

**GEO- ENVIRONMENTAL BASELINE
CONDITION REPORT**

Proposed Green Energy Facility
Margam Green Energy Plant
Margam

Prepared for:

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SECTION 1 Introduction and Proposed Development

Margam Green Energy Limited are proposing a new Green Energy Facility at Margam Green Energy Plant, Margam, Port Talbot.

Terra Firma (Wales) Limited has been retained by Margam Green Energy Limited, to prepare a Geo-Environmental Baseline Conditions Report (Pre-Operational).

The main objectives of the assessment programme were to:

- Determine the Ground Conditions beneath site using intrusive investigation
- Assess the chemistry of the soil beneath the site, prior to the commencement of the facility, using intrusive investigations and soil chemical testing.
- Determine the Hydro-Geological condition beneath the site via borehole monitoring and geotechnical testing
- Assess the chemistry of the groundwater beneath the site prior to the commencement of the facility

In order to achieve the above objectives, Terra Firma (Wales) Limited carried out an intrusive investigation using boreholes to collect soil samples, collect groundwater samples and allow long-term groundwater monitoring.

1.1 Limitations and Exceptions of Investigation

This report has been prepared for the sole internal reliance of Margam Green Energy Limited and their design and construction team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (Wales) Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geo-environmental and geo-technical consultants. Terra Firma (Wales) Limited does not provide legal advice and the advice of lawyers may also be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

SECTION 2 Setting and Ground Investigation

2.1 Physical Setting

The site locates to the south of the new Harbour Road, Margam at an approximate National Grid Reference of 278968, 186383. It occupies an approximate plan area of 2.86 hectares. The location of the site is presented in **Figure 2.1**.



Figure 2.1: Site Location (NTS)

2.2 Ground Investigation

2.2.1 General

Between 5th July 2017 and 11th July 2017 Terra Firma Wales Ltd installed five wells around the perimeter of the site as agreed with Natural Resources Wales in July 2017. Boreholes were extended to depths of between 8.80m and 10.00m and all boreholes were fitted with wells extending into the gravel aquifer located beneath the site. Borehole logs are presented in **Annex A**.

The development site located on raised ground and all locations encountered made ground, ranging between 2.50m and 5.00m thickness. A peat horizon was encountered in the east and south of the site in BH02 – BH05. The gravel aquifer was encountered in all boreholes at depths of between 3.50m and 5.00m bgl.

During drilling groundwater in BH01 was noted as being malodorous with a green discolouration. This is discussed further in Section 2.3.2.

2.2.2 Well Construction

50mm Groundwater Monitoring Wells were installed in all boreholes. Given the presence of malodorous water within BH01 a shallow well was installed within the made ground in addition to the deep well to allow the aquifer to be monitored as shallow and deep levels to determine if the cause of the malodour exists throughout the aquifer.

Detailed of the well installations are presented in **Table 2.1**.

| Table 2.1. Summary of Well Installations | | | |
|--|----------------|-------------------------------|-----------------------------------|
| Borehole I.D. | NGR | Well Elevation (m. a.o.d.) | Dept of Response Zones (m bgl) |
| BH01 (Deep) | 278999, 186462 | 6.820 | 5.80 – 8.80 |
| BH01 (Shallow) | | 6.768 | 1.00 – 3.80 |
| BH02 | 278863, 186373 | 6.077 | 5.00 – 10.00 |
| BH03 | 278867, 186350 | 6.000 | 4.50 – 9.70 |
| BH04 | 278873, 186314 | 6.237 | 4.50 – 9.00 |
| BH05 | 279000, 186325 | 6.730 | 4.00 – 9.00 |

2.2.3 Groundwater Monitoring and Flow

On 2nd August 2017 a round of groundwater monitoring was performed. The results of the monitoring are summarised in **Table 2.2**.

| Table 2.2. Summary of Groundwater Monitoring 02/08/2017 | | | |
|--|-------------------------------------|------------------------------|--------------------------------------|
| Borehole | Elevation (m AOD) | Groundwater Depth (m) | Groundwater Elevation (m AOD) |
| BH01 (Shallow) | 6.768 | 2.27 | 4.50 |
| BH01 (Deep) | 6.820 | 2.32 | 4.50 |
| BH02 | 6.077 | 2.50 | 3.58 |
| BH03 | 6.000 | 2.39 | 3.61 |
| BH04 | 6.237 | 2.57 | 3.67 |
| BH05 | Borehole Inaccessible on 02/08/2017 | | |

The monitoring data suggests a flow in a roughly westerly direction as shown in **Figure 2.2**.

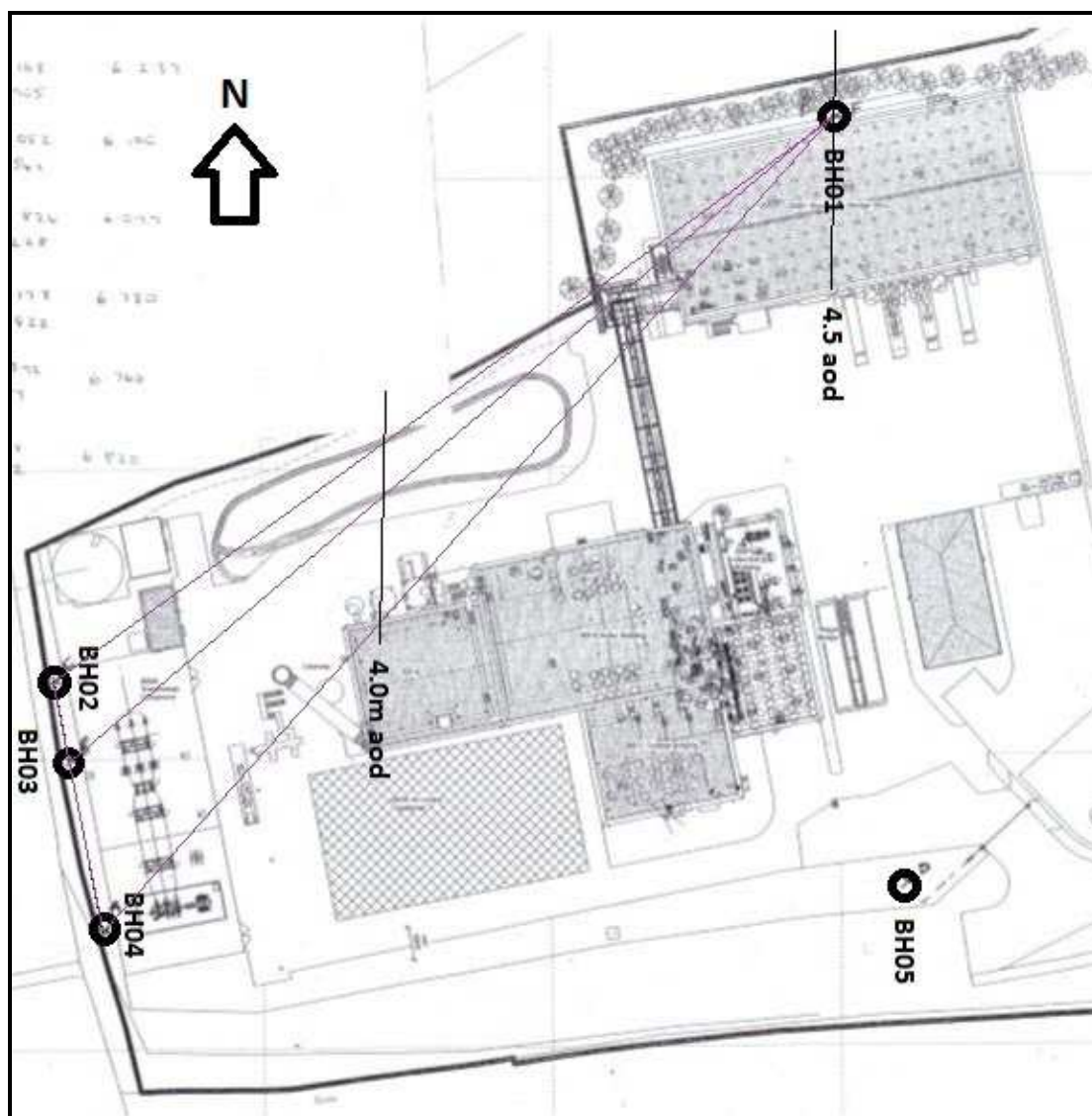


Figure 2.2. Borehole Locations and Groundwater Flow

BH05 was inaccessible during the monitoring due to on-site operations.

2.3.2 Groundwater Chemical Testing

On 26th July 2017 Terra Firma Wales Ltd undertook a round of groundwater monitoring. Each well was purged three times its calculated volume before sampling. Samples were immediately submitted to the MCERTS and UKAS Accredited laboratories of Concept Life Science.

The results of the groundwater chemical testing are presented in **Annex B** and summarised in **Table 2.4** along with the corresponding Environmental Quality Standards (EQS) and Drinking Water Standards (DWS).

2.3.2 Groundwater Chemical Testing (Continued)

| Concept Reference | | Freshwater EQS | Saltwater EQS | DWS | | 671805 001 | 671805 002 | 671805 003 | 671805 004 | 671805 005 | 671805 006 |
|--|--------|----------------|---------------|-------|----------|------------|------------|------------|------------|------------|------------|
| Customer Sample Reference | | | | | Date Sam | BH01 D | BH01 S | BH02 | BH03 | BH04 | BH05 |
| | | | | | Units | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 |
| Determinand | | | | | | | | | | | |
| As (Dissolved) | | 0.05 | 0.025 | 0.01 | mg/l | 0.0045 | 0.0038 | 0.0022 | 0.0019 | 0.0025 | 0.0007 |
| Cd (Dissolved) | | 0.00015 | 0.0009 | 0.005 | mg/l | 0.00003 | <0.00010 | <0.00002 | <0.00002 | <0.00002 | 0.00006 |
| Cr (Dissolved) | | | | | mg/l | <0.001 | <0.005 | <0.001 | <0.001 | <0.001 | <0.001 |
| Chromium (trivalent) | | | | | mg/l | <0.030 | <0.030 | <0.003 | <0.003 | <0.003 | <0.003 |
| Chromium VI | | 0.0034 | 0.0006 | | mg/l | <0.030 | <0.030 | <0.003 | <0.003 | <0.003 | <0.003 |
| Cu (Dissolved) | | 0.001 | 0.0215 | 2 | mg/l | <0.0005 | <0.0025 | <0.0005 | 0.0016 | 0.0023 | 0.0012 |
| Pb (Dissolved) | | 0.0012 | 0.014 | 0.01 | mg/l | <0.0003 | <0.0015 | <0.0003 | 0.0007 | <0.0003 | 0.0029 |
| Hg (Dissolved) | | 0.00005 | 0.00007 | 0.001 | mg/l | 0.00008 | <0.00025 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Ni (Dissolved) | | 0.004 | 0.034 | 0.02 | mg/l | 0.014 | 0.025 | 0.002 | 0.002 | 0.003 | 0.004 |
| Se (Dissolved) | | | | | mg/l | 0.021 | 0.028 | 0.0012 | 0.0007 | 0.015 | 0.0015 |
| Zn (Dissolved) | | 0.0137 | 0.007 | 5 | mg/l | 0.007 | 0.019 | <0.002 | <0.002 | 0.002 | 0.014 |
| pH | | | | | | 12 | 12 | 7.4 | 7.7 | 8 | 6.8 |
| Cyanide (Total) | | 0.01 | | | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Sulphate | | | | | mg/l | 180 | 82 | 470 | 100 | 320 | 92 |
| Sulphide | | | | | mg/l | 340 | 90 | 8 | <0.05 | <0.05 | <0.05 |
| Electrical Conductivity | | | | | uS/cm | 2400 | 2800 | 1300 | 730 | 950 | 780 |
| Biochemical Oxygen Demand (Allyl Thiourea) | | | | | mg/l | 23 | 313 | 18 | 7 | 8 | 6 |
| Chemical Oxygen Demand | | | | | mg/l | 1100 | 1400 | 20 | <20 | 26 | <20 |
| Calcium | | | | | mg/l | 360 | 380 | 120 | 94 | 76 | 87 |
| Total Hardness expressed as CaCO3 | | | | | mg/l | 910 | 970 | 400 | 340 | 240 | 300 |
| Ammoniacal nitrogen | | | | | mg/l | 5.2 | 2.9 | 1.8 | 0.07 | 0.11 | 0.07 |
| Chloride | | | | | mg/l | 950 | 1400 | 50 | 46 | 20 | 66 |
| TPH (C10-C40) | | | | | ug/l | 140 | 240 | 70 | 150 | 80 | 20 |
| TPH (C5-C6 aliphatic) | | | | | mg/l | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| TPH (C6-C8 aliphatic) | | | | | mg/l | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| TPH (C8-C10 aliphatic) | | | | | mg/l | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| TPH (C10-C12 aliphatic) | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| TPH (C12-C16 aliphatic) | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| TPH (C16-C21 aliphatic) | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| TPH (C21-C35 aliphatic) | | | | | mg/l | <0.01 | <0.01 | <0.01 | 0.03 | 0.01 | <0.01 |
| TPH (C35-C40 aliphatic) | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| TPH (C6-C7 aromatic) | | | | | mg/l | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| TPH (C7-C8 aromatic) | | | | | mg/l | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| TPH (C8-C10 aromatic) | | | | | mg/l | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| TPH (C10-C12 aromatic) | | | | | mg/l | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| TPH (C12-C16 aromatic) | | | | | mg/l | 0.06 | 0.07 | 0.01 | 0.01 | <0.01 | <0.01 |
| TPH (C16-C21 aromatic) | | | | | mg/l | 0.04 | 0.06 | 0.02 | 0.04 | 0.02 | 0.01 |
| TPH (C21-C35 aromatic) | | | | | mg/l | 0.03 | 0.06 | 0.02 | 0.06 | 0.03 | <0.01 |
| TPH (C35-C40 aromatic) | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Total TPH | | | | 10 | | | | | | | |
| Concept Reference: | | | | | | | | | | | |
| Project Site: | | | | | | | | | | | |
| Customer Reference : | | | | | | | | | | | |
| Water | | | | | | | | | | | |
| PAH and Phenols | | | | | | | | | | | |
| Concept Reference | | | | | | 671805 001 | 671805 002 | 671805 003 | 671805 004 | 671805 005 | 671805 006 |
| Customer Sample Reference | | | | | Date Sam | BH01 D | BH01 S | BH02 | BH03 | BH04 | BH05 |
| | | | | | Units | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 |
| Determinand | | | | | | | | | | | |
| Naphthalene | | | | | ug/l | 0.16 | 0.1 | 0.05 | <0.01 | 0.02 | 0.01 |
| Acenaphthylene | | | | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Acenaphthene | | | | | ug/l | 0.53 | 0.19 | 0.07 | <0.01 | <0.01 | <0.01 |
| Fluorene | | | | | ug/l | 0.14 | 0.04 | 0.03 | <0.01 | <0.01 | <0.01 |
| Phenanthrene | | | | | ug/l | 0.18 | 0.04 | 0.02 | <0.01 | 0.01 | 0.01 |
| Anthracene | | 0.1 | 0.1 | | ug/l | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Fluoranthene | | 0.0063 | 0.12 | | ug/l | 0.03 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Pyrene | | | | | ug/l | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Benzo(a)Anthracene | | | | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Chrysene | | | | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Benzo(b)fluoranthene | | | | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Benzo(k)fluoranthene | | | | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Benzo(a)Pyrene | | 0.00017 | 0.27 | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Indeno(123-cd)Pyrene | | | | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Dibenzo(ah)Anthracene | | | | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Benzo(ghi)Perylene | | | 0.0082 | | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH(total) | | | | | ug/l | 1.1 | 0.38 | 0.17 | <0.01 | 0.03 | 0.02 |
| Catechol | | | | | mg/l | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Cresols | | | | | mg/l | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Naphthols | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Phenol | | | | | mg/l | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Resorcinol | | | | | mg/l | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Trimethyl phenols | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Xylenols | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Total Phenols | | | | | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Concept Reference: | 671805 | | | | | | | | | | |
| Project Site: | Margam | | | | | | | | | | |
| Customer Reference : | 13952 | | | | | | | | | | |
| Water | | | | | | | | | | | |
| BTEX and MTBE | | | | | | | | | | | |
| Concept Reference | | | | | | 671805 001 | 671805 002 | 671805 003 | 671805 004 | 671805 005 | 671805 006 |
| Customer Sample Reference | | | | | Date Sam | BH01 D | BH01 S | BH02 | BH03 | BH04 | BH05 |
| | | | | | Units | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 | 26-Jul-17 |
| Determinand | Method | | | | | | | | | | |
| Benzene | T54 | 10 | | 1 | ug/l | <1 | <1 | <1 | <1 | <1 | <1 |
| Toluene | T54 | 50 | 40 | 700 | ug/l | <1 | <1 | <1 | <1 | <1 | <1 |
| EthylBenzene | T54 | 20 | 20 | 300 | ug/l | <1 | <1 | <1 | <1 | <1 | <1 |
| M/P Xylene | T54 | 30 | 30 | 500 | ug/l | <1 | <1 | <1 | <1 | <1 | <1 |
| O Xylene | T54 | 30 | 30 | 500 | ug/l | <1 | <1 | <1 | <1 | <1 | <1 |
| Methyl tert-Butyl Ether | T54 | | | | ug/l | <1 | <1 | <1 | <1 | <1 | <1 |

Table 2.4. Summary of 1st Round of Groundwater Testing

2.3.2 Groundwater Chemical Testing (Continued)

Groundwater from BH01 was noted as being malodorous during drilling and during sampling. During sampling the water was observed as being discoloured green (Plate 01).



Plate 2.1. Groundwater Samples From BH01, 26/07/2017.

The discolouration and odour were suggestive of eutrophication.

2.3.3 Soil Geotechnical Testing

A sample of the aquifer material was submitted to Geo- Site Testing Laboratories for Particle Size Distribution (PSD) Testing. The testing revealed that the material comprised 89% Gravel, 10% and 1% Silt/Clay. Hazen's equation suggests a permeability in the region of 0.04 ms^{-1} based on the soils D_{10} value.

A porosity of 12.5% was calculated for the aquifer material.

Geotechnical Test Results are presented in **Annex D**.

ANNEX A
Borehole Logs

ANNEX B
Soil Chemical Test
Results

ANNEX C
Groundwater Chemical Test
Results

ANNEX D
Soil Geotechnical Test Result