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6.4 Sampling and Analytical Rationale

Samples were collected from 10 test bore locations over the 1.1 ha site, giving an approximate sampling density of 9 points per hectare. It is considered that this number of sampling locations is appropriate for providing a preliminary assessment of the potential for contamination at the site. If a contamination assessment is required to fully characterise the site, at least of 12 additional systematic sampling locations will be required to meet the minimum requirements of the NSW EPA *Sampling Design Guidelines*.

One bore (Bore 101, which was also converted into a piezometer) was located in the vicinity of UST's associated with the former service station and one bore (bore 110) was located within a concrete sump pit within the former printing firm where by-products of the printing process may have been disposed (see Site Drawing, Appendix A). These 2 bores were targeted bores to evaluate the presence of contamination which may have resulted from leakages or spillages of fuel/process materials from the previous activities conducted in these areas. The remaining bores were placed in an approximate grid pattern (subject to site access restrictions), to provide representative site coverage.

The analytical scheme was designed around the inferred potential for contamination. Analysis focused on the upper 0.5 m of soil/ filling material, where contamination residue (including pesticides and heavy metals) is most likely to be present; and where filling material, which is of uncertain origin, has been placed. A summary of the analytical scheme is presented in Table 3. Analysis was conducted by Envirolab Services, a NATA accredited laboratory. It should be noted that sample 110A/0.15 (and its replicate Z3) was reanalysed following the receipt of the initial results, due to the high levels of TRH detected and to determine the extent of petroleum hydrocarbons in the sample. The initial results of this sample is labelled 110A/0.15 and is reported in Envirolab report no 05/1342 (Appendix C). The sample was reanalysed after undergoing a "silica gel clean-up" and for the purposes of distinguishing between the two results is identified in this report as $110A/0.15_{rep}$ (and replicate $Z3_{rep}$) and is reported in Envirolab report number 05/1342A (Appendix C).

Notwithstanding the site constraints, it is considered that the current assessment provides an appropriate sampling programme for providing a preliminary evaluation of the site condition with respect to contamination potential and its likely suitability for residential use with minimal access to soils. Sampling locations are indicated on Drawing 1 in Appendix A.

Table 2 - Summary of Material Encountered and Rationale of Analysis Undertaken

Bore	Depth	Material Description	Analysis	Rationale
101	0.3-0.5	Filling - Black sand filling with gravel and possible porous ash	HM, TRH, BTEX, PAH, Phenols, OPP, OCP, PCB	Site coverage, evaluate the presence of hydrocarbons as a result of UST's
	1.3-1.5	Filling – Yellow brown sandy clay filling with porcelain	Asbestos	Site Coverage, porcellian fragments in auger returns
	2.8-3	Sandy Clay – black sandy clay with organic matter	HM, TRH, BTEX, PAH, pH, Chloride, Sulphate	Site coverage, evaluate the presence of hydrocarbons as a result of UST's, potential for downward migration of contaminants in underlying natural materials
102	0.3-0.5	Filling - Brown sandy clay filling with gravel	HM, TRH, BTEX, PAH, Phenols, OPP, OCP, PCB, Asbestos,	Site Coverage
103	0.3-0.5	Filling - Brown sandy clay filling with gravel	HM, TRH, BTEX, PAH, pH, Chloride, Sulphate, Asbestos	Site coverage
	2.8-3	Sandy Clay – black sandy clay	SPOCAS	Based on field observations deemed likely to be PASS
104	0.3-0.5	Filling – Brown and black silty clay filling with gravel and possible porous ash	HM, TRH, BTEX, PAH	Site coverage
	2.8-3	Silty Clay – Dark grey silty clay	SPOCAS	Based on field observations deemed likely to be PASS
105	0.3-0.5	Filling - Brown sandy clay filling with gravel	HM, TRH, BTEX, Asbestos	Site coverage
106	0.3-0.5	Filling – Blue mottled grey sandy clay filling	HM, TRH, BTEX, PAH,	Site coverage
	1.3-1.5	Sandy Clay – White sandy clay	SPOCAS	Determine minimum depth of PASS
107	0.2-0.3	Filling – Dark grey sandy clay filling	HM, TRH, BTEX, PAH	Site coverage
108	0.3-0.5	Filling – Dark grey sand filling	HM, PAH Phenols, OPP, OCP, PCB, pH, Chloride, Sulphate	Site coverage
109	0.3-0.5	Filling – Red brown mottled grey and orange silty clay with gravel	HM, TRH, BTEX, PAH,	Site coverage, filling material not identified elsewhere on site
	1.2-1.4	Filling – Dark grey to black sandy clay filling	HM, TRH, BTEX, PAH, Asbestos	
	2.8-3	Sandy Clay – Light grey sandy clay	SPOCAS	Based on field observations deemed likely to be PASS
110/110A	110/0.0.1	Filling – medium grained yellow brown sand filling	HM, TRH, BTEX, PAH, OCP, PCB's, Phenols	Sample collected from a sump pit in the former printing workshop, identify potential contaminants as a results of previous printing press operations
	110A/0.15	Filling – yellow brown sand filling with some surficial black clay	HM, TRH, BTEX, PAH, VOC's, pH, Cyanide	
	110A/0.15rep	Filling – yellow brown sand filling with some surficial black clay	TRH	Sample 110A/0.15 returned high TRH, so sample was reanalysed to confirm results and to determine what the contribution of petroleum hydrocarbons

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Table 3 - Analytical Scheme

Sample ID	Sample Type (S – soil	Metals	TRH/BTEX	PAH	PCB OCP Phenols	Asbestos	VOC's,	pH	Cyanide	Chloride, Sulphate	SPOCAS
101/0.3-0.5	S	✓	✓	✓	✓	-	-	-	-	-	-
101/1.3-1.5	S	-	-	-	-	✓	-	-	-	-	-
101/2.8-3.0	S	✓	✓	✓	-	-	-	-	-	-	✓
102/0.3-0.5	S	✓	✓	✓	✓	✓	-	✓	-	✓	-
103/0.3-0.5	S	✓	✓	✓	-	✓	-	-	-	-	-
103/2.8	S	-	-	-	-	-	-	-	-	-	-
104/0.3-0.5	S	✓	✓	✓	-	-	-	✓	-	✓	-
104/2.8-3											✓
105/0.3-0.5	S	✓	✓	✓	-	✓	-	-	-	-	-
106/0.3-0.5	S	✓	✓	✓	-	-	-	-	-	-	-
106/1.3											✓
107/0.2-0.3	S	✓	✓	✓	-	-	-	-	-	-	-
108/0.3-0.5	S	✓	✓	✓	✓	-	-	✓	-	✓	-
109/0.3-0.5	S	✓	✓	✓	-	✓	-	-	-	-	-
109/1.2-1.4	S	✓	✓	✓	-	-	-	-	-	-	-
110/0-0.1	S	✓	✓	✓	✓	-	✓	-	-	-	-
110A/0.15	S	✓	✓	✓	-	-	✓	✓	✓	-	-
110A/0.15rep	S	-	✓	-	-	-	-	-	-	-	-
Z2	S	✓	✓	-	-	-	-	-	-	-	-
Z3	S	✓	✓	-	-	-	-	-	-	-	-
Z3rep	S	-	✓	-	-	-	-	-	-	-	-
101W	W	✓	✓	✓	-	-	-	-	-	-	-
104W	W	✓	✓	-	-	-	-	-	-	-	-
109W	W	✓	✓	-	-	-	-	-	-	-	-
ZW	W	✓	✓	-	-	-	-	-	-	-	-

Z2 Denotes field replicate of sample 108/0.3-0.5
Z3 Denotes field replicate of sample 110/0.15
ZW Denotes field replicate of 109W

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7 SITE ASSESSMENT CRITERIA

7.1 Soil

On the basis of the proposed development including residential apartments and commercial/industrial units but taking into account that the entire site will be paved/sealed the relevant soils assessment criteria include:-

- NSW EPA (1998) Contaminated Sites *Guidelines for the NSW Site Auditor Scheme,* Health-Based Investigation Levels for Residential with minimum access to soil (Column 2 HIL);
- NSW EPA (1994) Contaminated Sites *Guidelines for Assessing Service Station Sites,* Threshold Concentration for Sensitive Site Landuse (for TRH/ BTEX in the absence of other Department of Environment and Conservation endorsed guidelines).

In view that the proposed development offers no opportunity for soil access the, Provisional Phytotoxicity-Based Investigation Levels for sandy loams contained in *Guidelines for the NSW Site Auditor Scheme* do not apply in this case.

7.2 Groundwater

The guidelines selected for reference to groundwater quality in this assessment include:-

- ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, trigger values for toxicants in marine waters for protection of 95% of species.
- Dutch Intervention Value (Dutch IV) - intervention values for mineral oils, from *Environmental Quality Standards in the Netherlands*, 1999 (with respect to $C_{10}C_{36}$ fraction of TRH, in the absence of other high reliability guidelines for TRH in groundwater).

The Dutch IVs have been adopted in the absence of ANZECC 2000 guidelines and any other NSW EPA-endorsed criteria for detected contaminants. It is noted that, while the Dutch IVs (or other similar, internationally recognised standards such as the USEPA Modified Preliminary Remediation Goals) are not officially endorsed by NSW EPA (now part of DEC), they are regularly adopted in the industry as an acceptable alternative set of assessment criteria. This is due to the fact that the Dutch IVs have been established through a rigorous evaluation process which takes into consideration a range of possible impacts including human health and ecological effects, and are regularly updated. An alternative would be to develop site specific criteria through a rigorous risk assessment which is an onerous process and which will not necessarily result in an improvement in the level of certainty.

As clearly stated by the Ministry of Housing, Spatial Planning and the Environment of the Netherlands, the Dutch IVs are "founded on both a human and ecotoxicological basis" and are "corrected with soil type correction formulas". In other words, the concept and the main objective of the Dutch IV are compatible to the NEPM approach, that is, through the assessment of health and ecological impacts (via the use of Health-based Investigation Levels and Ecological Investigation Levels). It is thus considered that the Dutch IV have been developed on a basis compatible with the current DEC-endorsed assessment system, and they are therefore adopted in this assessment.

With respect to Acid Sulphate Soils, the relevant assessment criteria are sourced from the NSW *Acid Sulphate Soil Management Advisory Committee Manual (1998)* [ASSMAC]. The action criteria vary according to the type of material or the amount of ASS soil to be disturbed in the project. As on-site materials were observed to comprise silty clayey sand and sandy clays at different depths, the action criteria adopted was for sandy loams to light clay subsoil materials.

8 RESULTS

8.1 Field Observations

Details of the sub-surface conditions encountered during the course of the investigation are included in the Borehole Log Sheets together with notes describing the classification methods and descriptive terms (Appendix D). A summary of the materials encountered in the test bores is included in Table 4.

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Table 4 – Summary of Test Bore Results

TEST BORE	CONCRETE /BITUMEN	FILLING	SHALE FILLING	SAND	SILTY CLAY	SANDY CLAY	SANDSTONE
101	0-0.12	0.12-1.5	-	1.5-1.6	-	1.6-6	-
102	0-0.1	0.1-0.7	0.7-1.5	-	-	-	-
103	-	0-1.1	-	-	1.1-2	2-3	-
104	-	0-1.7	-	-	1.7-3.5	3.5-4.5	-
105	0-0.4	0.4-1.8	-	-	-	-	1.8-
106	0-0.15	0.15-0.6	-	-	-	0.6-2.2	2.2-
107	0-0.15	0.15-0.4	-	-	-	0.4-0.45	0.45-
108	0-0.12	0.12-1.3	-	1.3-1.8	-	1.8-3	-
109	0-0.12	0.12-1.4	-	-	-	1.4-4.5	-
110	0.5-	0-0.5	-	-	-	-	-

The majority of the site was paved with concrete or bitumen which the exception of the area surrounding Bore 103 and 104 which was covered by gravel. The conditions encountered in the test bores consisted of filling to a maximum depth of 1.8 m. The majority of the filling consisted of yellow brown sandy and silty clay as well as dark grey to black sandy clay filling. The majority of the filling appeared to be natural in origin and free of building rubble and other anthropogenic materials with the exception of the materials in Bore 101 which contained fragments of porcelain and vesicular ash (to a depth of 0.8 m) and 104 which contained vesicular ash (to a depth of 0.7 m). The filling in Bore 106 consisted of blue mottled grey silty clay and bore 109 consisted of red brown mottled grey and orange silty clay. The filling in bore 110 consisted of yellow brown sand with surficial black clay which had been heavily altered by black glue-like chemicals with a strong hydrocarbon odour.

The natural materials observed on site consisted of grey to black sandy clays with some silty clays from depths ranging from 0.4 – 1.8 m. There were high levels of organic matter observed in the auger returns, particularly below the water table. Shallow sandstone bedrock was also observed in Test Bores 105-107 from depths ranging from 0.45 – 2.2 m below ground level.