

CONSULTING EARTH SCIENTISTS

**QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN:
ENVIRONMENTAL MONITORING PROGRAMME
MANGROVE MOUNTAIN LANDFILL
HALLARDS ROAD, CENTRAL MANGROVE, NSW
PREPARED FOR VERDE TERRA PTY LTD
CES DOCUMENT REFERENCE: CES110703-VT-QAQC-CC**

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Date: 30 May 2016

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1) INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) have been commissioned by Verde Terra Pty Ltd (Verde Terra) to undertake an Environmental Monitoring Programme at Mangrove Mountain Landfill, located at Hallards Road, Central Mangrove, NSW (herein referred to as the Site).

The environmental monitoring program includes quarterly and/or yearly sampling and analysis of groundwater and leachate, quarterly monitoring of surface gas and landfill gas accumulation in buildings and monitoring of surface water.

This Quality Assurance/Quality Control (QA/QC) Plan provides an outline of methods and protocols to be adopted by CES in order to provide Verde Terra with quality assured, accurate and useful data to meet the environmental objectives of the monitoring program and the requirements of the NSW Environmental Protection Authority (EPA).

1.1 UPDATES TO THE QA/QC PLAN

This QA/QC Plan will be finalised and issued as a “controlled document”. Revisions will be incorporated into the document as required. Requests for modifications to this Plan should be made in writing to CES. This QA/QC Plan forms a sub-plan under the Landfill Environmental Management Plan (LEMP 2014) (CES document referenced CES110703-VDT-FA dated 14 June 2016).

2) OBJECTIVES AND SCOPE

The principal objectives of this QA/QC Plan are to:

- Ensure good communication between CES and Verde Terra;
- Ensure good communication between CES, the primary analytical laboratory (Envirolab Services Pty Ltd) and secondary analytical laboratory (Australian Laboratory Services Pty Ltd); and
- Document field methods and QA/QC procedures to ensure that appropriate and valid data are collected.

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This QA/QC Plan will guide the project manager, field sampling personnel and analytical laboratory and assist Verde Terra personnel to assess quality control during the monitoring programme. The scope of this Plan includes:

- A sampling and analysis schedule including analytical methods, container and preservation requirements;
- Procedures for groundwater and wet weather monitoring including sample collection, sample storage and handling procedures;
- Procedures for undertaking surface landfill gas monitoring;
- Procedures for undertaking subsurface landfill gas monitoring
- Procedures for field measurements;
- Procedures for documenting field and sampling activities;
- Outline of field and laboratory QA/QC programme; and
- Data Quality Objectives (DQOs) and procedures for data management and reporting.

3) HEALTH AND SAFETY

A site specific Project Safety Plan (PSP) shall be prepared for the monitoring works, a copy of this will be submitted to Verde Terra prior to commencement of the fieldwork.

The field team is to call the CES office on each field day in order to notify the operations manager regarding progress and expected time of departure. Important contact numbers are outlined below:

Contact List		
Title	Name	Contact Number
CES Staff	Duncan Lowe	0407 013 990
	Guillaume Hauvespre	0403 273 626
Verde Terra Pty Ltd	Damian Ryan	0424 165 199
Envirolab Services	Reception	02 9910 6200
Australian Laboratory Services	Reception	02 8784 8555

4) SAMPLING AND ANALYSIS SCHEDULE

The sampling and analysis programme consists of the sampling and analysis of water (groundwater, leachate, surface water) and the monitoring of landfill gas (building gas accumulation, surface gas and sub-surface gas) on a quarterly basis. Wet weather discharge monitoring will be conducted during discharge event from the outlet of the proposed terminal sediment basin. Monitoring locations are presented in Figure 2.

4.1 QUARTERLY MONITORING

4.1.1 Groundwater

- Sampling and analysis of groundwater from 6 existing groundwater monitoring wells (2AS, 2AD, 3AS, 3AD, 6AS, 6AD) as described in Table 1a;
- Sampling and analysis of groundwater from 10 additional groundwater monitoring wells installed in five borehole locations (VDTBH1, VDTBH2, VDTBH3, VDTBH4 and VDTBH5) that will be installed at the site following approval of LEMP 2014.

The final well installation details are to be confirmed based on ground conditions encountered during drilling, however as per the existing monitoring wells at the site, they will comprise a shallow well (S) and a deep well (D) as described in Table 1b.

- Measurement of field observations and measurements including groundwater standing water levels in each well included in the monitoring programme;
- Laboratory analysis in accordance with the quarterly suite of analytes identified in the licence. The analytical suite is provided in Table 5.

4.1.2 Landfill Gas

- Quarterly monitoring of subsurface gas from 12 subsurface gas monitoring wells (2AS, 2AD, 3AS, 3AD, 6AS, 6AD, VDTBH2 (x2 wells (to be installed)), VDTBH3 (x2 wells (to be installed)) and VDTBH1 (x2 wells (to be installed)) as described in Table 3;
- Surface gas survey of landfill gas emissions carried out on a quarterly basis over areas of intermediate and final cover;
- Surface gas survey of landfill gas emissions carried out on a quarterly basis over areas within 250m of subsurface gas well showing exceedance; and
- Building gas accumulation monitoring in and under structures within 250m of the landfill void or subsurface gas well showing exceedance.

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4.1.3 Surface Water

- Quarterly monitoring of the terminal sediment basin and the existing dam located at the north-eastern corner of the golf course as described in Table 2 for the analytical suite provided in Table 5 in order to identify any leachate or sediment impact from the landfill;
- Weekly measurement of the Standing Water Level and Quarterly monitoring of the sedimentation dams located at the north-eastern corner of the landfill as described in Table 2.

4.1.4 Leachate Monitoring

- Monitoring of leachate at the Leachate pond as described in Table 2. These results will be used to assess any leachate impact on groundwater or surface water;
- Laboratory analysis for the same analytical suite as the groundwater analytical suite. The analytical suite is provided in Table 5.

4.1.5 Cut Off Trench Riser Monitoring

- Quarterly monitoring of groundwater at the Cut Off Trench Riser in Table 1b in order to identify any leachate impact in the groundwater;
- Laboratory analysis for leachate indicators (Total Alkalinity, Total Dissolved Solids, Chloride, Sulphate, Nitrate, Nitrite, Ammonia, Total Phosphorus, Cations, Biological Oxygen Demand, Total Organic Carbon).

4.2 WET WEATHER DISCHARGE MONITORING

- Field observations, sampling and analysis of surface water during periods of discharge from the outlet of the proposed terminal sediment basin as described in Table 2;
- Laboratory analysis in accordance with the analytes identified in section 11 of the NSW EPA letter DEC15/527997 dated 23 December 2015 (Standing Water Level, pH, Electrical Conductivity, Total Organic Carbon, Nitrate, Ammonia and Total Suspended Solids). The analytical suite is provided in Table 5.

4.3 ANNUAL MONITORING

The yearly monitoring programme for groundwater will be undertaken as per the quarterly monitoring event with an extended suite of analytes tested on an annual basis. The analytical program for annual monitoring is also outlined in Table 5.

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4.4 MONITORING SCHEDULE

The proposed monitoring schedule for quarterly environmental monitoring at the site will be undertaken as follows:

- Quarter 1 – February;
- Quarter 2 – May;
- Quarter 3 – August; and
- Quarter 4 – November (Monitoring must be completed prior to the 20 November).

The licence anniversary is currently 21 November, therefore, the November monitoring event is the fourth and last sampling event for the monitoring year. The annual reporting period is from 21 November to 20 November.

Discharge monitoring will be undertaken during periods of wet weather discharge from the outlet of the proposed terminal sediment basin (Verde Terra to advise when wet weather is occurring).

4.5 SAMPLING SEQUENCE

The proposed sampling sequence during each monitoring event is provided in Table 6.

4.6 ANALYTICAL SCHEDULE

The analytical schedule, including analytical parameters, laboratory Practical Quantitation Limit (PQL) and methods are presented in Table 5.

4.7 ANALYTICAL LABORATORIES

Two National Association of Testing Authorities (NATA) accredited laboratories are used for the analysis of samples from the site. The primary laboratory, Envirolab Services Pty Ltd, analyses the groundwater and surface water (wet weather sampling) samples. The secondary laboratory, ALS Laboratory Group Pty Ltd analyse the split sample (inter-laboratory duplicate sample) and are a check laboratory to ensure consistency in results.

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5) SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

The addition of preservatives to water samples is required in order to maintain sample integrity. Similarly, containers must be appropriately selected and cleaned to prevent sample contamination. Strict adherence to sample holding times is also necessary in order to ensure that laboratory data are representative of field conditions. Sample preservation, container selection and holding times conform to the requirements of APHA 20th Edition *Standard Methods for the Examination of Water and Wastewater*. Methods generally also conform to AS/NZS 5667.1:1998 for water quality sampling.

Sample bottles used in the monitoring programme shall be colour coded to prevent confusion and incorrect labelling. Groundwater and surface water samples should be placed in a cooler containing ice bricks and/or ice immediately following sample collection,

Sample preservation, containers, colour codes and maximum holding times adopted are listed in Table 7.

6) DOCUMENTATION OF SAMPLING AND FIELD ACTIVITIES

A copy of this QA/QC Plan as well as multiple blank copies of the Chain of Custody (COC) form and Field Data Sheets will be carried into the field. All relevant correspondence, COCs, laboratory reports are to be stored in a dedicated project file. The file is clearly marked with the project code (CES110703-VT). COCs, Sample Acknowledgement Receipt forms, laboratory certificates and field data sheets will be stored electronically within the project directory. Field data sheets and other relevant hard copy information will be stored in separate, clearly marked, dedicated sections of the project file.

Instructions on the use of Field Data Sheets, field notes, sample labels, COCs and laboratory security seals are provided in subsequent sections. Examples of the COCs and Field Data Sheets are provided in Appendix 1.

6.1 SAMPLE IDENTIFICATION

Each sample is to be assigned an identification code as follows: **ddmmyy- INITIALS-##**. For example, the tenth sample collected by technician with initials ‘AB’ on 15 February 2015 shall be assigned the identification ‘150215-AB-10’. Sample details must be recorded in the field on the appropriate Field Data Sheet. Details are to be entered in the EQUIS database upon return to the office.

Sample identifications are to be quoted on COCs and Field Data Sheets.

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6.2 FIELD DATA SHEETS

All field measurements, observations and comments are to be recorded on the respective Field Data Sheets (Appendix 1). Additional notes are to be recorded on separate sheets of paper or on the back of the field data sheets. Separate sheets are to be attached to the Field Data Sheet at the conclusion of field work. Comments on the Field Data Sheet will refer to the attached sheets as appropriate. Page numbers are also employed when multiple sheets are used. Field data sheets are to be completed using permanent blue or black ink.

A summary of the details to be included on the groundwater, surface water, subsurface gas and gas accumulation Field Data Sheets are outlined below.

6.2.1 Groundwater Field Data Sheet

- Project information including client, CES project ID, project, location, sampler, project manager, well ID, sample ID, purge date and sampling date;
- Well status information including the general condition of the well and surrounds and groundwater information including water levels, volumes purged, purging and sample equipment; and
- Purging details including time, volumes and general water chemistry information (DO, EC, pH, Eh, temperature and general comments including odour, colour, clarity etc.).

6.2.2 Surface Water Field Data Sheet

- Project information including client, CES project ID, project, sampler, project manager, and date; and
- Sample location information including dam water levels and surface conditions of the water;
- Sample details including sample ID, site, date, time and general water chemistry information (DO, EC, pH, Eh, temperature, and general comments including flow, odour, colour, clarity etc.).

6.2.3 Subsurface Gas Field Data Sheet

- Project information including client, CES project ID, project, location, sampler, project manager, well ID and monitoring date and time;

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- Well status information including the general condition of the well and surrounds and gas information including ambient air pressures, length and volumes of air columns, formation pressure, venting information and flow rates; and
- Monitoring details including volumes, maximum negative pressure on well, recovery times and landfill gas monitoring results (CH₄, CO₂, O₂).

6.2.4 Surface Gas and Building Accumulation Field Data Sheet

- Project information including client, CES project ID, project name, date, sampler, project manager;
- Weather conditions and general comments;
- Field calibration and instrument details; and
- Sampling information including date, time, co-ordinates (x,y), methane concentrations and local information (odour, wind, leachate).

6.3 SAMPLE LABELLING

Water samples are to be labelled in blue or black indelible ink. Only biros or xylene-free permanent markers are to be used to label samples. Every sample label will include the following elements:

1. Project identification name and/or number
2. Sample identification number unique to the sample (Section 7.1);
3. Date of sample collection; and
4. Field scientist's initials.

Labels are to be covered with clear tape to prevent removal or damage during transit.

Labels that are provided by the analytical laboratory are to be used. For sampling rounds with a large number of bottles, pre-printed CES bottle labels may be affixed to sample bottles in order to minimise time spent in the field labelling bottles.

6.4 CHAIN OF CUSTODY FORMS

The handling of all samples collected must be traceable from the time of collection, through sample transport, analysis and final disposal. This documentation of sample collection and transport history is referred to as a “chain of custody” (COC). The COC records to be maintained for all water and leachate samples are described below.

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A sample is considered under the custody of a particular person if it is:

1. In that persons physical possession;
2. Placed in a secure place by that person;
3. Not recorded to have been transferred to another person or party with proper notation on the COC documents.

Samples will be placed in a cooler containing ice and/or ice bricks immediately following collection. At the conclusion of each field day and prior to delivery to the laboratory, a laboratory custody seal will be placed on each cooler by CES staff. Samples will be collected by a courier for transport to the laboratory. The following details are to be completed on COC forms in indelible blue or black ink:

- CES contact details including project manager and sampler;
- Laboratory address and contact details;
- Date dispatched and date results required (10 working days otherwise notify);
- Number of pages (“Page 1 of 1” when only a single sheet and “Page X of Y” when multiple sheets used);
- CES project identification name and number of sampling round (i.e., Round 1 being the first round);
- Laboratory quote number containing references to required PQLs;
- Account code;
- Released for CES (name and signature);
- List of samples (list by sample ID);
- Date and time of sample collection (twenty four hour clock);
- Matrix;
- Comments (note samples potentially containing hazardous materials);
- Total number of containers for each sample;
- List of analytes, preservation, bottle colour;
- Total number of bottles submitted for analysis; and
- Laboratory representative is to sign and date the COC to document the change of sample custody.

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Samples potentially contaminated with Volatile Organic Compounds (VOCs) should be placed at the end of the COC with blanks listed first such that samples will be analysed in order of increasing levels of contamination.

Laboratory supplied COCs provided in the carbon copy manifest books should be used (where available).

Where possible, COC forms should be faxed/ emailed directly to the laboratory (no cover letter required) prior to pickup in order to expedite the process of sample log in.

Upon arrival at the laboratory the chain of custody will be checked against samples delivered, signed, copied by laboratory staff and emailed to CES together with a laboratory sample receipt acknowledgement. The laboratory will contact CES immediately if discrepancies are noted between the samples listed on the COC and those delivered.

Envirolab will email a signed copy of the COC within 24 hours of receipt along with a sample acknowledgement receipt form. COCs and sample acknowledgement forms will be saved within the project directory.

6.5 CUSTODY SEALS

Custody seals will be used to detect improper handling or interference with samples between sample collection and analysis. Gummed paper seals or custody tape will be used for this purpose. Custody seals are to be attached to coolers such that they must be broken to open the container. Custody seals will be affixed to coolers before the samples are transferred from the custody of the sampling personnel.

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6.6 LABORATORY ANALYSIS REPORTS

The laboratory analysis reporting format shall include the following:

- Date issued;
- Report number;
- Page;
- Client;
- Sample type;
- Date sampled;
- Laboratory numbers;
- Reference;
- Method;
- Results;
- QA Appendices;
- Authorising chemist;
- Copy of signed COC form;
- Date of sample extraction for each test;
- Date of sample analysis for each test;
- Preservation compliance;
- Holding time compliance;
- COC compliance;
- Chromatography calibration data acceptance; and
- Envirolab QA/QC compliance and specific comments with respect to the analysis of each batch of samples.

In addition, the listing of results will include sample location, PQL, units of measurement and analytical details if required.

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7) SAMPLE PACKAGING, HANDLING AND STORAGE

Samples will be placed in coolers containing ice bricks immediately following collection to maintain temperatures at 4°C. At the conclusion of each field day, a laboratory custody seal will be placed on each cooler prior to dispatch. Samples will be collected by a courier for transport to the laboratory.

Volatile Organic Analytes (VOAs) vials are to be packaged in “bubble wrap” or similar packing material in order to avoid damage during transit.

Sample pickup for Envirolab couriers should be booked on 02 9910 6200. Samples for Envirolab are to be transported on Envirolab COC forms.

Sample pickups from Australian Laboratory Services (ALS) should be booked on 02 8784 8555. Samples for ALS are to be transported on ALS COC forms.

Samples will be transported under the respective laboratories COC. The use of COCs is explained in Section 6.4.

8) QUALITY ASSURANCE AND QUALITY CONTROL PROGRAMME

8.1 FIELD QA/QC PROGRAMME

Field QA/QC for quarterly/yearly monitoring events will consist of field duplicates (blind and split samples), a rinsate blank, field blank and a trip blank.

The field QA/QC programme outlined below is consistent with NSW EPA and the relevant procedures outlined in the National Environment Protection Council (NEPC), *National Environment Protection (Assessment of Site Contamination) Measure, 1999 as amended 2013*.

8.1.1 Environmental Samples

Environmental samples are the representative samples of groundwater, leachate or surface water collected for analysis to determine aspects of their chemical composition. Environmental samples are the original sample taken from a particular location and other samples are replicates or triplicates of the original.

8.1.2 Blind Replicates

Blind replicate samples are provided by the collection of two environmental samples from the same location or successively from the same monitoring well. These samples are preserved,

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stored, transported, prepared and analysed in an identical manner. As a minimum, the results of analyses on the blind replicate sample pair are assessed by calculating the Relative Percentage Differences (RPDs) between the results. The RPD is calculated as the difference between the results divided by their mean value and expressed as a percentage. If the RPD exceeds the value adopted for any analytes, additional investigation will be required, or justification provided for not conducting additional investigation.

Blind replicate samples will be collected at a rate of one sample per monitoring event.

8.1.3 Split Samples

Split samples, otherwise known as ‘inter-laboratory duplicates’, provide a check on the analytical proficiency of the laboratories. Split samples are collected from the same location or successively from the same monitoring bore. Split samples are preserved, stored, transported, prepared and analysed in an identical manner to environmental samples. The secondary laboratory where the split samples will be sent to is ALS.

Split samples will be collected at a rate of one per monitoring event.

8.1.4 Field Blanks

Field blank samples are used for projects where the potential for atmospheric contaminant inputs needs to be assessed. Field blanks consist of pre-washed bottles containing distilled or de-ionised water and appropriate preservatives will be supplied by the analytical laboratory. These samples reside in transport vessels during sampling activities and are opened once in the field. Field blanks are analysed at the laboratory as regular samples or only for volatile organic compounds.

One field blank is required for each groundwater monitoring round.

8.1.5 Trip Blanks

Trip blanks consisting of pre-washed bottles containing distilled or de-ionised water and appropriate preservatives will be supplied by the analytical laboratory. The role of trip blanks is to detect potential contamination during sample transport. These samples reside in transport vessels during sampling activities and are not opened in the field. Trip blanks are analysed at the laboratory as regular samples or only for volatile organic compounds, as deemed appropriate.

One trip blank is required for the annual groundwater monitoring round.

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8.1.6 Rinsate (Equipment) Blanks

Rinsate blanks consist of pre-preserved bottles filled with laboratory-prepared water that is passed through decontaminated field equipment. Rinsate blanks will be prepared on site, exposed to the atmosphere and rinsed through decontaminated field equipment. These samples assess the efficacy of decontamination procedures.

Rinsate samples are to consist of the required complement of sample bottles labelled with a unique CES sample identification number. Rinsate blanks are to be prepared by pouring blank, laboratory supplied, rinsate water through or over the sampling equipment after the final cleaning rinse. Rinsate blanks are to be transported and analysed at the laboratory as regular samples.

For inorganic compounds and semi-volatile organic compounds (SVOCs), rinsate water must consist of milli-Q water (distilled tap water passed through a resin de-ioniser). This water is unsuitable for the analysis of volatile organic compounds (VOC) due to the inclusion of volatiles in the milli-Q water. Only purged water is to be used for volatiles (VOC) rinsate blanks. This water is produced at the laboratory by purging spring water that has not been adulterated by VOCs as with tap water. Purged water is unsuitable for the production of rinsate samples for inorganics and SVOCs due to the presence of trace levels of inorganic compounds.

One rinsate blank is required for each monitoring round.

8.2 LABORATORY QA/QC PROGRAMME

The reliability of test results from the analytical laboratories will be monitored according to the QA/QC procedures used by the National Association of Testing Authorities (NATA) accredited laboratory. The QA/QC programme employed by the NATA registered laboratory specifies sample tracking procedures, methods of extraction, analysis, PQLs and acceptance criteria for results. Laboratory QA/QC procedures adopted by Envirolab are summarised below. The laboratory QA/QC programme outlined below is consistent with NSW EPA and NEPC requirements.

8.2.1 Laboratory Duplicate Samples

Laboratory duplicates provide data on analytical precision for each batch of samples. Where required and in order to provide sufficient sample for analysis of laboratory duplicate, two batches of samples will be collected listed on the COC. This is done in order to ensure that sufficient sample is collected. Duplicate analyses are conducted on separate extractions in each instance.

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8.2.2 Standards

Calibration standards are prepared from individual certified materials, AR Grade or better reagents purchased as certified mixtures. Stock solutions are replaced every 6 months. Working standards are prepared at least every month from the stock solutions.

8.2.3 Laboratory Control Samples

Laboratory control samples consist of a clean matrix (de-ionised water or clean sand) spiked with a known concentration of the analyte being measured. These samples monitor method recovery in clean samples and can also be used to evaluate matrix interference by comparison with matrix spikes. Laboratory control samples may be certified reference materials.

8.2.4 Surrogates

For target organic analytes, a surrogate is added at the extraction stage for every sample in order to verify method effectiveness. The surrogate is then analysed and reported as a percentage recovery with every sample.

8.2.5 Matrix Spike

A matrix spikes consist of samples spiked with a known concentration of the analyte being measured, in order to identify properties of the matrix that may hinder method effectiveness. Samples are spiked with concentrations equivalent to 5 to 10 times the PQL. Percent recovery is calculated and reported.

8.2.6 Method Blanks

Method blanks (de-ionised water or clear sand) are carried through all stages of sample preparation and analysis at a rate of 1 per batch or 1 per day. Analyte concentrations in blanks should be less than the stated PQL. Reagent blanks are run if the method blank exceeds the PQL. The purpose of method blanks is to detect laboratory contamination.

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9) GROUNDWATER MONITORING SAMPLING METHODS

Sampling methods for the groundwater monitoring programme are presented below. Samples are to be analysed according to the schedule outlined in Table 5.

9.1 WELL IDENTIFICATION

Groundwater bores should be labelled with identification details marked on the protective casing or an aluminium sign beside the well. This may not be possible for wells with gatic covers.

9.2 PURGING MONITORING WELLS

9.2.1 Pre-Purging Procedure

The condition of each well is to be assessed prior to purging and sampling. Conditions of the well and surrounding area will be recorded on a Groundwater Field Data Sheet for each monitoring well.

The CES project manager must be notified of any damage to monitoring wells. The project manager must notify Verde Terra in writing of any damage to monitoring wells. Damage to wells should also be noted in monitoring reports.

Prior to purging a clean work space will be prepared. The work space will be used to lay out decontaminated purging and sampling equipment in a manner that prevents contamination of wells from external sources.

9.2.1.1 Purging Procedures

Purging of bores is required prior to sampling in order to remove standing or stagnant water in the well and to ensure that samples are representative of the groundwater in the water-bearing stratum. Purging will be performed with a suitable purging technique (e.g. Grundfos, bladder pump, bailer or foot valve).

Standing Water Level (SWL) refers to the depth to the water level in non-artesian bores, as measured from the top of the PVC casing. SWL will be measured using a decontaminated water level indicator (dip meter). Decontamination procedures are outlined in Section 6.5.3. This reading, along with borehole and well dimensions obtained from construction details will then be used to estimate the bore and purging volumes. For the purpose of this procedure, a bore volume is defined as the volume of water enclosed within the cross-sectional area of the full bore hole (corrected for solids volume in the packing material) down the length of the screened section of the water column beneath the bentonite (or other) seal. Typically, the volume of water held in the

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sand filter pack in the bore annulus is approximately 30-40% the total annual volume around the screen.

Purging volumes required to obtain representative samples vary depending on the purging method and hydrogeological conditions experienced. The following guidance is provided for purging non-artesian bores:

- All bores will be sampled within 24 hours of being purged;
- If a bore has not been sampled within 24 hours of purging, re-purging of the bore will be performed;
- Due to the relatively slow rate of groundwater recharge in the groundwater wells at the site, CES consider that groundwater wells can be purged until dry;
- The total volume purged from each well and time taken is to be recorded on the Groundwater Field Data Sheet.

9.3 GROUNDWATER SAMPLE COLLECTION

Groundwater samples will be collected using bailers made of suitable material. Bottles are to be filled until they develop a convex meniscus, capped tightly, checked to ensure no air bubbles have been trapped and placed in a cooler filled with ice bricks for transport. Bottles should be filled in order of most to least volatile analytes.

Discharging bailers into sample containers will be carried out with minimum disturbance to the sample by:

- Regulating flow slowly through the check valve (bottom-emptying device);
- Minimising the distance between the bailer and sampler container; and
- Tilting the container so that discharge flows gently down the inner walls of the container.

Sampling and purging equipment will be decontaminated according to procedures outlined in Section 15.

Sample labelling and documentation procedures outlined in Section 6 must be adhered to at all times. Bore purging and sampling activities are to be documented on a Groundwater Field Data Sheet.

All groundwater analysis for metals is to be undertaken as dissolved analysis. Where required, field filtration will be conducted in accordance with section 9.3.1 below.

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9.3.1 Field Filtration Procedure

Field filtration is generally required for groundwater samples at the annual monitoring event prior to preservation and analysis. However, project specific requirements regarding filtration should be confirmed prior to the execution of fieldwork. Where required, field filtration of groundwater samples involves the following steps:

1. Collect sample in a preservative free, spare sample bottle;
2. Rinse new, plastic syringe with sample;
3. Open appropriately preserved sample bottle and place on stable surface and place filter on top;
4. Extract water from the spare sample bottle with the syringe and fit syringe to top of filter. Expel water through the filter, into the appropriately preserved sample bottle;
6. Replace filters as they become clogged;
8. Discard filters and syringe in clearly-marked “WASTE” receptacle; and
9. Place sample in cooler filled with ice-bricks for transport to the laboratory.

Note:

1. Disposable membrane filter disks (0.45 µm) are generally used;
2. For very turbid samples the use of disposable filter cartridges may be used in preference to membrane filter disks. Be sure to check pore size on filter cartridges. If larger than specified, a 0.45 µm filter disk should be attached to the end of the cartridge.

9.4 GROUNDWATER DISPOSAL PROCEDURE

Based on the analytical results of groundwater sampled from each well during the previous monitoring round, groundwater will be disposed of as follows:

- If water is not significantly contaminated in excess of ANZECC (2000) guideline values for the protection of aquatic ecosystems, water removed from the well will be discharged on the ground, down gradient of the well and away from surface-water monitoring points;
- If water is significantly contaminated, groundwater removed from the bore will be stored in drums placed near the monitoring well by CES. For safety reasons, these drums must be marked with a “WASTE WATER” label. This water will need to be disposed of appropriately by CES subject to prior arrangements; or
- If the site has not been sampled previously, visual and olfactory means should be used to identify contaminated water. If in doubt, water should be drummed on site pending the receipt of analytical results.

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10) SURFACE WATER AND LEACHATE SAMPLING METHOD

The following procedure provides a guide to surface-water and leachate sampling methods. Standard sample, handling, documentation, labelling and transport procedures outlined in Section 5, 6 and 7 of this QA/QC Plan must be adhered to at all times. Surface-water and leachate samples are to be collected directly into each bottle according to the following procedures:

- Label sample bottles according to procedures outlined previously;
- Note colour, odour, algal growths or debris and weather conditions on the Field Data Sheet ;
- Don new pair of un-powdered latex gloves;
- The wet weather discharge sample is to be collected from the outlet of the proposed terminal sediment basin, as illustrated on Figure 2, not from within the sediment dam.
- Submerge a decontaminated, pre-preserved sample bottle to the desired sampling depth. Samples to be collected at approximately 2 cm depth;
- Tilt the bottle upwards at an angle of approximately 45°, remove the lid and allow the bottle to fill completely;
- Exclude air bubbles from the sample by tilting gently for glass bottles or, in the case of plastic bottles, by squeezing and releasing gently;
- Replace the lid with a convex meniscus (zero headspace unless headspace analysis required).
- Repeat this procedure until the required complement of sample bottles has been collected. Fill bottles in order from most volatile to least volatile parameters;
- Measure field parameters by immersing electrodes directly into the channel without the use of an intermediary transfer vessel (where possible);
- Place samples in a cooler containing ice and/or ice bricks for transport to the laboratory at 4°C (Section 6); and
- Decontaminate equipment according to procedures outlined in section 15.

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11) SURFACE LANDFILL GAS MONITORING METHOD

Gas emissions from the landfill will be monitored on a quarterly basis at the surface of the landfill and as accumulation in buildings within 250 m. A summary of the building accumulation sampling locations are provided in Table 4.

Quarterly monitoring will be undertaken at the start of each month. As previously mentioned the licence anniversary date for this site is currently 20 November, therefore the November monitoring event is the last event for the monitoring year.

11.1 DOCUMENTATION OF MONITORING AND FIELD ACTIVITIES

The following information is to be recorded at the time of each monitoring event:

- Project information including client, CES project ID, project, date, sampler, project manager;
- Weather conditions and general comments;
- Field calibration and instrument details;
- Grid details and datum; and
- Sampling information including date, time, co-ordinates (x, y), methane concentrations and location information (odour, wind, and leachate).

11.2 LANDFILL SURFACE GAS SURVEY

Landfill gas monitoring is undertaken to detect gas emissions and migration from the Site. Procedures for gas monitoring are based on NSW EPA (1996) *Environmental Guidelines: Solid Waste Landfills* and are outlined in the following sections.

Surface gas monitoring should demonstrate that cover material is controlling the emission of landfill gas into the atmosphere. The following procedure is to be followed for surface gas monitoring at landfill sites:

Monitoring will be performed on calm days with wind speeds below 10 km hr⁻¹. The Australian Government Bureau of Meteorology website shall be referred to for latest weather observations including wind speeds.

11.2.1 Equipment required

- A calibrated Flame Ionisation Detector (FID);
- 2 metre wand;

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- A calibrated Landfill Gas Analyser (LGA);
- Hand held Global Positioning System (GPS) unit;
- Data logger system, including the logger support;
- Field data sheets; and
- Personal Protective Equipment (PPE) kit.

11.2.2 Equipment preparation

- Start the FID and attach the 2 metre wand (refer to FID procedure QWP F023);
- Start the GPS unit; and
- Record the start time of the marking process.

11.2.3 Surface gas monitoring field work

- The FID and GPS unit are set and ready to go, the field technician is to undertake the field work;
- Field technician to walk parallel transect lines, on approximately 25 m spacing or other appropriate interval;
- Combustible Volatile Organic Compounds (VOC) concentrations (measured as methane equivalents) are measured in the atmosphere 5 cm above the ground surface in areas with intermediate or final cover where waste has been placed;
- Measurements of combustible VOC concentrations (measured as methane equivalents) are required at depressions and surface fissures in the cover material and at leachate and auxiliary risers;
- If the field technician encounters an area with readings above the EPA NSW (1996) threshold for further investigation of 500 ppm, the field technician is to walk in concentric circles at 1 metre intervals centred on the elevated readings until the measurements of VOC concentrations (measured as methane equivalents) are less than 500 ppm while marking the location on the map using the GPS;
- Measurements of combustible VOC concentrations using the FID (measured as methane equivalents) are required at and around leachate and auxiliary risers. The measurements are to be recorded on the form entitled “QWP F013 Landfill Gas Survey Field Data Sheet” associated with this procedure;
- Weather conditions and other comments are also to be recorded on the form entitled “QWP F013 Landfill Gas Survey Field Data Sheet”;

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- Due to safety reasons, the field technician is not to undertake methane concentration measurements in the areas of truck movement and active tipping.

Surface gas monitoring is to be conducted using an FID calibrated at low range (less than 5000 ppm) with a zero background and 505 ± 10 ppm methane span gas. For most applications, a PhotoVAC portable FID is to be used for landfill gas monitoring. The FID is capable of measuring combustible VOC concentrations (measured as methane equivalents) between 0.1 and 52 000 ppm. The instrument ‘flames out’ at 52 000 ppm (5.2% methane v/v) and will need to be turned on again.

It should also be noted that the FID is a non-specific detector. As such, the instrument measures concentrations of total combustible gases in air reported as methane equivalents. Response factors for different compounds may be used if compounds other than methane are the dominant combustible gases at a given location. For instruction on calibration of the PhotoVAC portable FID, please follow QWP-F023.

To quantify combustible gas concentrations above the Lower Explosive Limit (LEL) for methane (5% v/v), it will be necessary to utilise an infrared Landfill Gas Analyser (LGA). The BM2K – E000H₂S Biogas LGA measures the percentage of methane, carbon dioxide and oxygen in the air around the leachate risers where landfill gas concentrations exceed the low range of the FID. The LGA is calibrated using oxygen (0.0 % and 17.0 %), methane (0.0 %, 2.5 % and 50.0 %) and carbon dioxide (10.0 %) span gases. For instruction on calibration of the LGA, please follow QWP-F024.

In accordance with EPA NSW (1996) *Solid Waste Landfill Guidelines*, the threshold concentration for further investigation and potential action is 500 ppm (v/v) of methane at any point on the landfill surface. Corrective action is necessary if this threshold is exceeded. This action may involve repairing or replacing cover material and/or adjusting or installing gas extraction equipment.

It should be noted that instruments are to be calibrated daily prior to use with span gases that have been tested and certified by a NATA laboratory. A check of calibration gases should be conducted at the conclusion of work.

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12) LANDFILL GAS ACCUMULATION MONITORING

Landfill gas is monitored for accumulation in 7 buildings at the site. Details of the building gas accumulation monitoring locations are summarised in Table 4 and illustrated on Figure 4. EPA NSW (1996) guidelines state that landfill gas must not accumulate in buildings and pose a danger of explosion. As part of gas accumulation monitoring programmes, all buildings within a 250 m radius of deposited waste and/or areas identified in the relevant QA/QC as having potential to accumulate methane concentrations of greater than 1.25% (v/v) in the subsurface, should be tested.

The procedure for landfill gas accumulation monitoring is as follows:

- (i) Measure the combustible VOC concentration (measured as methane equivalents) at one point in buildings within a 250 m radius of deposited waste. Measurements are to be also taken under buildings if possible; and
- (ii) If methane concentrations exceeding 1.25% (v/v) are observed in buildings on site, the site manager (or responsible representative) must be notified prior to CES leaving the site and daily testing must be undertaken until ventilation or other control measures are implemented.

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13) SUBSURFACE GAS MONITORING METHOD

Twelve subsurface landfill gas monitoring wells to be monitoring quarterly at the site. Details of the subsurface monitoring locations are provided in Table 3 and the proposed monitoring locations are shown in Figure 12 of LMP 2014, a copy of which is enclosed with this document.

13.1 DOCUMENTATION OF MONITORING AND FIELD ACTIVITIES

13.1.1 Subsurface Gas Field Data Sheet

- Project information including client, CES project ID, project, location, sampler, project manager, well ID and monitoring date and time;
- Well status information including the general condition of the well and surrounds and gas information including ambient air pressures, length and volumes of air columns, formation pressure, venting information and flow rates; and
- Monitoring details including volumes, maximum negative pressure on well, recovery times and landfill gas monitoring results (CH₄, CO₂, O₂, Flame Ionisation Detector (FID) readings and general comments).

13.2 SUBSURFACE LANDFILL GAS MONITORING METHODS

Subsurface landfill gas monitoring will be undertaken using specified landfill gas monitoring wells. Gas monitoring wells should be fitted with special caps designed to fit directly into inlet hoses for monitoring instruments. The use of such caps minimises the potential for gas loss during sampling.

13.2.1 Equipment Required

- A calibrated Landfill Gas Analyser (LGA);
- Pressure and flow gauges;
- Stop watch;
- Field data sheets; and
- Personal Protective Equipment (PPE) kit.

The procedure for monitoring landfill gas wells involves the following stages:

- Initial measurements and observations;
- Purge well by the application of negative pressure (if required); and

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- Gas measurements in well.

13.2.2 Initial Measurements and Observations

The procedure for initial measurements and observations upon arrival at a subsurface landfill gas monitoring well is as follows:

1. Carefully approach the well and open the monument lid or remove the gatic cover. Do not stand directly over the well head as gas pressure may force caps from gas wells with considerable force;
2. Inspect the well, noting: damage; standing water or vegetation around the monument; water between PVC and protective casing; whether the well is locked; whether a vapour cap has been installed on the well; whether the well identification is visible; whether the monument is damaged. Observations and notes should be recorded on the field data sheet;
3. Estimate the air volume in the gas monitoring well (Rule of Thumb: 4.2L/m air in 50mm internal diameter screen with gravel pack inside 110 mm internal diameter borehole);
4. Measure formation pressure (gas pressure in well before venting) using a pressure gauge fitted with a “Quicklock” fitting. Pressure gauges with different pressure ratings are available (2 kPa, 10 kPa, 100 kPa). To prevent damage to the gauges, start by using the highest rated gauge (100 kPa) and work down to the appropriate gauge. Readings taken in this manner provide a measure of the accumulated gas pressure in the formation above atmospheric pressure. Note that the well should not be vented when measuring formation pressure;
5. Connect a “Quicklock” fitting to the well cap and vent gas while taking care not to breathe in the emissions (stand up wind of the well). Depending on the formation pressure, gas monitoring wells will respond to venting in one of the following ways:
 - no response;
 - brief initial vent (typically 1-2 s);
 - long vent (>5 s); or
 - Continuous gas emission.

Record the initial vent behaviour in the “*Subsurface Gas Monitoring Field Data Sheet*”;

6. If the well continuously vents gas when exposed to atmospheric pressure, the flow rate should be periodically measured every 2 – 5 minutes using the gas flow meter until the flow rate stabilises +/-10 %. Flow meters with different flow reading are available (440 L/hr, 3000 L/hr and 10,000 L/hr);

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7. To prevent damage to the LGA, a reusable gas sampling bag should be prepared prior to venting in order to collect vented gas from continuous emissions typically greater than 3000L/hr and/or if the well is discharging water from the monitoring well. Open the bag inlet, connect to tube on the “Quicklock” fitting;
8. Using the LGA, measure the gas concentrations in the well. If a bag sample was collected during venting, then concentrations should be measured from the bag. If the well exhibited no response, brief or long pulse that was insufficient to fill the bag then the LGA should be connected to the well cap with a “Quicklock” fitting to measure concentrations in the well. All concentrations should be recorded on the field data sheet;
9. Measure the formation pressure after the initial vent and record on the field data sheet; and
10. If the well continuously vents gas from the monitoring well when exposed to atmospheric pressure, gas concentrations should be measured every 2 – 5 minutes using a LGA (after the flow rate has been measured) until concentrations stabilise within +/-10 %. The flow rate and gas concentrations should be noted on the subsurface gas monitoring field data sheet.

13.2.3 Purging the well

A specialised compressor unit has been developed for purging headspace from gas monitoring wells. The unit is powered from a 12 volt supply (car cigarette lighter or direct from car/marine/truck battery). Gauges fitted to the unit provide the following data:

- Measurement of initial negative pressure applied to the well; and
- Measurement of the volume of gas extracted from the well.

Operating instructions for purging gas wells are as follows:

1. Attach the inlet hose to the top of the gas well. Make sure the line control valve is closed;
2. Make sure the line control valve to the well is closed. Turn on the pump and allow negative pressure to form in the tank. Pump the tank down to the desired pressure. Note that the pump is NOT operated during sampling. That is, the pump is operated to create negative pressure in the tank, which is then applied to the well;
3. Switch the pump off;
4. Open the line control valve and note the initial negative pressure applied to the well (small gauge);
5. Record the time required for the well pressure to reach atmospheric pressure (recovery time) on the field data sheet;

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6. When the well has recovered to atmospheric pressure (zero reading on gauge), disconnect the negative pressure hose, connect a “Quicklock” cap to the well and measure concentrations using the LGA. Record the volume of gas extracted (volume purged) and the concentrations on the field data sheet; and
7. Repeat the purging and measurement process until concentrations stabilise to within +/- 10% or three well volumes have been purged. Also, record the volume of gas extracted (volume purged) and the concentrations on the field data sheet.

It should be noted that when the line control valve is opened, gas from the well fills the tank. Consequently, depending on the chemical composition of gas in the well, the tank may become filled with explosive, flammable or corrosive gases. Methane is of particular concern in and around landfill sites. When the unit is next turned on to create negative pressure, the gases stored in the tank are vented to the atmosphere. Consequently, under no circumstances should naked flames, ignition sources be present when the unit is in operation.

As a precaution, at the conclusion of sampling at each monitoring point, gas in the tank should be replaced with atmospheric air. This is done by turning on the unit, creating full negative pressure and then opening the line control valve to allow air to enter the tank. If the inlet hose is fitted with a Quicklock fitting, it will be necessary to attach a male fitting (eg, well cap) to allow air to enter the tank.

The following points should be noted:

- Be sure to watch the sample line when applying negative pressure and shut off immediately at the first sign of water entering the tank. If water enters the tank, vent the negative pressure to restore atmospheric pressure, remove the bung from the end of the tank and empty any water. Replace the bung;
- Recovery times of greater than 10 minutes should be considered to be suspect, as the effect of sample train leakages is increased with long recovery times. If recovery times of greater than 10 minutes occur, it is concluded that the formation has a low permeability to gas, the final negative pressure is recorded and no further action taken;
- Start the purging process with the same initial tank pressure (full negative pressure). This causes equal disturbance with respect to the applied pressure change in each well; and
- Before each use, check the sampling train for leaks. This is done by creating negative pressure in the tank, opening the line control valve (with Quicklock fitting at end) and monitoring tank pressure. A leak is present in the sample train if negative pressure in the tank is not monitored and returns to atmospheric pressure.

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14) EQUIPMENT DECONTAMINATION PROCEDURE

All reusable sampling equipment will be decontaminated between sites using the procedure outlined below. Decontamination in the field is not required where dedicated equipment exists for each site (*e.g.* pump tubing, plastic beakers). The procedures for decontamination between sample locations for reusable equipment will be:

- Remove encrusted materials by scraping
- Scrub with phosphate-free detergent solution (Decon 90, Extran, Tepol, Alconox); and
- Rinse with laboratory prepared distilled water.

At the conclusion of each sampling round, sampling equipment is decontaminated by soaking for a minimum of 24 hours in a phosphate-free detergent solution prior to rinsing with potable water. This procedure ensures that equipment is thoroughly cleaned prior to the commencement of each sampling job.

15) FIELD WATER-QUALITY MEASUREMENTS

All meters are to be calibrated against fresh, known standards according to manufacturer's instructions prior to sampling. Records of calibration are to be recorded in Calibration Record Sheets contained in the Calibration Book retained at the CES office. The following details are to be recorded in the calibration book:

- Instrument and serial number;
- Date and time;
- Calibrated by; and
- Calibration standards for each parameter.

Results of calibration checks and end of day checks are also to be recorded in the Calibration Book.

The following procedure will be used in taking field measurements:

- Rinse electrodes (pH, temperature, conductivity, DO) in distilled water and dry with tissue paper;
- Place electrodes at the measuring point or in plastic beaker and allow readings to stabilise;
- Measure field parameters in appropriate units according to manufacturers instruction
- Check data acceptance criteria and record observations on the Field Data Sheet;

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- If readings are outside data acceptance criteria, instruments may be checked against known standards;
- Rinse electrodes in distilled water, dry with tissue paper and pack for transport to the next site; and
- Check all instruments against calibration solutions at the conclusion of each field day. Record results in Calibration Book.

It should be noted that:

- Water-quality meters are equipped with automatic temperature compensation. However, as a prudent measure, a check of calibration standards or recalibration should be undertaken if significant changes in ambient temperatures occur during a field day;
- Ensure that aeration and agitation of samples collected for the measurement of DO and Eh is minimised in order to provide representative data; and
- The DO meter should be left on throughout each field day to ensure that the electrode remains polarised for all sites.

16) DATA ACCEPTANCE CRITERIA

16.1 FIELD MEASUREMENTS

Readings for each field water-quality parameter will be compared with data from the previous sampling run (where available). Readings outside the ranges listed below will be re-measured:

- Temperature $\pm 3^{\circ}\text{C}$;
- pH ± 1 unit;
- Eh $\pm 10\%$;
- Turbidity ± 1 NTU;
- Conductivity $\pm 10\%$; and
- DO $\pm 2 \text{ mg L}^{-1}$.

Instrument calibration may also be checked in the field against standard solutions unless there are clear reasons for deviations (e.g. high flow or cease-to-flow conditions). Records of calibration are to be recorded in Calibration Record Sheets contained in the Calibration Book retained at the CES office.

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16.2 ANALYTICAL DATA

Data Acceptance Criteria (DAC) for this project are summarised in Table 8. An investigation will be conducted if results fall outside the QA/QC acceptance criteria. This may include the following steps:

- Check instrument performance;
- Check operator performance;
- Check standard solutions;
- Check sample preparation procedures; and
- Repeat analysis of 5% of samples in the batch.

If the investigation indicates no difference between results then the report will be issued. Affected results will be flagged with the following statement “QC results not within acceptable criteria”. If the problem occurs again, the Laboratory Manager or QA Supervisor must be notified and no further results reported until the problem has been rectified.

16.3 HOLDING TIMES

Analytical results will be qualified in terms of holding times for specific analyses. In the event that holding times are exceeded, results will be flagged with the following statement “Holding times not within acceptable criteria”. Maximum holding times for the specific analytes are contained in Table 7.

17) ASSESSMENT CRITERIA

17.1 WATER

Assessment criteria and/or trigger values for groundwater are not outlined in the licence, therefore groundwater is not assessed against assessment criteria.

Assessment criteria for surface water (wet weather monitoring carried out during a wet weather discharge event), have been outlined in the licence and includes concentration limits for ammonia, pH and total suspended solids. Assessment criteria for surface water are outlined in Table 9.

17.2 LANDFILL GAS

The Solid Waste Landfill Guidelines (EPA NSW, 1996) define a threshold for further investigation of 500 ppm of methane at any point on the landfill surface including areas with

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intermediate or final cover. Corrective action, consisting of repairing or replacing cover material, should be undertaken if this threshold is exceeded.

A threshold of 1.25 % methane (v/v) is defined for monitoring gas accumulation in buildings or structures within 250 m of deposited waste (note that 1.25 % methane (v/v) is equivalent to 25 % of the lower explosive limit or 12,500 ppm). Daily monitoring of buildings is required if this threshold is exceeded until ventilation or other measures to control methane accumulation are implemented.

A threshold of 1.25 % methane (v/v) is defined for monitoring subsurface gas. Detection above 1.25 % methane (v/v) will require notification to the NSW EPA within 24 hours of monitoring.

18) REPORTING TO THE CLIENT

Reporting requirements on this project are as follows:

- Quarterly: A brief report providing an overview of the quarterly water (groundwater, surface water and leachate) monitoring conducted at the site including a review of QA/QC data is to be provided to Verde Terra within 28 days of sampling;
- Quarterly: A brief report providing an overview of the surface gas monitoring conducted at the site is to be provided to Verde Terra within 28 days of monitoring;
- Quarterly: A brief report providing an overview of the subsurface gas monitoring conducted at the site is to be provided to Verde Terra within 28 days of monitoring;
- Annual: An annual report is to be prepared for submission to VT. A draft report is to be submitted to Verde Terra no later than 40 days after the anniversary date. Following acceptance of the draft, 3 final copies are to be provided to Verde Terra (2 hard copy, 1 electronic copy) for submission to the EPA no later than 60 days after the anniversary date (i.e. no later than 15th January); and
- Provision of EPA Annual Return completed with monitoring results to Verde Terra no later than 30 days after the anniversary date, to allow for Verde Terra to complete operational sections and submit to EPA within 60 days of the licence anniversary date.

NOTE: The Anniversary Date for this site is: 21st November.

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19) REFERENCES

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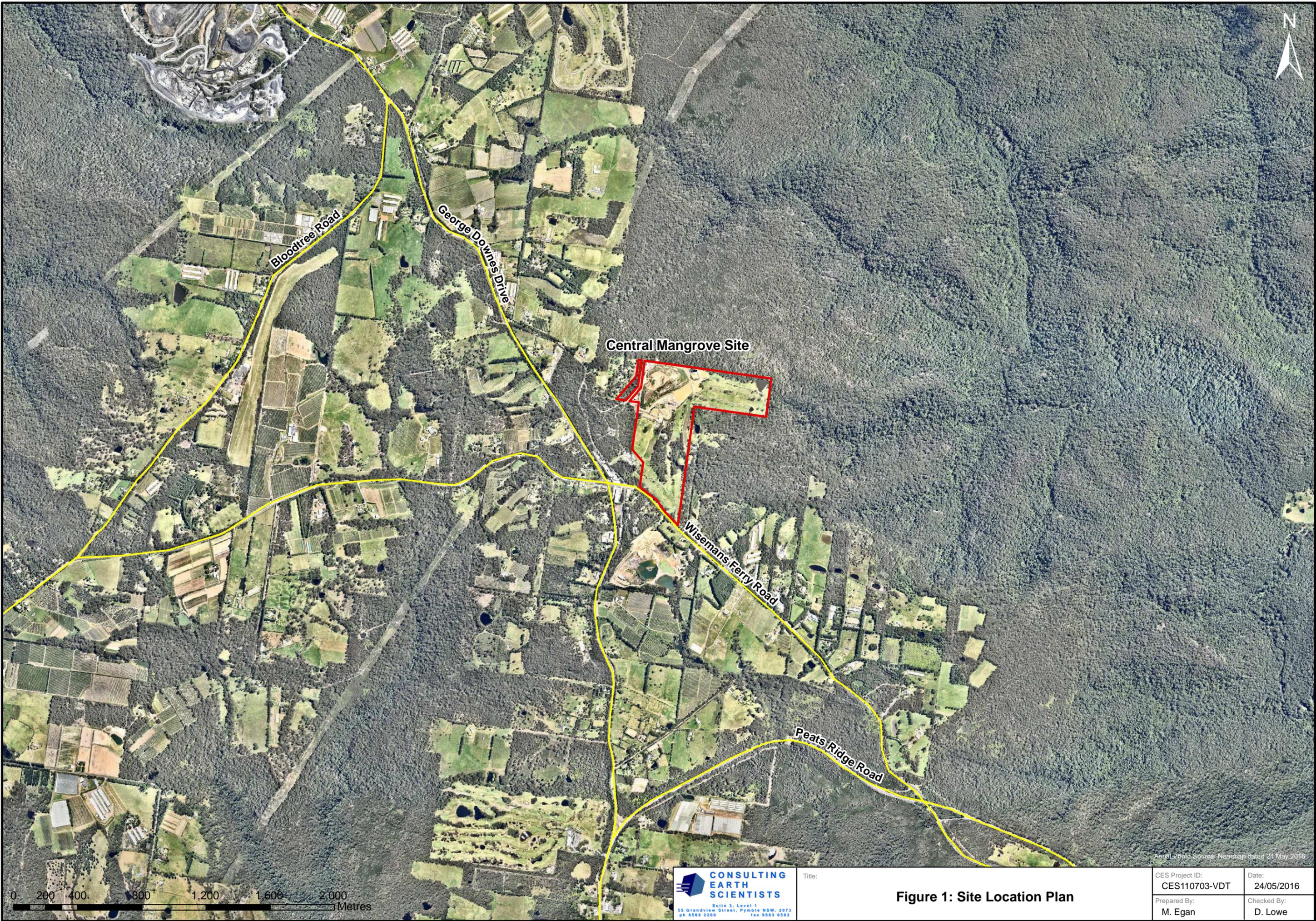
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Aerial Photo Source: Nearmap dated 24 May 2016

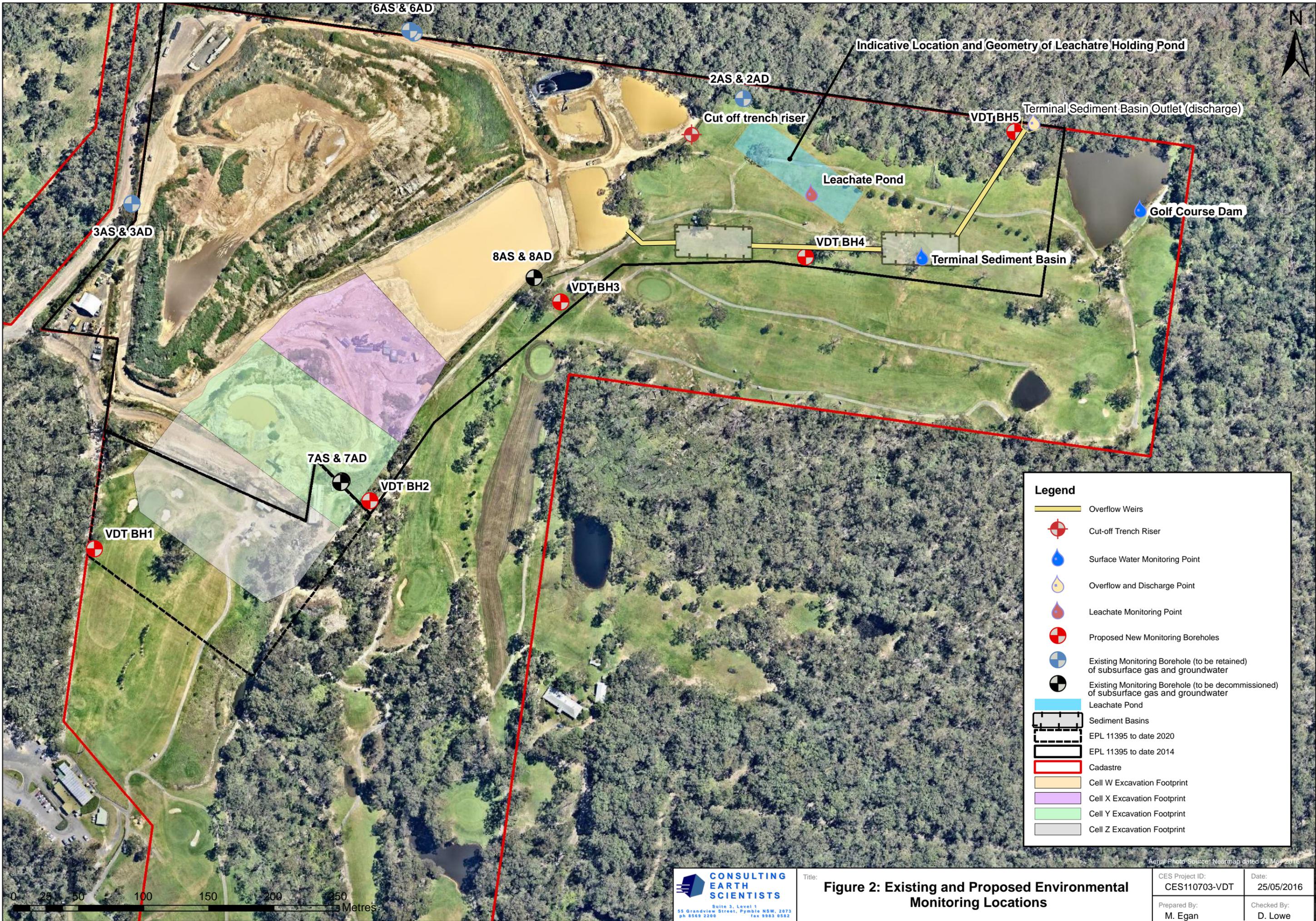
0 200 400 800 1,200 1,600 2,000 Metres

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Figure 1: Site Location Plan

CES Project ID: CES110703-VDT	Date: 24/05/2016
Prepared By: M. Egan	Checked By: D. Lowe



Legend

- Overflow Weirs
- Cut-off Trench Riser
- Surface Water Monitoring Point
- Overflow and Discharge Point
- Leachate Monitoring Point
- Proposed New Monitoring Boreholes
- Existing Monitoring Borehole (to be retained) of subsurface gas and groundwater
- Existing Monitoring Borehole (to be decommissioned) of subsurface gas and groundwater
- Leachate Pond
- Sediment Basins
- EPL 11395 to date 2020
- EPL 11395 to date 2014
- Cadastre
- Cell W Excavation Footprint
- Cell X Excavation Footprint
- Cell Y Excavation Footprint
- Cell Z Excavation Footprint

0 25 50 100 150 200 250 Metres

Tables

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Table 1a: Summary of Groundwater Sampling Locations (Installed)

Well ID¹	Bore depth (m)	Approx. SWL² (m BTOC)	Screened interval (m)	Location Description³
2AS	6.8	4.37	1.2-6.8	Nested wells located on the mid section of the northern site boundary
2AD	15.7	5.55	12.8-15.7	
3AS	6.8	Dry	1.2-6.8	Nested wells located on the northern section of the western site boundary
3AD	38.1	36.5	35.2-.38.06	
6AS	7.2	Dry	1.2-7.2	Nested wells located on the western portion of the northern site boundary
6AD	23.7	18.39	20.9-23.7	

Note 1: Well ID refers to original identification of wells at installation

Note 2: mBTOC = metres below top of casing. Water level measurements were taken on 3 November 2011.

Note 3: Location description given in relation to entire site boundary, not restricted to the active area. Monitoring locations are shown on Figure 2.

Table 1b: Summary of Groundwater Sampling Locations (To Be Installed)

Well ID¹	Bore depth (m)	Approx. SWL² (m BTOC)	Screened interval (m)	Location Description⁴
VDT BH1(S)	To be installed	To be installed	To be installed	South-western portion of the landfill
VDT BH1(D)	To be installed	To be installed	To be installed	South-western portion of the landfill
VDT BH2(S)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 7AS and 7AD
VDT BH2(D)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 7AS and 7AD
VDT BH3(S)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 8AS and 8AD
VDT BH3(D)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 8AS and 8AD
VDT BH4 (S)	To be installed	To be installed	To be installed	South-eastern portion of the landfill in the golf course
VDT BH4(D)	To be installed	To be installed	To be installed	South-eastern portion of the landfill in the golf course
VDT BH5(S)	To be installed	To be installed	To be installed	North-eastern portion of the landfill in the golf course
VDT BH5(D)	To be installed	To be installed	To be installed	North-eastern portion of the landfill in the golf course

Table 2a: Summary of Surface Water and Leachate Monitoring Locations	
Location ID	Location Description
Proposed Terminal Sediment Basin (TSB)	Terminal sediment basin located on the north-eastern corner of the landfill
Golf Course Pond	Surface water monitoring point of the Golf Course Dam located at the north-eastern corner of the golf course
Leachate Pond	Leachate monitoring at the Leachate Pond
Terminal Sediment Basin Outlet	During discharge event, stormwater volume and quality monitoring at the outlet from the terminal sediment basin

Table 2b: Cut off Trench Riser Monitoring Location	
Location ID	Location Description
Cut off Trench Riser	Monitoring of the groundwater at the Cut Off Trench Riser located along the north-western site boundary

Table 3: Summary of Subsurface Gas Monitoring Locations

Well ID¹	Bore depth (m)	Approx. SWL² (m BTOC)	Screened interval (m)	Location Description³
2AS	6.8	4.37	1.2-6.8	Nested wells located on the mid-section of the northern site boundary
2AD	15.7	5.55	12.8-15.7	
3AS	6.8	Dry	1.2-6.8	Nested wells located on the northern section of the western site boundary
3AD	38.1	36.5	35.2-.38.06	
6AS	7.2	Dry	1.2-7.2	Nested wells located on the western portion of the northern site boundary
6AD	23.7	18.39	20.9-23.7	
VDT BH1(S)	To be installed	To be installed	To be installed	South-western portion of the landfill
VDT BH1(D)	To be installed	To be installed	To be installed	South-western portion of the landfill
VDT BH2(S)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 7AS and 7AD
VDT BH2(D)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 7AS and 7AD
VDT BH3(S)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 8AS and 8AD
VDT BH3(D)	To be installed	To be installed	To be installed	Southern portion of the landfill facing 8AS and 8AD
Note 1: Well ID refers to original identification of wells at installation				
Note 2: mBTOC = metres below top of casing. Water level measurements were taken on 3 November 2011.				
Note 3: Location description given in relation to entire site boundary, not restricted to the active area. Monitoring locations are shown on Figure 2.				

Table 4: Building Gas Accumulation Monitoring Locations

Monitoring Location
Weighbridge Office – Inside
Weighbridge Office - Under
Office – Inside
Office – Under
Kitchen- Inside
Kitchen – Under
Toilets – Inside
Toilets – Under
Container (Workshop) – Inside
Container (Workshop) - Under
Container (Storage) – Inside
Container (Storage) – Under
Shed (Storage) – Inside
Shed (Storage) - Under

Table 5: Analytical Program, Parameters, PQLs and Methods

Parameter	Unit	PQL	Method	CMW-GW and CMW-LCH (Quarterly)	CMW-GW and CMW-LCH (Yearly)	Cut off Trench Riser Location	CMW-SW (Surface Water and Wet weather Discharge)
Field Parameters							
Standing Water Level	m	+/- 0.01 mBTOC	Decontaminated dip meter	✓	✓	✓	-
pH	Units	0.1	Field Meter	✓	✓	✓	✓
Electrical Conductivity	uS/cm	1	Field Meter	✓	✓	✓	✓
Dissolved Oxygen (field)	mg L ⁻¹	0.01	Field Meter	✓	✓	✓	-
Redox	MV	+/- 1	Field Meter	✓	✓	✓	-
Temperature	°C	0.1	Field Meter	✓	✓	✓	-
Laboratory Analytical Suite							
pH	Units	0.1	APHA 4500H+	✓	✓	-	✓
Conductivity	µS/cm	1	APHA 2510B	✓	✓	-	-
Chloride	mg L ⁻¹	1	APHA 4110B	✓	✓	✓	-
Sulphate	mg L ⁻¹	1	APHA 4110B	✓	✓	✓	-
Potassium	mg L ⁻¹	0.05	USEPA 200.7	✓	✓	✓	-
Magnesium	mg L ⁻¹	0.05	USEPA 200.7	✓	✓	✓	-
Sodium	mg L ⁻¹	0.05	USEPA 200.7	✓	✓	✓	-
Calcium	mg L ⁻¹	0.05	USEPA 200.7	✓	✓	✓	-
Total Organic Carbon (TOC)	mg L ⁻¹	1	APHA 5310	✓	✓	✓	✓
Fluoride	mg L ⁻¹	0.1	APHA 4500F-C	✓	✓	-	-
Alkalinity (as calcium carbonate)	mg L ⁻¹	1	APHA 2320-B	✓	✓	✓	-
Nitrate	mg L ⁻¹	0.1	EPA353.2	✓	✓	✓	✓
Nitrite	mg L ⁻¹	0.1	EPA353.2	-	-	✓	-
Nitrogen (ammonia)	mg L ⁻¹	0.1	EPA353.2	✓	✓	✓	✓
Iron - dissolved	mg L ⁻¹	0.02	USEPA 200.7	✓	✓	-	-
Manganese - dissolved	mg L ⁻¹	0.01	USEPA 200.7	✓	✓	-	-
Total Phosphorus	mg L ⁻¹	0.05	APHA5530	-	-	✓	-
Total Phenolics	mg L ⁻¹	0.05	APHA5530	✓	✓	-	-
Total Suspended Solids (TSS)	mg L ⁻¹	5	APHA 2540-D	-	✓	-	✓
Total Dissolved Solids (TDS)	mg L ⁻¹	5	APHA 2540-C	-	✓	✓	-
Biological Oxygen Demand	mg L ⁻¹	0.5	APHA 5210B	-	✓	✓	-
Phosphate	mg L ⁻¹	0.05	EPA365.1	-	✓	-	-
Aluminium – dissolved	mg L ⁻¹	0.1	USEPA 200.7	-	✓	-	-
Arsenic - dissolved	mg L ⁻¹	0.05	USEPA 200.7	-	✓	-	-
Barium - dissolved	mg L ⁻¹	0.01	USEPA 200.7	-	✓	-	-
Cadmium - dissolved	mg L ⁻¹	0.01	USEPA 200.7	-	✓	-	-
Cobalt - dissolved	mg L ⁻¹	0.001	USEPA 200.8	-	✓	-	-
Copper - dissolved	mg L ⁻¹	0.001	USEPA 200.8	-	✓	-	-
Lead - dissolved	mg L ⁻¹	0.03	USEPA 200.7	-	✓	-	-
Zinc - dissolved	mg L ⁻¹	0.02	USEPA 200.7	-	✓	-	-
Chromium - total	mg L ⁻¹	0.01	USEPA 200.7	-	✓	-	-
Chromium (hexavalent)	mg L ⁻¹	0.01	USEPA 200.7	-	✓	-	-
Mercury	mg L ⁻¹	0.0004	USEPA 7471A	-	✓	-	-

Table 5 continued: Analytical Program, Parameters, PQLs and Methods

Parameter	Unit	PQL	Method	CMW-GW and CMW-LCH (Quarterly)	CMW-GW and CMW-LCH (Yearly)	Cut off Trench Riser Location	CMW-SW (Surface water and wet weather discharge monitoring locations)
Benzene	mg L ⁻¹	0.001	USEPA 8260, 5030	-	✓	-	-
Toluene	mg L ⁻¹	0.001	USEPA 8260, 5030	-	✓	-	-
Ethyl Benzene	mg L ⁻¹	0.001	USEPA 8260, 5030	-	✓	-	-
Total Petroleum Hydrocarbon	mg L ⁻¹	0.1	USEPA200.7	-	✓	-	-
Polycyclic Aromatic Hydrocarbons	mg L ⁻¹	0.001	USEPA8310,8270	-	✓	-	-
Chlorinated volatile compounds	mg L ⁻¹	various	various	-	✓	-	-
Organochlorine Pesticides	mg L ⁻¹	0.0002	USEPA8081	-	✓	-	-
Organophosphate Pesticides	mg L ⁻¹	0.0002	USEPA8081	-	✓	-	-
PCBs	mg L ⁻¹	0.0002	USEPA8081	-	✓	-	-

Notes:

CMW-LCH: leachate pond location as specified in Table 2a.

CMW-GW: groundwater monitoring locations as specified in Table 1

Cut Off Trench Riser as specified in Table 2b.

CMW-SW: Surface Water as specified in Table 2a:

- Surface water monitoring from the Terminal Sediment Basin and the Golf Course pond; and
- Discharge monitoring from the terminal sediment basin outlet.

Table 6: Proposed Sampling Sequence

Site ID	Task	Comments
Groundwater	Sampling	-
Surface water, leachate and cut off trench riser	Sampling	-
Wet weather monitoring¹	Sampling	Wet weather discharge point from the outlet of Golf Course.
Landfill gas (surface)²	Survey	Surface gas survey conducted at the beginning on the day depending on conditions.
Landfill gas (Building gas accumulation)²	Survey	Surface gas survey conducted at the beginning on the day depending on conditions.
Landfill gas (subsurface)	Purge and sample	All wells to be purged and sampled on first day of monitoring prior to groundwater monitoring.

Note 1: Surface water is only monitored during wet weather discharge events.

Note 2: Surface gas survey is conducted over areas of the site with intermediate or final cover in a 25 meter grid across the site.

Table 7: Sample Preservation, Containers, Colour Codes and Maximum Holding Times.

Sample Type	Analytes	Minimum Volume Required (mL)	Type	Preservative	Colour Code	Field Filtered
CMW-SW (wet weather)	pH, TDS, cations, carbonate, chloride, sulphate, fluoride	500	Plastic	None	Green	No
	TOC, ammonia	250	Plastic	H ₂ SO ₄	Purple	No
CMW-GW and (Quarterly)	pH, TDS, cations, carbonate, chloride, sulphate	500	Plastic	None	Green	No
	TOC, ammonia	250	Plastic	H ₂ SO ₄	Purple	No
CMW-GW and (Yearly)	pH, TDS, cations, carbonate, chloride, sulphate, fluoride, nitrate, nitrite	500	Plastic	None	Green	No
	Metals	150	Plastic	HNO ₃	Red	Yes
	TOC, ammonia, phenolics	250	Plastic	H ₂ SO ₄	Purple	No
	OCP, OPP, TPH, PAH	1,000	Glass	None (acid washed/solvent rinsed)	Orange	No
	TPH C ₆ -C ₉ , BTEX	2 x 40	Glass vial	HCl or NaHSO ₄	Maroon	No

Table 8: QA/QC Data Acceptance Criteria

QA/QC Sample Type	Method of Assessment	Acceptable Range
Field QA/QC		
Split Replicates	<p>The assessment of split replicate is undertaken by calculating the Relative Percent Difference (RPD) of the replicate concentration compared with the original sample concentration. The RPD is defined as:</p> $RPD = 100 \times \frac{ X_1 - X_2 }{\text{Average}}$ <p>Where: X₁ and X₂ are the concentration of the original and replicate samples.</p>	<p>The acceptable range depends upon the levels detected:</p> <ul style="list-style-type: none"> ▪ 0 – 100% RPD (When the average concentration is < 5 times the PQL) ▪ 0 – 75% RPD (When the average concentration is 5 to 10 times the PQL) ▪ 0 – 50% RPD (When the average concentration is > 10 times the PQL)
Blanks (Rinsate, Trip and Field Blanks)	Each blank is analysed as per the original samples.	Analytical Result < PQL
Laboratory QA/QC		
Laboratory Duplicates	Assessment as per Split Replicates.	<p>The acceptable range depends upon the levels detected:</p> <ul style="list-style-type: none"> ▪ 0 – 100% RPD (When the average concentration is < 4 times the PQL) ▪ 0 – 50% RPD (When the average concentration is 4 to 10 times the PQL) ▪ 0 – 30% RPD (When the average concentration is > 10 times the PQL)
Surrogates Matrix Spikes Laboratory Control Samples	<p>Assessment is undertaken by determining the % Recovery of the known spike or addition to the sample.</p> $\% \text{ Recovery} = \frac{C - A}{B} \times 100$ <p>Where: A = Concentration of analyte determined in the original sample; B = Added Concentration; C = Calculated Concentration.</p>	<p>70% - 130% (General Analytes) 50% - 130% (Phenols) 60% - 130% (OP Pesticides)</p> <p>If the result is outside the above ranges, the result must be < 3x Standard Deviation of the Historical Mean (calculated over past 12 months)</p>
Method Blanks	Each blank is analysed as per the original samples.	Analytical Result < PQL
<p>Note: PQL = Laboratory Practical Quantitation Limit (PQL) or the minimum detection limit for a particular analyte.</p>		

Table 9: Wet Weather Discharge Assessment Criteria

Analyte	Units	Assessment criteria concentrations ¹
Ammonia	mg L ⁻¹	0.9
pH	pH units	6.5-8.5
Total suspended solids (TSS)	mg L ⁻¹	50