15 Membrane Life Span & Warranty

The nominated membrane product (VI-20/Liquid Boot) has been reported to have a life span of the dwelling. The manufactures warranty will provide replacement at no charge, proven not to meet the material properties listed in product literature. This warranty is in lieu of any and all other warranties expressed or implied.

VI-20 is manufactured to ISO 9001 Quality Assurance Standards with batch traceability.

12.16 Design Alterations

Once the VI-20 has been certificated and “sign-off” no further alteration can be made to the membrane structure as it would remove the integrity.

If alterations (retro fitting) is required then further validation/certification is required to ensure that the membrane performing proficiently. This should be completed by the nominated installer CETCO.

Alterations to foundation design and construction need to be approved by a certified engineer or architect.

12.17 Further Requirements or Contingencies

In future if the owner wishes to extend or redevelop the property then the measures outlined in this management plan must be adhered to and carried out on any remodeling or construction. Therefore, a membrane and passive ventilation as per the design specification must be incorporated in any redesign to the building footprint.

CETCO state that the works will be completed in accordance with the quality assurance plan. However, the following have been considered potential issues which may require structural quality assurances which are in line with the parameters set out for CETCO products.

- Substrate preparation and expectations.
- Builder and Site contractor obligations
- Membrane protection during staging.
- Smoke testing and associated QA documentation.
- Post Construction Performance.

CETCO identified that although most of the roles have been appropriated defined within their CQA plan within the CETCO report (Appendix B), all parties are responsible for the success or failure of the system implementation. To assist in the success of the application, an independent CQA regime will be adopted within the application and sign off of the selected system.

13 REFERENCES

Davidson, WA. (1995): *Hydrogeology and Groundwater Resources of the Perth Region*, Western Australia. Geological Survey of Western Australia Bulletin 147.

CETCO (2016) – Gas Barrier and Mitigation system – Technical Specification for proposed Passive ventilation system and Chemical Resistant Barrier Membrane (Final)

CIRIA. *Assessing risks posed by hazardous ground gases to buildings*, CIRIA (2007).

Building Research Establishment (BRE) report 212 (1991)

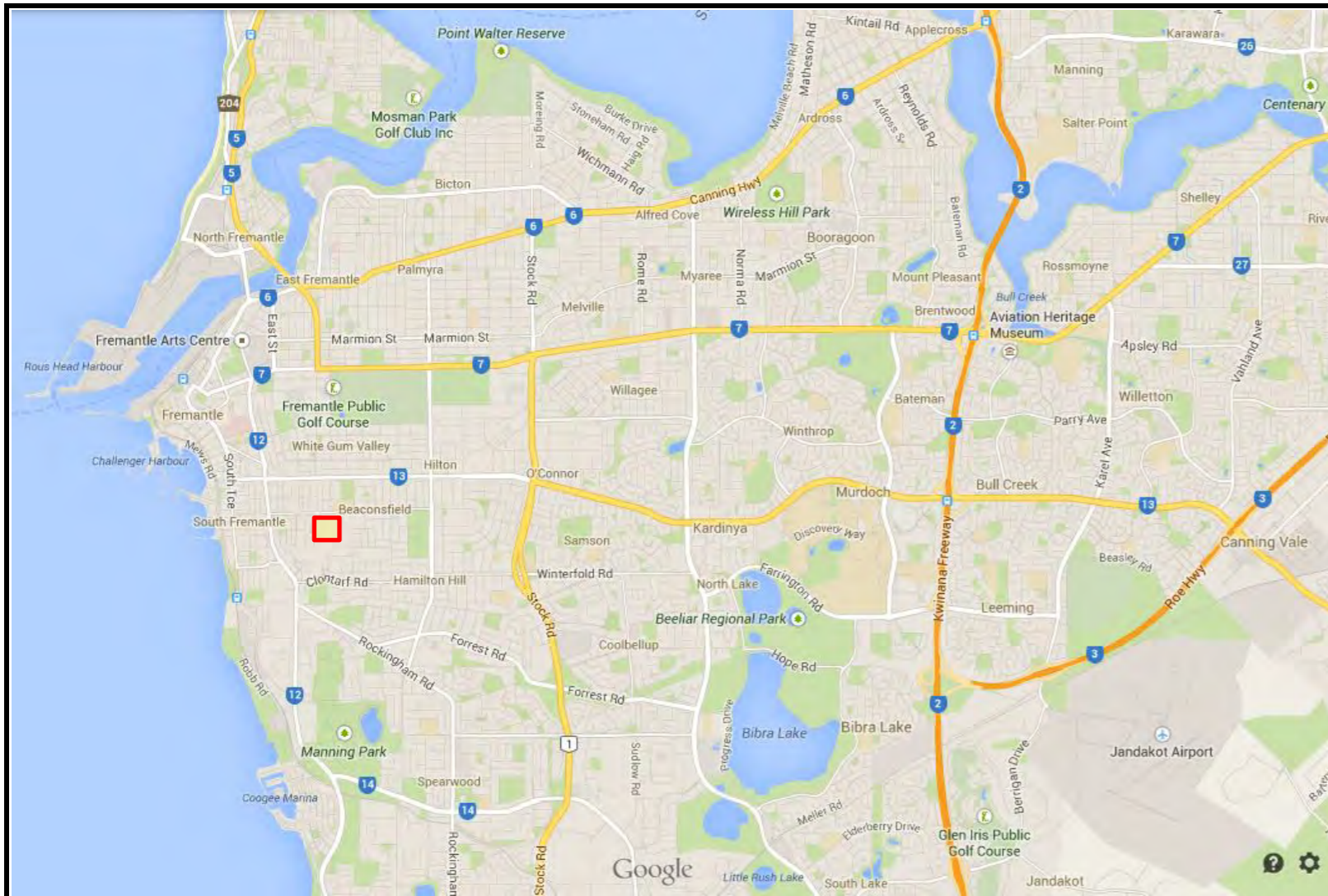
Nearmap (2012) *PhotoMaps by Nearmap* (Online), <http://www.nearmap.com>.

CRC CARE 2013, *Petroleum hydrocarbon vapour intrusion assessment: Australian guidance*, CRC CARE Technical Report no. 23, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

Puraflex (2014) - Hydrocarbon and Chemical Resistant Environmental Protection Barrier Membrane – Design Detail & Installation Guide (Revision 2.3)

Edition 3 of the Minimum Construction Guidelines for Water Bores in Australia (National Water Commission 2012).

FIGURES





Client:
Lot 902 Longford Road Pty Ltd


Project:
Beaconsfield

Location:
Lot 902 Longford Road, Beaconsfield

Drawing Title:
Site Location Map

Notes:

-  Site Boundary
-  B³ area

Drawn by: DA	Scale: Not to scale	 North
Date: 16/06/2014		
Project No: E2014-004	1	Rev: v1





Client:
Lot 9002 Longford Road Pty Ltd

Project:
Beaconsfield

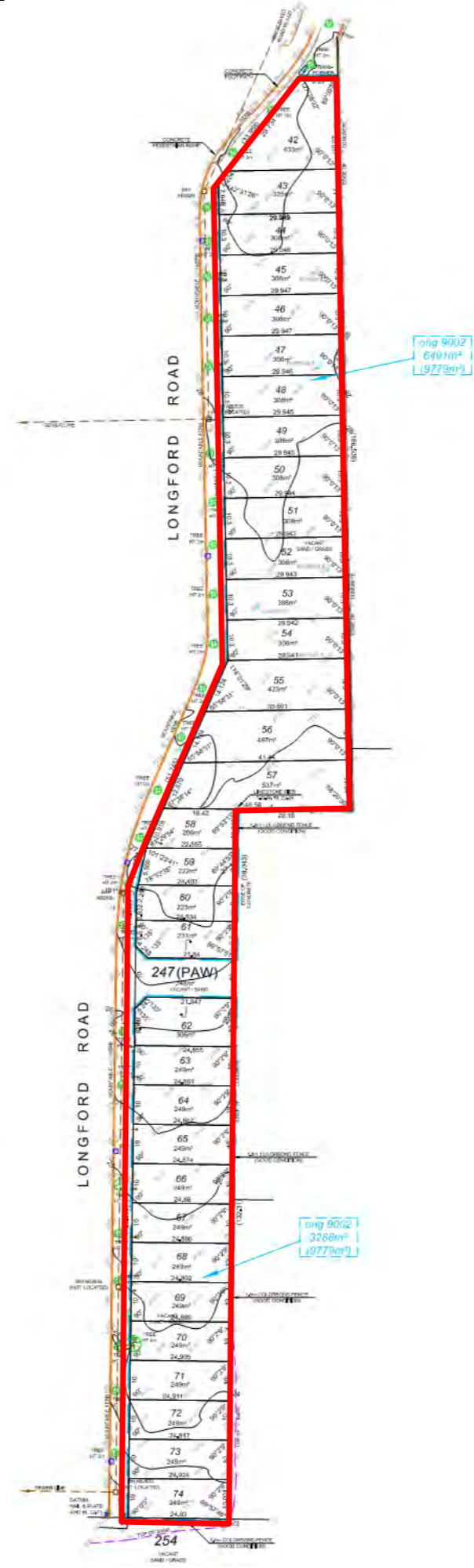
Location:
Lot 9002 Longford Road, Beaconsfield

Drawing Title:
Site Location

Notes:
 Site Boundary

Drawn by: MB	Scale: Not to Scale	 North
Date: 7/07/2014		

Project No: E2014 - 004	Figure No: 2	Rev: v1
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Client:
Lot 9002 Longford Road Pty Ltd

Project:
Beaconsfield

Location:
Lot 9002 Longford Road, Beaconsfield

Drawing Title:
Site Boundary and Lot Divisions

Notes:

-  Area A, old landfill
-  Area B, New Landfill (B1 & B2)


Drawn by: MB	Scale: Not to scale.	 North
Date: 8/07/2014		
Project No: E2014 - 004	Figure No: 3	Rev: v1

Image sourced from the Land Survey document Proposed Green Title Subdivision.

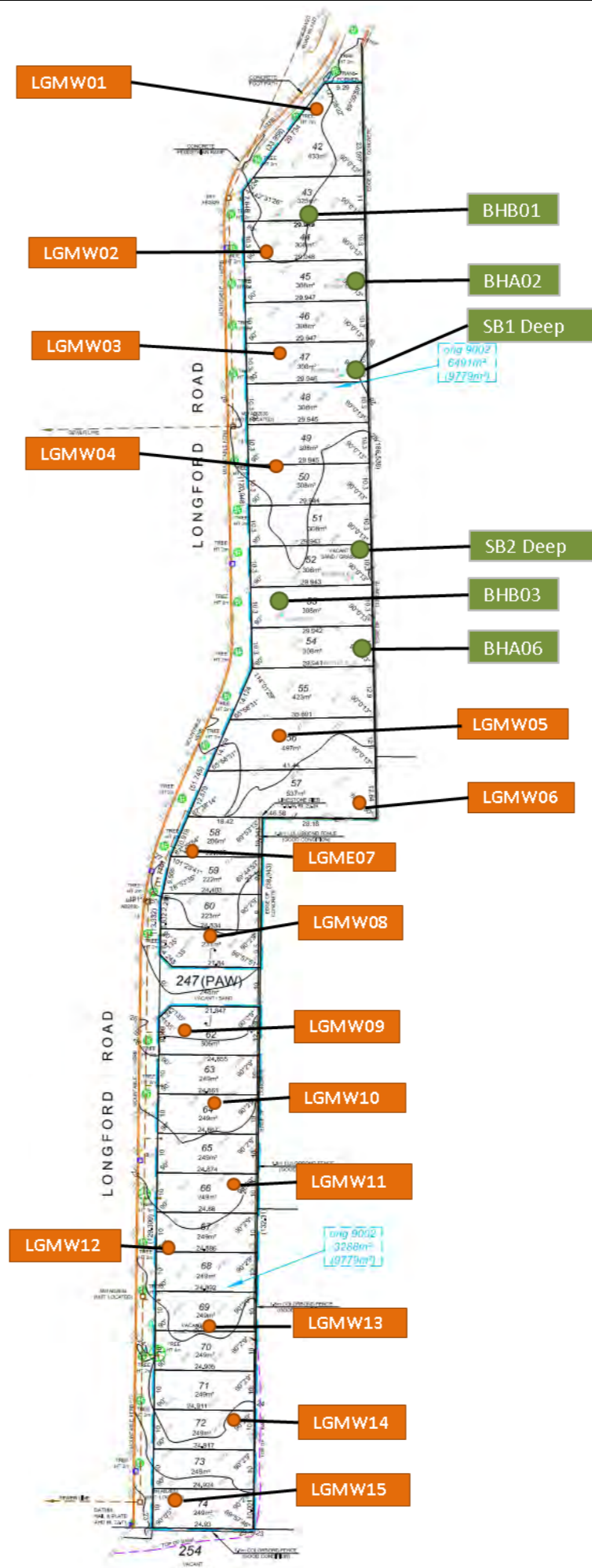




Image sourced from the Land Survey document *Proposed Green Title Subdivision* included within Appendix F.

MDW Environmental Services PERTH PEEL  ENVIRONMENTAL SERVICES T: (08) 9250 6960 F: (08) 92508269 www.environmentalservices.com.au info@environmentalservices.com.au		
Client:		
Lot 9002 Longford Road Pty Ltd		
Project:		
Beaconsfield		
Location:		
Lot 9002 Longford Road, Beaconsfield		
Drawing Title:		
Lot Subdivisions and LGMW Locations		
Notes:		
<ul style="list-style-type: none"> ● Previously installed land gas monitoring well ● Newly installed land gas monitoring well Area A, old landfill Area B, New Landfill (B1 & B2) 		
Drawn by:	Scale:	 North
DA	Not to scale.	
Date:		
17/06/2014		
Project No:	Figure No:	Rev:
E2014 - 004	4	v1



Client:

Lot 9002 Longford Road Pty Ltd

Project:

Beaconsfield

Location:

Lot 9002 Longford Road, Beaconsfield

Drawing Title:

**Passive Ventilation System
(OPTION A)**

Notes:

OPTION A

Drawn by:

MB

Scale:

Not to Scale

Date:

23/06/2015



North

Project No:

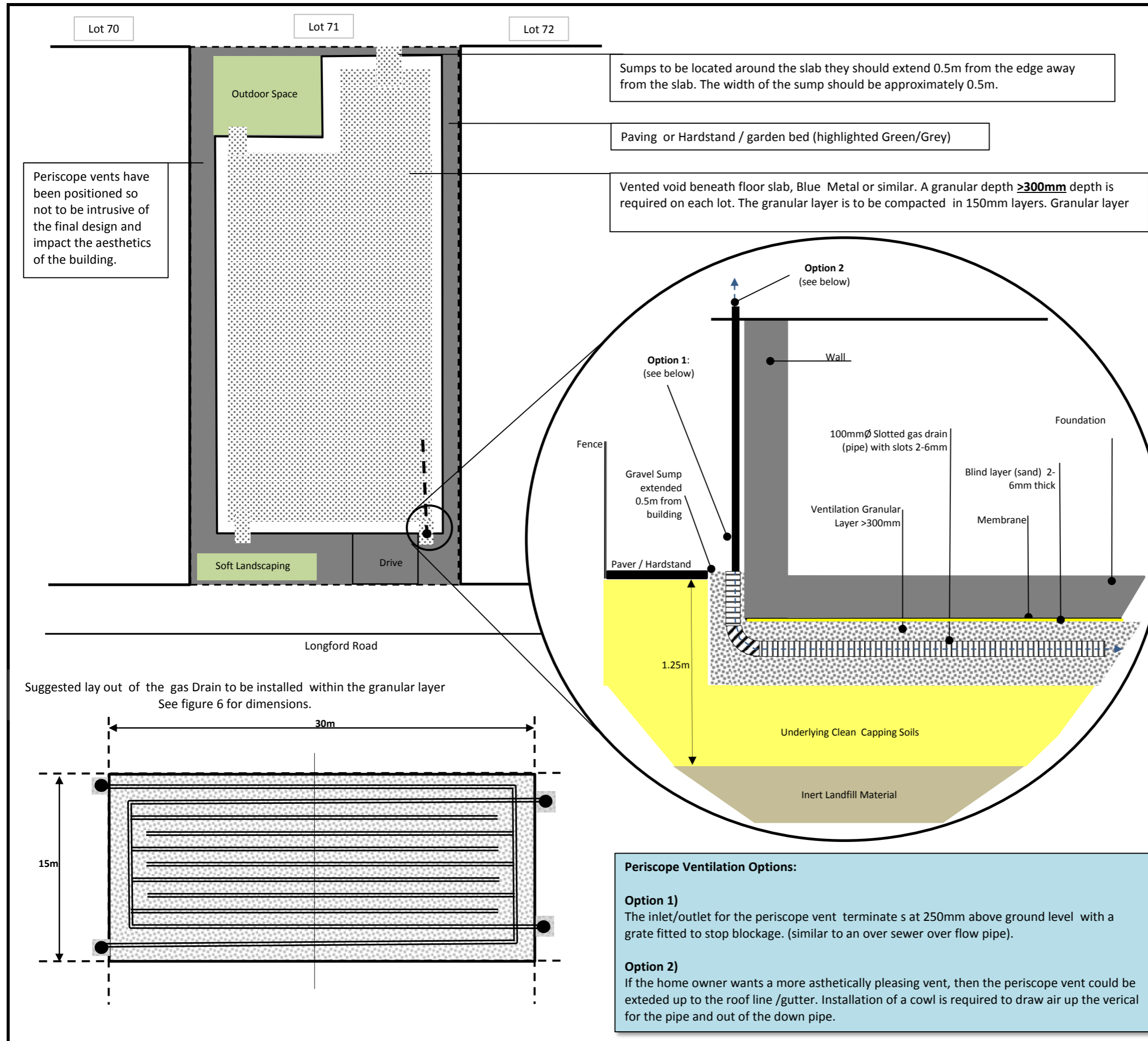
E2014 - 004

Figure No:

5

Rev:

v4

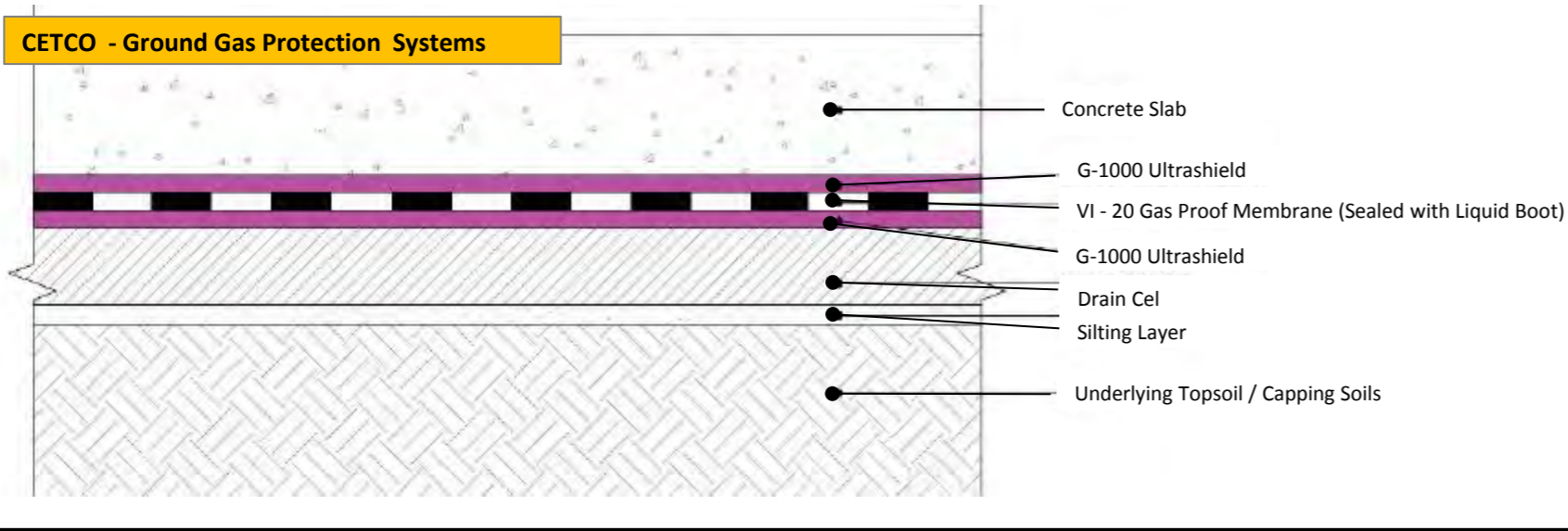


Periscope Ventilation Options:

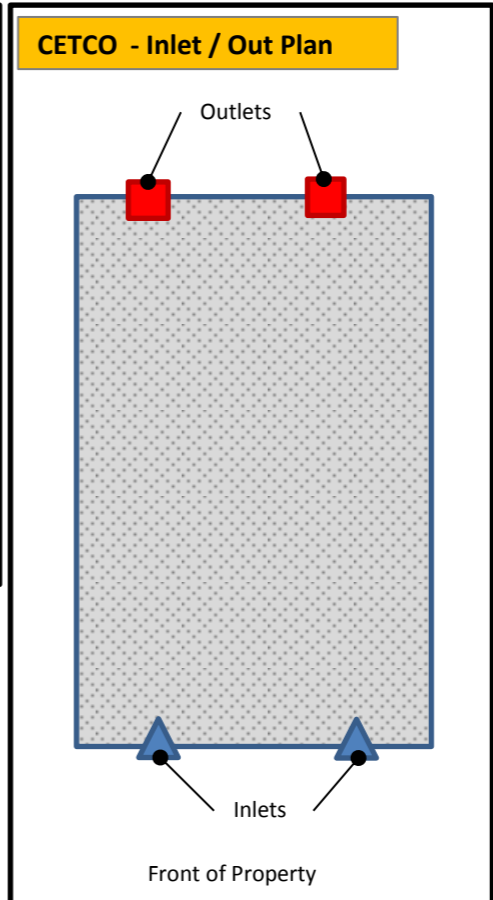
Option 1)
The inlet/outlet for the periscope vent terminate s at 250mm above ground level with a grate fitted to stop blockage. (similar to an over sewer over flow pipe).

Option 2)
If the home owner wants a more asthetically pleasing vent, then the periscope vent could be exteded up to the roof line /gutter. Installation of a cowl is required to draw air up the verical for the pipe and out of the down pipe.

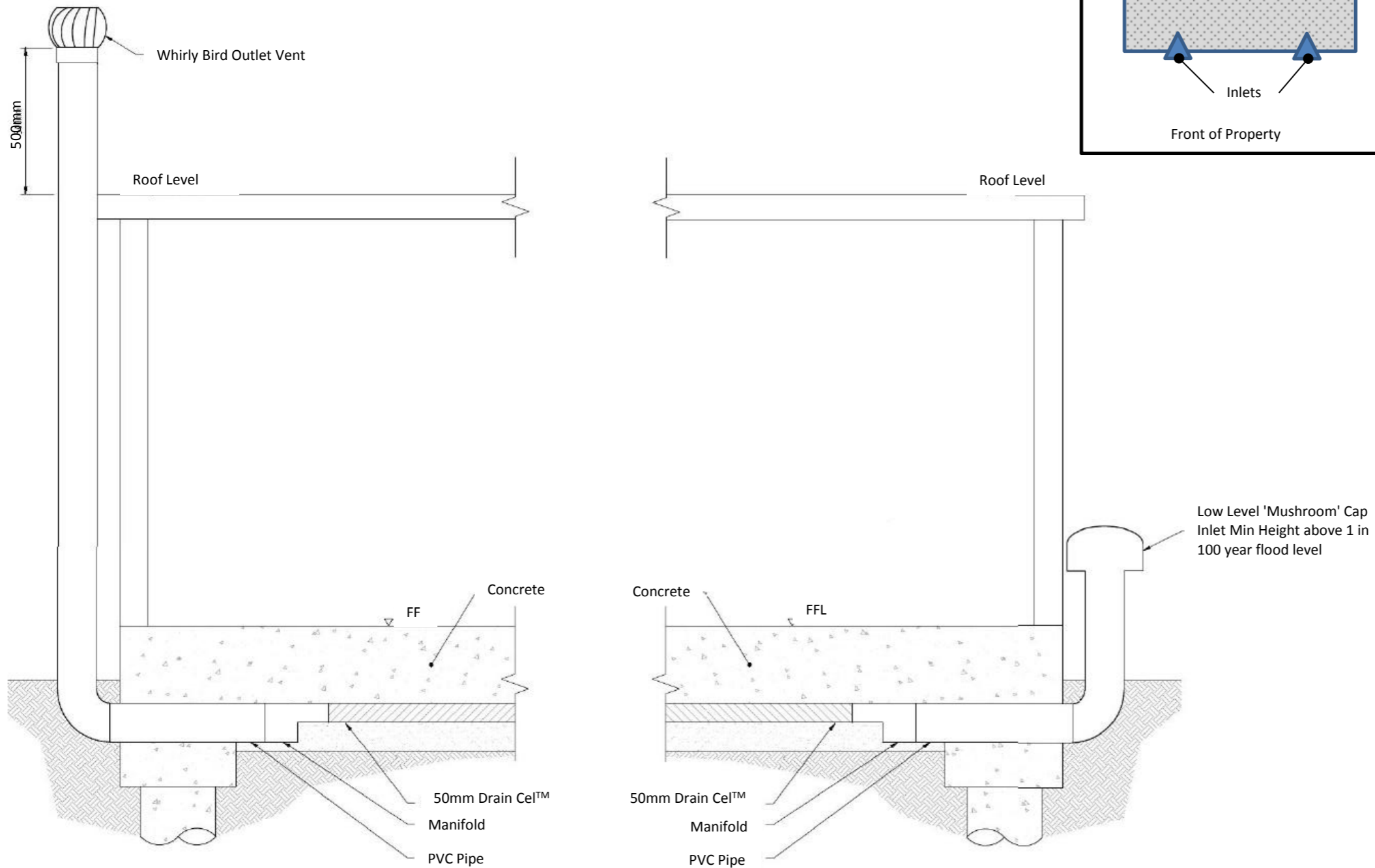
CETCO - Ground Gas Protection Systems



CETCO - Inlet / Out Plan



CETCO - Inlet and Outlet Ventilation Design



Client:
Lot 9002 Longford Road Pty Ltd

Project:
Beaconsfield

Location:
Lot 9002 Longford Road, Beaconsfield

Drawing Title:
Passive Ventilation System using a Drain Cell Product (OPTION B)

Notes:
 Images Technical Drawing Taken from CETCO report. For All drawing please See CETCO report.

OPTION B

Drawn by: MB	Scale: Not to Scale	North
Date: 10/03/2016		
Project No: E2014 - 004	Figure No: 7	Rev: v2