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Project 92277.02
18 August 2020
R.005.Rev0
GAR

Attention: Daniel Iuliano

Email: daniel.iuliano@macegroup.com

Response to Auditors Interim Advice Report (IA1)
Proposed Upgrade Works
Darlington Public School, 417 Abercrombie Street, Darlington, NSW

1. Introduction and Background

Douglas Partners Pty Ltd (DP) has been commissioned by Mace Australia Pty Ltd (Mace) on behalf of NSW Department of Education (NSW DoE) to provide comments in response to Interim Advice (IA1) prepared for a non-statutory Audit being completed at Darlington Public School, 417 Abercrombie Street, Darlington NSW (hereinafter referred to as the 'site'). The IA1 was provided by NSW EPA accredited Auditor Rebeka Hall (accreditation No.0802) of Zoic Environmental Pty Ltd (Zoic) in the document titled *Interim Advice 1 (IA1) on the review of existing environmental information for Darlington Public School, 417 Abercrombie Street, Darlington NSW* dated 31 July 2020.

DP previously prepared the following documents relevant to the site which were recently reviewed by the Auditor as part of the IA1:

- *Preliminary Site Investigation, Darlington Public School Upgrade, 417 Abercrombie Street, Darlington NSW*, Project 92277.00.R.001.Rev0 ('the PSI'; DP, April 2018);
- *Hazardous Building Materials Assessment, Darlington Public School Upgrade, 417 Abercrombie Street, Darlington NSW*, Project 92277.00.R.003.Rev0 ('the Hazardous Materials Assessment'; DP, April 2018a);
- *Detailed Site Investigation, Darlington Public School Upgrade, 417 Abercrombie Street, Darlington NSW*, Project 92277.01.R.002.Rev0 ('the DSI'; DP, February 2019);
- *Soil Vapour Assessment, Darlington Public School Upgrade, 417 Abercrombie Street, Darlington NSW*, Project 92277.02.R.003.Rev0 ('the SVA'; DP, May 2020); and
- Remediation Action Plan, Darlington Public School Upgrade, 417 Abercrombie Street, Darlington NSW, Project 92277.01.R.001.Rev2 ('the RAP'; DP, June 2020);

The following represent our responses to address the comments made within the IA1.

2. Comments and Response

Auditors Comments	DP Response and Comments
General	
1.	DP has confirmed the current owner of the site and has updated the RAP accordingly.
2.	DP has attached the Sydney water sewer plans to this letter.
3.	Review of historical aerial images indicates that most of the site generally has a history of residential land use and then for use as a school since circa 1975. A large building, that was potentially used for commercial/industrial purposes, was however, historically located in the southern portion of the site and was demolished prior to 1975. Commercial/industrial buildings were also historically located to the northwest and west of the site. Given that the reviewed historical aerial images did not identify any evidence of fire at the site or apparent firefighting activities or operations associated with the production of firefighting foams the potential for use of PFAS at the site is considered low. The origin of the fill at the site has not been able to be established, although potentially sourced from blast furnace activities, and thereby being unknown the presence of PFAS cannot be completely ruled out. The presence of PFAS is however unlikely given that the fill is likely to have been imported to the site prior to the 1950's before substantial PFAS production in Australia. If required DP can complete additional sampling of the fill for laboratory analysis of PFAS. Historical soil samples previously collected at the site during the PSI and DSI are out of holding time and have been disposed of. PFAS sampling could be completed at the time of sampling soil beneath buildings following demolition.
4.	
a)	A discussion of Regional Geology, Soils, Hydrogeology and Hydrology was included in Section 3.4 of both the PSI and the DSI and has now been included in the RAP. Whilst one licenced groundwater bore, registered for domestic use, was identified within 500 m of the site, use of the bore for drinking water purposes is considered unlikely given that the region is serviced by reticulated water and has been for some time.

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Auditors Comments	DP Response and Comments
General	
b)	As presented in Section 3.4 of both the PSI and the DSI, groundwater at the site is expected to follow the overall regional topography and flow to the north towards Lake Northam located within Victoria Park. Bore holes were completed during the PSI to a maximum depth of 2.0 m bgl. No free groundwater was observed in the bores during the drilling for the short time that they were left open.
c) and d)	Groundwater at the site is expected to follow the regional topography and hydrogeology and flow to the north towards Lake Northam located within Victoria Park. Given the low topographic relief of the regional area and the encountered geology underlying the fill at the site is generally silty clay and weathered sandstone which generally have a low permeability, the expected hydraulic conductivity is expected to be similar to the rates commonly encountered within clays and shales of less than 1×10^{-7} metres per second. Based on the geology encountered at the site and DP investigations in nearby areas the aquifer is expected to be either unconfined or semi confined.
e)	Field work for the PSI and DSI were not completed during any significant rain events and therefore ponding areas on site were not observed. There are several stormwater drains within the site and in the nearby streets of Abercrombie and Golden Grove street which are likely to collect surface water runoff.
f)	Preferential water courses are likely the site drains and nearbv drains on Abercrombie and Golden grove streets. It is unclear where the drains lead to.
g)	A review of average climatic data for the nearest Bureau of Meteorology monitoring location (Sydney Observatory #66062) indicates the site is located within the following meteorological setting: • Average minimum temperature varies from 13.9 degrees Celsius in July to 23.1 degrees Celsius in January; • Average maximum temperature varies from 19.9 degrees Celsius in July to 29.6 degrees Celsius in January; • The average annual rainfall is approximately 1211 mm; and • Monthly rainfall varies from an average of 68.1 mm in September to an average of 133.1 mm in June. The wettest period appears to occur between February to June.

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Auditors Comments	DP Response and Comments
General	
h)	A site description has been provided in 3.2 of both the PSI and DSI reports and has been included in the updated RAP. The site description describes the unsealed gardens in different portions of the site and the grassed area in the north eastern portion of Lot 592 DP752049. No observations of distressed or discoloured vegetation were reported within these descriptions. Furthermore, a re-review of photographs taken during the site inspections confirms this.
i)	No significant odours were noted in the bore logs completed during the PSI, DSI and Soil Vapour Assessment.
Site Characterisation DP PSI (2018) and DSI (2019a)	
5.	Section 5.1 of the DSI discusses the adopted sampling methodology and rationale. The third bullet point discusses that deeper fill or natural samples were collected at five locations across the site. Deeper samples (>1.0 mbgl) were generally selected to be analysed at locations where elevated metals, total recoverable hydrocarbons (TRH) or polycyclic aromatic hydrocarbons (PAHs) had been identified in shallower samples. Contaminants of concern were not identified at concentrations exceeding the adopted site assessment criteria (SAC) in any of the deeper samples (>1.0 mbgl) analysed.
6.	Bore holes, rather than test pits, were completed during the PSI and DSI due to the sensitive setting of the site within an operational primary school and with the aim to minimise disturbance to the sites surfaces or disruption to school operations. An amendment to the RAP has been made which includes further investigation requirements to assess % content of ACM and AF/FA in sites soils with reference to Western Australia Department of Health (2009) *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia* (WA DoH, 2009). Further investigation will include the use of test pits to collect samples, where feasible.

Auditors Comments	DP Response and Comments
General	
7.	Given that contaminants of concern were not detected at concentrations exceeding the adopted SAC in all collected deeper fill and natural soil samples the pathway between impacted fill and groundwater at the site was considered to be incomplete and did not warrant further investigation. In addition, the identified contaminants (longer chain TRH, PAHs and metals) are generally considered largely immobile and relatively insoluble. Leachate testing, in the form of toxicity characteristics leaching procedure (TCLP) has been completed on five selected samples for waste classification purposes. Whilst the waste classification report is still to be completed the results of TCLP testing did not identify leachable contaminants at concentrations exceeding laboratory reporting limits in four of the five samples collected. Leachable lead was however identified in one sample (BH105/0.5 concentration 2,500 mg/lkg) at a TCLP concentration of 7.3 mg/L. To further assess the leachability of the fill additional testing may be required in the form of Australian Standard Leaching Procedure (ASLP). Additional leachate testing may be able to be completed with further testing beneath buildings proposed to be demolished.
8.	Given that the site has been used for residential or educational purposes since at least 1975, when the large building appears to have been demolished and removed, the presence of, and records pertaining to, dangerous goods or underground storage tanks (USTs), stored chemicals at the site was considered unlikely. If required DP can apply for a Safe Work NSW dangerous good search and complete a title search for the property.
9.	Whilst the purpose of inter-laboratory testing is to provide a check of the analytical performance of the primary laboratory and the reproducibility of primary laboratory data testing of interlaboratory samples were not considered necessary given that: • Internal laboratory QA/QC procedures including analysis of laboratory prepared blanks and matrix spike were regularly analysed as part of the QA/QC process; and • Intra laboratory duplicate results showed relative data precision for all analytes with the exception of metals chromium, copper and lead which were attributed to the heterogeneity of the fill soil. All QA/QC was considered within acceptable ranges and compliant with DP standard operating procedures

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Auditors Comments	DP Response and Comments
Soil Vapour Assessment	
10.	Both the PSI and DSI conclusions discussed slag and charcoal type material being identified within fill at several locations and that TRH, PAH and lead impact to fill at the site is potentially associated with the historic sourcing of fill from an industrial site with blast furnace activities. Given that no other potential sources of contamination have been identified at the site it is therefore considered likely that the F2 (TRH) exceedance at BH5 is attributed to the slag and charcoal within the fill.
11.	Preferential vapour migration pathways were considered. One soil vapour bore BH102 was placed between BH5 (the location of the F2 exceedance on soil) and an identified sewer service trench located 3 to 4 m to the north. F2 and naphthalene were not detected exceeding HSLs in all soil vapour samplers demonstrating that the extent of exceedance in soil is highly localised and does not appear to present a vapour risk to the proposed school buildings.
12	The waterloo low uptake membrane passive samplers (WMS - LU) were selected because they can be deployed for a much longer time than many other forms of samplers and give a time-integrated measurement and therefore reduce the uncertainty due to temporal variations. It is understood that calculation of the vapour concentrations within the samplers were estimated by the laboratory by determining an uptake rate for the passive collector over the period that they were deployed into the bore. Passive samplers are recognised as a screening tool by CRC CARE *Technical Report No. 23 Petroleum Hydrocarbon Vapour Intrusion Assessment: Australian Guidance* (2013). Several recent studies have shown that they provide quantitative concentrations with similar accuracy to other active methods.
13.	DP has requested a specification of the waterloo samplers from the laboratory as attached.
14.	Did not use a PID due to technical problems on the day of the field work.
15.	Weather conditions preceding and during the sampling were dry and conducive to vapour sampling. There had been no significant rainfall at Darlington in the days leading up to the sampling completed on 28 April 2020.

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Auditors Comments	DP Response and Comments
RAP DP (2020)	
16.	
17. a)	Given that the works are considered designated development they are considered category 1 remediation works and therefore will require development consent. The RAP has been updated to reflect this. The site however does not meet any other category 1 remediation works requirements (ie: not a critical habitat, no threatened species, not environmental protection etc.).
17. b)	The requirement for notification to Safework NSW for asbestos related works is included in section 12.3 of the RAP
18.	Yes, DP agrees that fill is quite heterogenous and therefore has amended the RAP to include remediation action criteria (RAC) extended to all TRH fractions and standard 8 heavy metals.
19.	Section 12.2 Containment cell/Capping layer has been updated to include a discussion that other barriers (ie: elevated boardwalk or fencing) must be implemented. Advice should be obtained from a suitably qualified arborist about the best design for the trees.
20.	Detail on capping method and intended locations for capping to be included in specification document. Section 12.3 has been updated to reflect this.
21.	Enforcement mechanism – Section 12.4.3 has been updated to discuss consultation to determine the most suitable enforcement mechanism.
22.	Section 12.12 has been updated to include sampling rates and requirements of recovered aggregate if necessary.
23.	Agree, if asbestos cannot be ruled out, without further testing, validation should include 500 mL AF/FA testing supplemented with an asbestos clearance. Have included further testing and rates of sampling requirements in Section 8 of the RAP.
24.	Agree, site inspections and photographic evidence should be included. Sections 13.1.2 and 13.1.3 of RAP have subsequently been revised to include these.
25.	Agree, will update RAP to include reference to this recent document.
26.	A description of the proposed development is included in Section 12.1 of the amended RAP.
27.	Agree, clearance and possibly surface sampling should be included to ensure no cross contamination as a result of any future demolition. The RAP will subsequently be amended to include this.

The above comments and any further Auditors' responses to the comments can be further discussed at a site inspection or online meeting held at the earliest opportunity.

The RAP or any additional investigations can be further refined and amended if required after the Auditor has read and responded to the above comments and a site inspection has been completed by both DP and the site Auditor.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Grant Russell
Senior Environmental Scientist

Reviewed by

Glyn Eade
Senior Environmental Scientist / Associate

Attachments: Sydney Water Sewer Plans
Waterloo Passive Sampler Specification and Standard Operating Procedure

Sydney WATER

Guide to reading Sydney Water DBYD Plans

February 2015

Legend

Sewer

- Sewer Main (with flow arrow & size type text) — 225 PVC
- Disused Main
- Rising Main
- Maintenance Hole (with upstream depth to invert) — 1.7
- Sub-surface chamber
- Maintenance Hole with Overflow chamber
- Ventshalft EDUCT — VSE
- Ventshaft INDUCT — VSI
- Property Connection Point (with chainage to downstream MH) — 10.6
- Concrete Encased Section — Concrete Encased
- Terminal Maintenance Shaft — TMS
- Maintenance Shaft — MS
- Rodding Point — RP
- Lamphole
- Vertical — VERT
- Pumping Station — SP0882
- Sewer Rehabilitation

Pressure Sewer

- Pressure Sewer Main
- Pump Unit (Alarm, Electrical Cable, Pump Unit) — A
- Property Valve Boundary Assembly
- Stop Valve
- Reducer / Taper
- Flushing Point — FP

Vacuum Sewer

- Pressure Sewer Main
- Division Valve
- Vacuum Chamber
- Clean Out Point

Stormwater

- Stormwater Pipe
- Stormwater Channel
- Stormwater Gully
- Stormwater Maintenance Hole

Property Details

- Boundary Line
- Easement Line
- House Number
- Lot Number
- Proposed Land
- Sydney Water Heritage Site (please call **132 092** and ask for the **Heritage Unit**)

Water

- WaterMain - Potable (with size type text) — 200 PVC
- Disconnected Main - Potable
- Proposed Main - Potable
- Water Main - Recycled
- Special Supply Conditions - Potable
- Special Supply Conditions - Recycled
- Restrained Joints - Potable
- Restrained Joints - Recycled
- Hydrant
- Maintenance Hole
- Stop Valve
- Stop Vale with By-pass
- Stop Valve with Tapers
- Closed Stop Valve
- Air Valve
- Valve
- Scour
- Reducer / Taper
- Vertical Bends
- Reservoir
- Recycled Water is shown as per Potable above. Colour as indicated

Private Mains

- Potable Water Main
- Recycled Water Main
- Sewer Main
- Symbols for Private Mains shown grey

Pipe Types

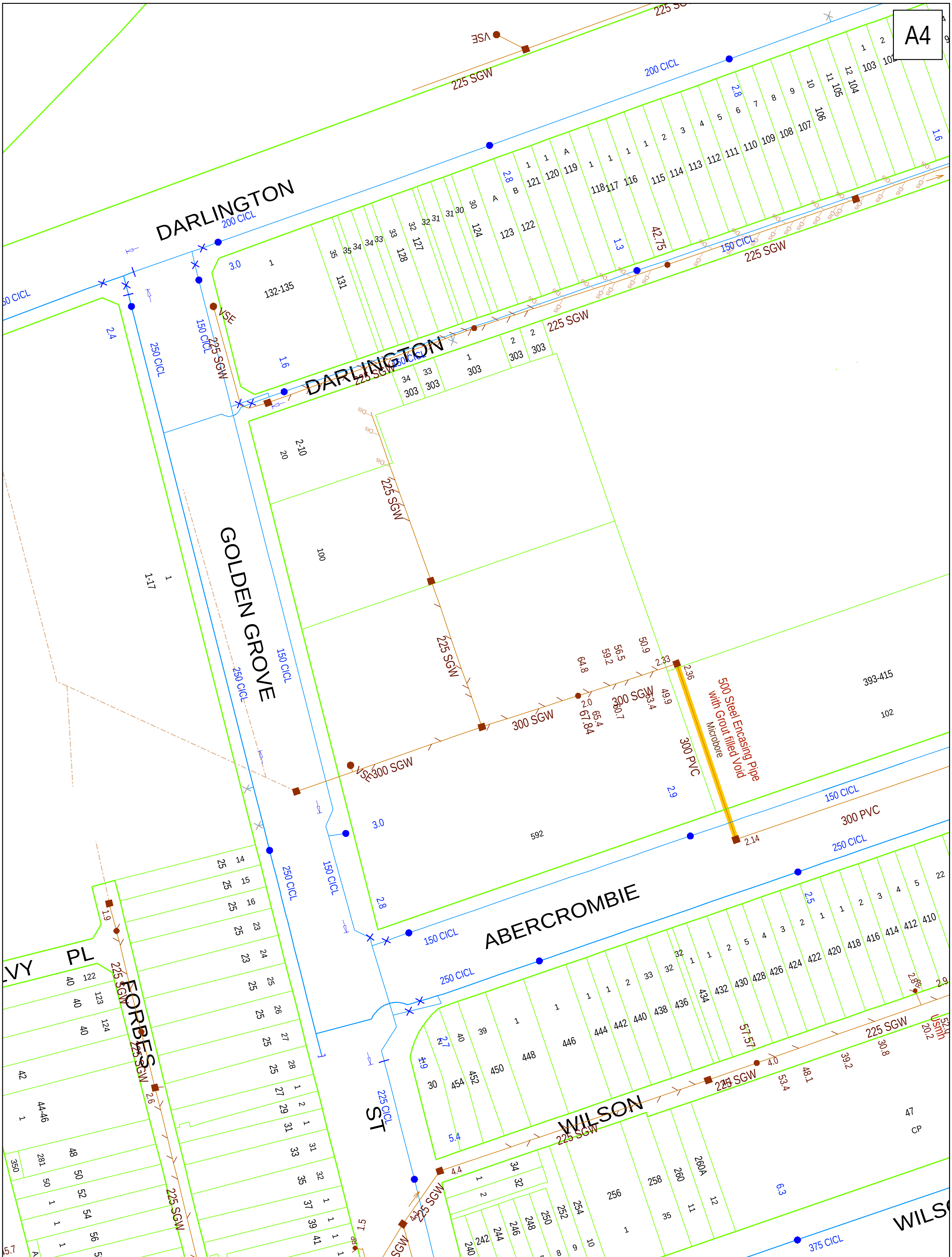
ABS	Acrylonitrile Butadiene Styrene	**AC**	Asbestos Cement
BRICK	Brick	**CI**	Cast Iron
CICL	Cast Iron Cement Lined	**CONC**	Concrete
COPPER	Copper	**DI**	Ductile Iron
DICL	Ductile Iron Cement (mortar) Lined	**DIPL**	Ductile Iron Polymeric Lined
EW	Earthenware	**FIBG**	Fibreglass
FL BAR	Forged Locking Bar	**GI**	Galvanised Iron
GRP	Glass Reinforced Plastics	**HDPE**	High Density Polyethylene
MS	Mild Steel	**MSCL**	Mild Steel Cement Lined
PE	Polyethylene	**PC**	Polymer Concrete
PP	Polypropylene	**PVC**	Polyvinylchloride
PVC - M	Polyvinylchloride, Modified	**PVC - O**	Polyvinylchloride, Oriented
PVC - U	Polyvinylchloride, Unplasticised	**RC**	Reinforced Concrete
RC-PL	Reinforced Concrete Plastics Lined	**S**	Steel
SCL	Steel Cement (mortar) Lined	**SCL IBL**	Steel Cement Lined Internal Bitumen Lined
SGW	Salt Glazed Ware	**SPL**	Steel Polymeric Lined
SS	Stainless Steel	**STONE**	Stone
VC	Vitrified Clay	**WI**	Wrought Iron
WS	Woodstave		

Further Information

Please consult the Dial Before You Dig enquiries page on the Sydney Water website

For general enquiries please call the Customer Contact Centre on **132 092**

In an emergency, or to notify Sydney Water of damage or threats to its structures, call 13 20 90 (24 hours, 7 days)



DBYD Address:
n/a Abercrombie Street
Darlington NSW 2008

DBYD Job No: 13827427

DBYD Sequence No: 69296548

SYDNEY WATER CORPORATION

Scale: 1:1000

Date of Production: 07/03/2018

Plan 1 of 1

N

0m 5m 10m 15m 20m

WATERLOO MEMBRANE SAMPLER™

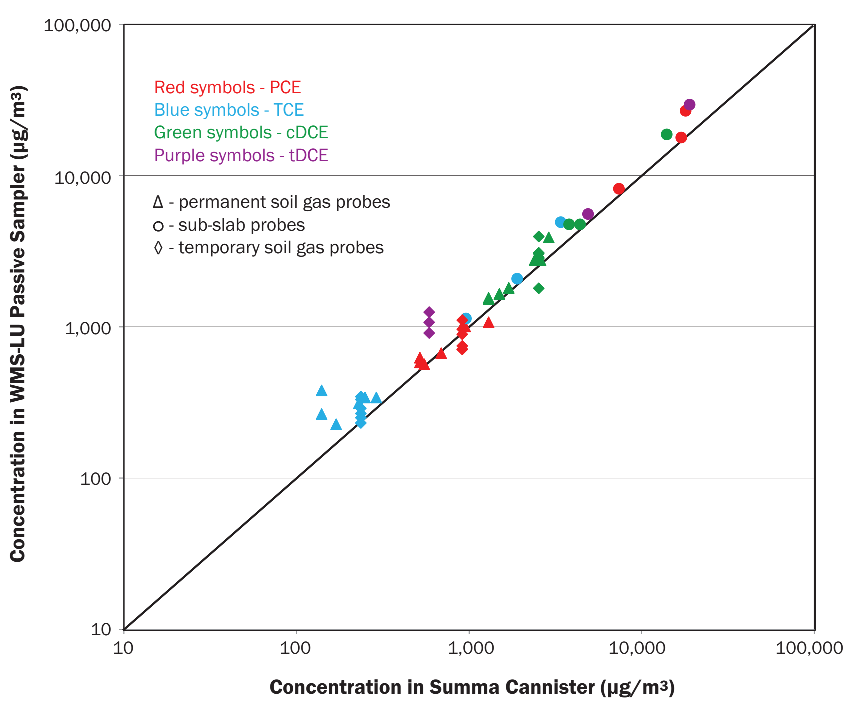
Quantitative Passive Soil Vapor Sampling with the Low Uptake Rate Waterloo Membrane Sampler™ (WMS™-LU)

Until recently, passive soil vapor sampling has shown limited ability to quantify concentrations, and has therefore been relegated to a screening tool needing verification by other methods. After 5 years of research, the Low Uptake Rate Waterloo Membrane Sampler™ (WMS-LU)[1] has recently emerged as a breakthrough in this field, and has been shown to provide quantitative concentration measurements with similar accuracy and precision to conventional active soil gas samples collected using Summa canisters and EPA Method TO-15. The chart below shows the correlation for soil gas and sub-slab samples collected as part of an ESTCP/Navy funded study:

The membrane should be protected from coming in contact with the soil by adding a wire bumper (top) or wrapping the WMS™-LU in wire screen (above, right).

The WMS™-LU sampler can be installed in temporary or semi-permanent probes (see above, left). For shallow samples, hand-tools can be used, which makes the process very fast, with minimal damage and disruption.

Soil Gas Sampling with the Waterloo Membrane Sampler - Low Uptake



[1] Patent pending: Patent Application No: PCT/US2013/059062

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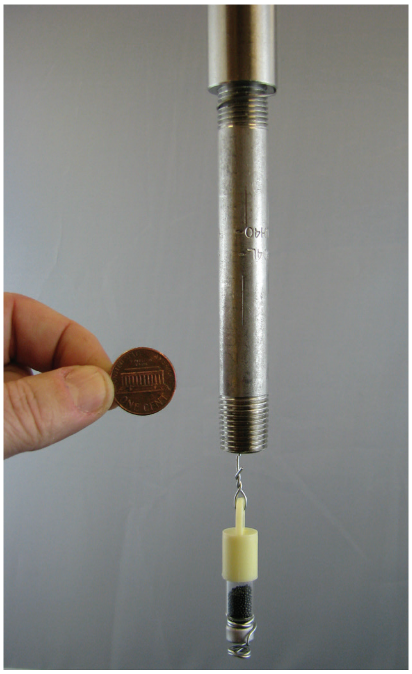

The WMS™-LU fits through an open hole, or through a 3/8" sub-slab probe (see photo on left), both of which can be easily sealed at surface using a cork, rubber stopper or a coupling with an end plug. A skim-coat of concrete can be used to cover the probe, if desired.

Advantages:

- Simpler sampling protocols (see over) for less training and less risk of inter-operator error
- Smaller size for ease of shipping and handling
- Lower cost (save as much as half the cost for a sampling program)
- The smallest commercially available passive sampler (able to fit within a ½ inch probe)
- Hydrophobic membrane excludes water, which reduces competition for adsorptive sites and analytical interference

Membrane also prevents turbulent uptake, so the WMS™ sampler can be deployed in high velocity environments, such as extraction system vent-pipes

Determination of Concentration (Equation 1)

Concentrations in the sampled air are calculated according to Equation 1, where:

C = concentration in sampled air ($\mu g/m^3$)
M = mass on sampler (picograms)
t = sampling time (min)
UR = known analyte-specific uptake rate (mL/min)

Reporting Limits and Sampling Time (Equation 2)

The sampling time required to meet a desired reporting limit can be calculated using Equation 2, where:

t = sampling time required to achieve the reporting limit (min)
M_{LOQ} = minimum mass on sampler that analytical method can measure (picograms)
C_{RL} = reporting limit required ($\mu g/m^3$)
UR = known analyte-specific uptake rate (mL/min)

Sample durations of about 24 hours are sufficient to provide reporting limits that meet data quality objectives for most vapor intrusion guidance documents.

Equation 1

$$C = \frac{M}{t \times UR}$$

Equation 2

$$t = \frac{M_{LOQ}}{C_{RL} \times UR}$$

For more information contact
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direct: (519) 515-0837
bpautler@siremlab.com

References

McAlary, T.A., X. Wang, A. Unger, H. Groenevelt and T. Górecki, Quantitative Passive Soil Vapor Sampling for VOCs - Part I: Theory. Environmental Science: Processes & Impacts, DOI:10:1039/C3EM00652B: http://xlink.rsc.org/?doi=C3EM00652B

McAlary, T.A., H. Groenevelt, S. Seethapathy, P. Sacco, D. Crump, M. Tuday, B. Schumacher, H. Hayes, P. Johnson and T. Górecki, Quantitative Passive Soil Vapor Sampling for VOCs – Part 2: Laboratory Experiments. Environ. Sci.: Processes Impacts, 2014, DOI: 10.1039/C3EM00128H: http://xlink.rsc.org/?doi=C3EM00128H

McAlary, T.A., H. Groenevelt, P. Nicholson, S. Seethapathy, P. Sacco, D. Crump, M. Tuday, H. Hayes, B. Schumacher, P. Johnson, T. Górecki and I. Rivera Duarte, Quantitative Passive Soil Vapor Sampling for VOCs - Part 3: Field Experiments. Environ. Sci.: Processes Impacts, 2014, DOI: 10.1039/C3EM00653K: http://xlink.rsc.org/?doi=C3EM00653K

U.S. Navy (in press). Project 424 on "Improved Assessment Strategies for Vapor Intrusion (VI)" funded by the Navy Environmental Sustainability Development to Integration (NESDI) program.

ESTCP (in prep). Development of More Cost-Effective Methods for Long-Term Monitoring of Soil Vapor Intrusion to Indoor Air Using Quantitative Passive Diffusive-Adsorptive Sampling Techniques.

Seethapathy, S. and T. Górecki, 2011a. Polydimethylsiloxane-based permeation passive air sampler. Part I: Calibration constants and their relation to retention indices of the analytes. J Chromatogr A. 2011 Jan 7; 1218(1):143-55. Epub 2010 Nov 9.

Seethapathy, S. and T. Górecki, 2011b. Polydimethylsiloxane-based permeation passive air sampler. Part II: Effect of temperature and humidity on the calibration constants. J Chromatogr A. 2010 Dec 10; 1217(50):7907-13. Epub 2010 Oct 21.

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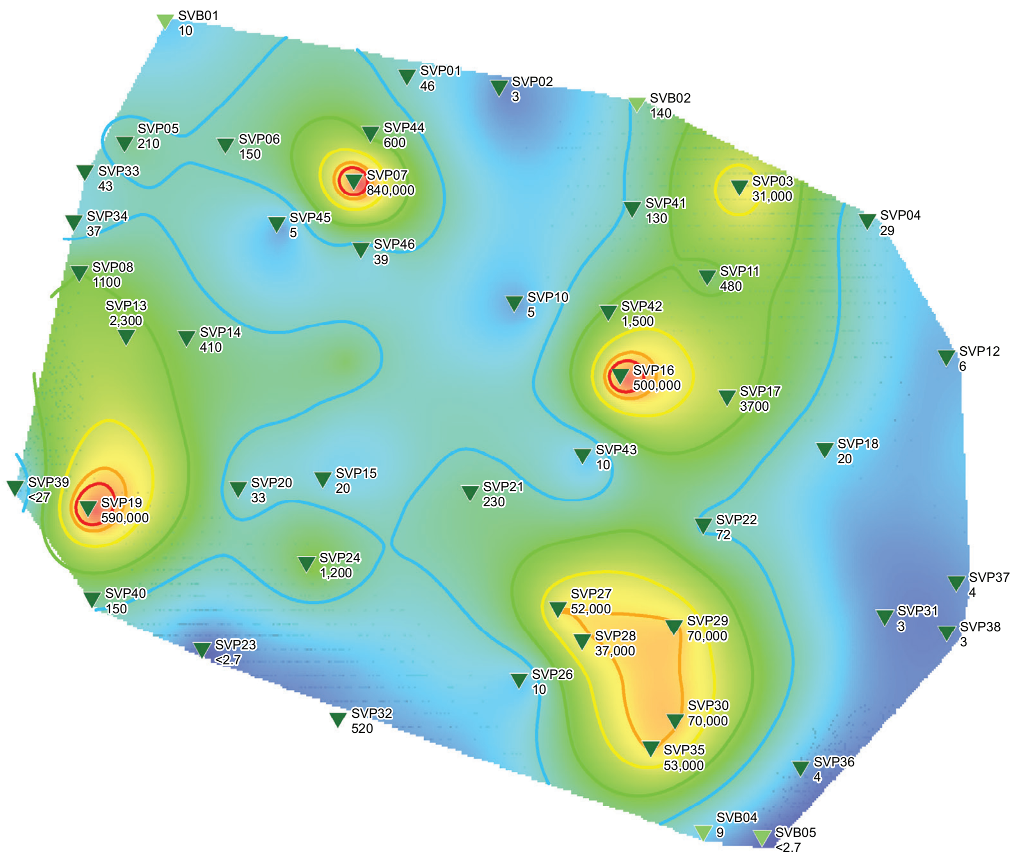

Sampler Ordering and Analysis:

Sample Reception
Eurofins Air Toxics, Inc.

180 Blue Ravine Road, Suite B
Folsom, California, 95630
Ph: 916-985-1000
Toll Free: 800-985-5955

Technical Information:

SiREM

130 Research Lane, Suite 2
Guelph, ON N1G 5G3
Ph: (519) 822-2265
Toll Free: 1-866-251-1747

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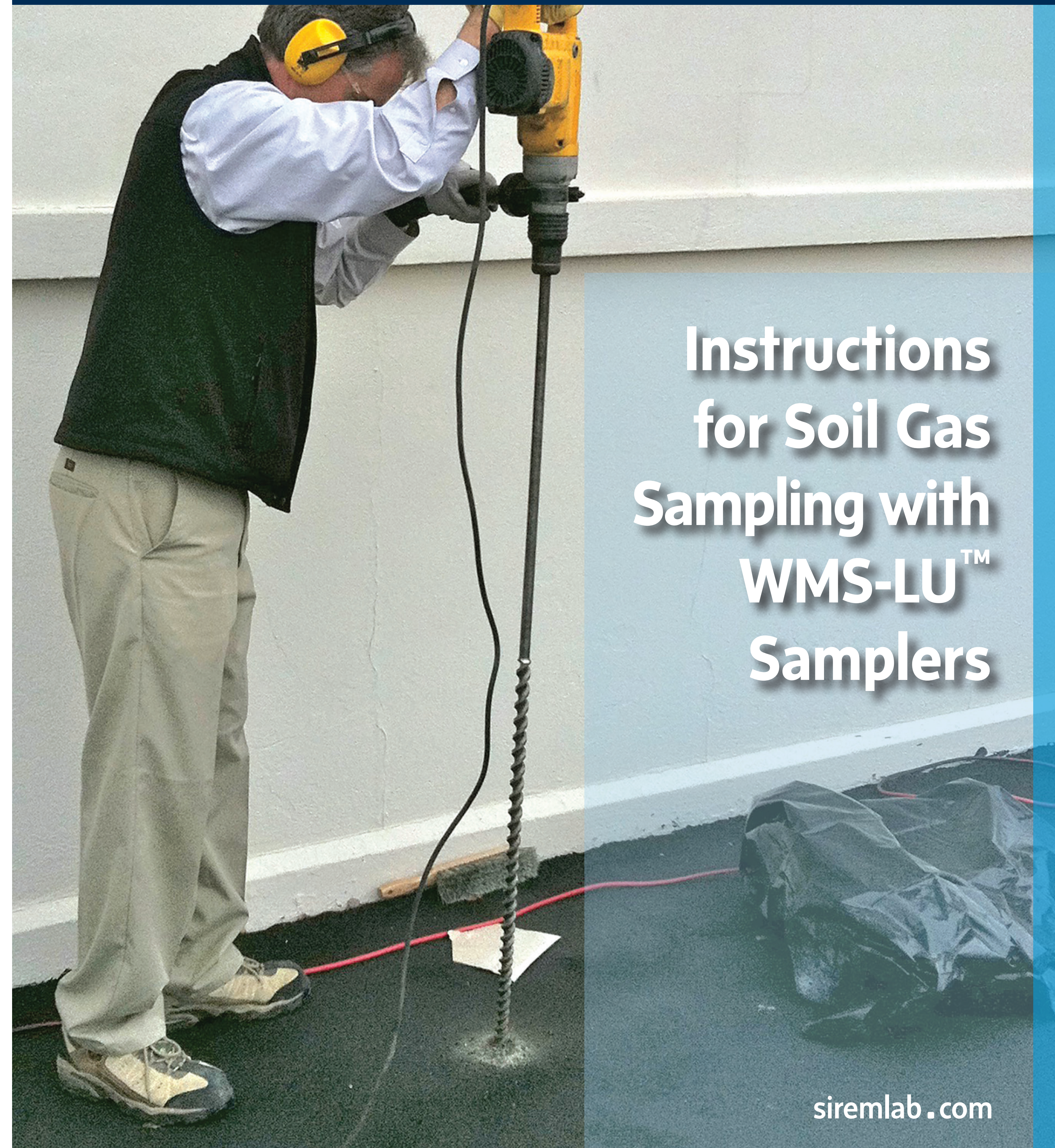
WATERLOO MEMBRANE SAMPLER™



Instructions for Soil Gas Sampling with WMS-LU™ Samplers

siremlab.com

Overview

Passive soil gas sampling has been available for over 30 years, but only recently Geosyntec discovered the secret to determining the soil vapor concentrations.

This document provides operating instructions for passive soil gas sampling and quantitative analysis of volatile organic compound (VOC) vapor concentrations using the Waterloo Membrane Sampler™, or WMS. The key to quantitative passive sampling is having a passive sampler with an uptake rate that is similar to or lower than the rate of diffusive delivery of soil vapors to the void-space in which the passive sampler is deployed. Mathematical modeling, laboratory testing and field testing to demonstrate this innovation was published by McAlary et al.[1]. The low-uptake variety of the WMS sampler is referred to as WMS-LU™.

This innovation is subject to U.S. Patent #9399912: "Passive Sampling Device and Method of Sampling and Analysis", and cannot be used without expressed written consent of Geosyntec Consultants, Inc. This invention was made with financial support from the U.S. Federal government under Contract W912HQ-08-C-0046 awarded by the Environmental Security Technology Certification Program (ESTCP), so all U.S. government agencies are granted royalty-free use of this patented technology.

[1] McAlary, T.A., X. Wang, A. Unger, H. Groenevelt and T. Górecki, Quantitative Passive Soil Vapor Sampling for VOCs - Part I: Theory. Environmental Science: Processes & Impacts, DOI:10:1039/C3EM00652B: http://xlink.rsc.org/?doi=C3EM00652B

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Instructions:

1. Acquire apparatus:
   - WMS-LU™ Sampler and deployment materials (described further in item 2);
   - Borehole drilling, coring, or augering equipment;
   - A piece of rigid pipe (acrylic or PVC), slightly smaller in diameter than the borehole diameter, about 1 foot longer than the depth that the WMS-LU™ samplers will be deployed; and
   - A piece of dowel, slightly smaller in diameter than the pipe, about 2 feet longer than the depth that the WMS-LU™ sampler will be deployed.

2. Open the plastic bag of deployment materials. It should contain **(Fig 1)**:
   - a 4-inch long piece of 3-inch diameter foam plug
   - a rubber stopper with an eyelet in the top and in the bottom
   - a 5½-foot long, 4-inch diameter flexible plastic sleeve, sealed at one end and open at the other
   - a small plastic bag containing 5 feet of 20-pound fishing line

   Note: the plastic bag of deployment materials does NOT include a WMS-LU™ sampler.

3. Tie one end of the fishing line to the top of the wire hanger **(Fig 2)** and tie the other end to the eyelet at the BOTTOM of the rubber stopper, leaving sufficient length of fishing line between the rubber stopper and the WMS-LU™ sampler to position the sampler at the desired deployment depth.

4. The Waterloo Membrane Sampler is shipped in a protective Ziploc aluminum package and glass vial, which protects the sampler from exposure to chemicals during shipping. Tear or cut open pouch above the zip-lock seal. Remove the glass vial from the bubble pack and remove the aluminum foil wrap. Insert the WMS-LU™ sampler membrane first into wire hanger **(Fig. 3)**. The end of the wire hanger must be moved to one side to allow the WMS-LU™ sampler to enter or exit the wire hanger coil **(Fig. 4)**. Once inserted, the WMS-LU™ sampler will sit approximately half-way down in the wire hanger, with several coils of wire underneath the bottom of the WMS-LU™ sampler to protect the sampling end of the WMS-LU™ sampler from contact with soil at the bottom of the borehole **(Fig. 5)**. The sampler must be positioned with the membrane down during sampling to keep the sorbent inside the vial in contact with the inner side of the membrane.

Figure 1 - Contents of the soil gas sampling kit

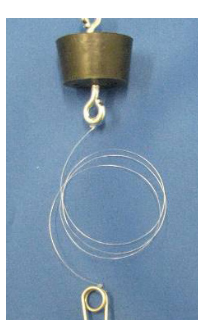

Figure 2 - complete sampler/wire hanger/ rubber stopper assembly

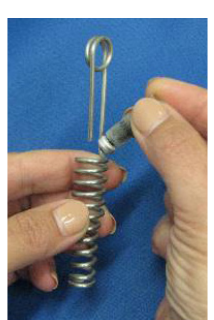

Figure 3 - aligning the sampler in the wire hanger

Figure 4 - bending the wire to insert the sampler

Figure 5 - complete sampler/wire hanger assembly

Figure 6 - lowering the sampler down the borehole (represented by the glass cylinder)

Figure 7 - foam plug and the pipe

Figure 8 - insertion of compressed foam plug into the pipe

Figure 9 - insertion of the pipe, with foam plug at bottom, into plastic sleeve

Figure 10 - positioning of pipe and foam plug at the bottom of plastic sleeve

Figure 11 - insertion of pipe/foam plug and flexible plastic sleeve into borehole (represented by the glass cylinder)

Figure 12 - insertion of dowel into rigid pipe

Figure 13 - extrusion of foam plug from the pipe, approximately 6 inches above the WMS-LU™ sampler

5. Lower the WMS-LU™ sampler, attached to the fishing line and the rubber stopper, down the borehole to the desired deployment depth **(Fig. 6)**. Lay the rubber stopper beside the opening of the borehole.

6. Compress the 4-inch long piece of 3-inch diameter foam plug **(Fig. 7)** along its cylindrical axis and insert it into one end of the pipe **(Fig. 8)**.

7. Insert the pipe, with the foam plug at the BOTTOM, into the open end of the 5-foot flexible plastic sleeve **(Fig 9)**, down to the sealed end of the 5-foot flexible plastic sleeve **(Fig 10)**.

8. Lower the 5½-foot flexible plastic sleeve containing the pipe (with the foam plug at the bottom) down the borehole to approximately 6 inches above the WMS-LU™ sampler. The fishing line holding the WMS-LU™ sampler will be between the borehole wall and outside of the 5½-foot flexible plastic sleeve **(Fig. 11)**.

9. Insert the dowel into the pipe until it touches the top of the foam plug **(Fig. 12)**. Hold the dowel stationary while slowly pulling the pipe upwards. The foam plug will be extruded from the pipe **(Fig. 13)** and expand inside the 5½-foot flexible plastic sleeve, at a depth of approximately 6 inches above the WMS-LU™ sampler. This will press the flexible plastic sleeve against the borehole wall to provide a seal between the WMS-LU™ sampler and the rest of the borehole and the atmosphere, resulting in a depth-discrete soil vapor sample.

10. Remove the pipe and dowel from the flexible plastic sleeve and seal the top of the borehole with the rubber stopper. The 5½-foot flexible plastic sleeve will be pinned between the rubber stopper and the borehole, and will be visible at ground surface. Excess plastic on the 5½-foot flexible plastic sleeve can be trimmed, if needed. Place a piece of dowelling, steel rod, etc. through the eyelet at the top of the rubber stopper to prevent the rubber stopper sliding into the borehole **(Fig 14)**. This can also aid in removing the rubber stopper after sampling.

11. When sampling is complete, remove the rubber stopper and slowly pull the 5½-foot flexible plastic slleve containing the foam plug out of the borehole along with the fishing line attached to the WMS-LU™ sampler. The foam plug will keep the borehole open as it slides upward, providing a path for the WMS-LU™ sampler, even if there has been any sloughing of the borehole wall.

12. Remove the WMS-LU™ sampler from the wire hanger by holding the wire hanger upside down and pushing the end of the wire hanger to one side and allowing the WMS-LU™ sampler to slide out **(Fig. 15)**. Brush any loose soil from the WMS-LU™ sampler, taking care not to damage the membrane.

13. Remove the MiniPax scavenger carbon from the 20 mL glass vial, and put it in the aluminum pouch **(Fig. 16)**. Return the WMS-LU™ sampler to the glass vial, replace the cap and seal with Teflon™ tape. Aluminum foil around glass vial does not need to be replaced. Put the vial in bubble pack, place in aluminum pouch and seal. Record stop date and time on pouch label.

14. Complete chain of custody form and ship with samplers to Eurofins-Air Toxics Ltd (180 Blue Ravine Road, Suite B, Folsom, California, 95630) for analysis.

Figure 14 – restraining the rubber stopper

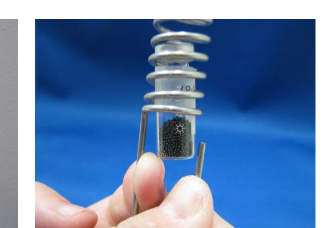

Figure 15 – removal of WMS-LU™ sampler from wire hanger

Figure 16 – repackaging of WMS-LU™ sampler for shipment to laboratory