BEFORE THE ENVIRONMENT COURT
AT WELLINGTON

ENV-2015-WLG-024

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of applications for resource consent by Site 10 Redevelopment Limited Partnership and Wellington City Council in respect of the area known as Site 10

STATEMENT OF EVIDENCE OF PENELOPE EMMA KNEEBONE ON BEHALF OF SITE 10 REDEVELOPMENT LIMITED PARTNERSHIP AND WELLINGTON CITY COUNCIL

3 JULY 2015

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INTRODUCTION

1. My name is Penelope Emma Kneebone. I hold the position of Principal Environmental Scientist at Tonkin & Taylor Ltd. I have been in this position since February 2006.

2. I hold a PhD in Environmental Engineering Science from California Institute of Technology and a BSc with First Class Honours in chemistry from University of Otago. Full details of my qualifications and relevant past experience are at **Attachment A** to this evidence.

3. I have been engaged by the applicants to provide evidence in relation to management of contaminated soil including handling, testing and disposal during construction and assessing potential risk to future site users of contaminants in soil around the basement car park.

4. I am the author of the report entitled "*Ground Contamination Assessment: Wellington Waterfront Sites 8, 9, 10*" that formed part of the Assessment of Environmental Effects (AEE) lodged in support of the applications (Appendix 18). It included a draft Contaminated Site Management Plan, which I prepared. I have since produced a revised version of this report and the Contaminated Site Management Plan in response to a request for further information from the Wellington City Council. A copy of the revised report is at **Attachment B** to this evidence. I also contributed to the ground contamination aspects of the report entitled "*Wellington Waterfront Site 10 - Groundwater and Contamination Assessment and Basement Dewatering Effects*", which is attached to this evidence at **Attachment C**.

CODE OF CONDUCT

5. I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014 and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise.

BACKGROUND AND SCOPE OF EVIDENCE

6. I have been asked to provide evidence in relation to ground contamination matters at Site 10, Wellington Waterfront. This includes describing the ground contamination at the site, the proposed contamination management plan, and the potential effects of ground contamination on the use of the site.

7. The key issues are the safe management of contaminated soil within the basement carpark area during earthworks and during use of the new building.

8. I have been providing the applicants with my expertise in relation to ground contamination at Site 10 since April 2014. I have also been involved in investigation of ground contamination at other sites within the Wellington reclamation for Wellington Waterfront Limited and CentrePort Limited since 2006.

9. The key documents I have used in forming my view are set out in the reports described in paragraph 4 of my evidence. I have not relied on any other witnesses while preparing this brief of evidence.

CONTAMINATION AT SITE 10

Contaminated Soil

10. Most of the soil that has to be excavated from the proposed basement is contaminated.

11. Most of the contamination is there because the fill used to reclaim the site was contaminated. The area was reclaimed in the early 1900s. Different types of fill were placed, which has resulted in varying levels of contamination in the fill, from clean to contaminated. The contamination at Site 10 is typical of fill in those parts of the Wellington waterfront that were reclaimed at that time.

12. Some of the soil at Site 10 also contains asbestos. The asbestos could be from demolition of historical buildings.

13. The soil at Site 10 contains metals and hydrocarbons above expected background levels but within levels that are considered by the Ministry for the Environment to be acceptable to human health, based on the proposed use of the site.

14. The contaminants in soil at Site 10 are commonly encountered on contaminated sites elsewhere in Wellington and in New Zealand. Practices to appropriately manage these contaminants in soil during earthworks are therefore relatively standard and well proven.

Contaminated groundwater

15. Some groundwater will have to be extracted from excavations during earthworks. Groundwater that comes into contact with contaminated soil can become contaminated. The level of contamination in groundwater depends on how easily the contaminant dissolves into the groundwater. The hydrocarbons and metals that are in soil at the site typically stick well to soil and do not readily dissolve into water.

16. Testing shows that groundwater at three bores on the site contains low levels of hydrocarbons and metals. All hydrocarbons tested and most metals were below the marine water quality guidelines that have been developed by the Australian and New Zealand Conservation Council for protection of 95% of marine species.

17. Because the soil has variable amounts of contamination, and because groundwater at the site is tidally influenced, it is possible that more highly contaminated groundwater may be present at locations or times that were not tested.

18. Ground disturbance may release contamination into water primarily by the release of contaminated suspended sediment into water.

CONTAMINATED SITE MANAGEMENT PLAN (CSMP)

19. Potential adverse effects on human health and the environment from disturbing contaminated soil arise from direct contact with contaminants and discharges, including dust, runoff, and disposal. Controls in the CSMP are designed to minimise these effects.

20. Details of the control methods are provided in the CSMP. I have summarised these below.

Disturbance of contaminated soil

21. The first earthworks will be the removal of asbestos contaminated soil. A visual inspection shall be carried out when the asphalt is removed, and potential asbestos containing materials shall be collected and tested. If the nature of asbestos contamination triggers the restricted works criteria, then the removal of asbestos-containing soil shall be done in accordance with the Health and Safety in Employment (Asbestos) Regulations 1998, including supervision by a person who holds an appropriate certificate of competence.

22. When asbestos-containing soil has been removed, the remaining fill shall be tested to confirm that controls to manage asbestos hazards are no longer needed. However, controls to manage other contaminants shall remain in place throughout the works, whenever contaminated soil is exposed. In general, controls to manage discharges during earthworks in contaminated soil include dust control and erosion and sediment control.

Disposal of contaminated soil

23. Surplus soil from the basement excavation has to be disposed offsite. Testing shows the contaminated soil meets criteria for disposal to landfill without pre-treatment. Soil that contains asbestos must be managed and disposed as asbestos-containing waste.

24. Some of the fill is clean. However, because of the variability of the fill, it would have to be tested to confirm it is clean before it could be disposed to clean fill.

25. Controls to manage the disposal, including truck loading and covering, wheel washing, and documentation, are detailed in the CSMP.

Dewatering

26. Groundwater that enters the excavations and stormwater that accumulates in the excavations following rainfall may have to be removed to enable earthworks to continue. Groundwater shall be tested before works begin to confirm the type of management that might be required before the water is discharged.

27. Possible management methods might include detention to remove sediment or chemical treatment. Managing stormwater to minimise the amount of rainwater that comes into contact with contaminated soil will minimise the amount of contaminated water that has to be removed from the excavation area.

Workers and future users of the site

28. During the works, contact with contaminated soil shall be minimised. This includes requirements for using appropriate personal protective equipment (such as gloves) and personal hygiene for site workers.

29. Additional controls (such as dusts masks or respirators) will be required while asbestos containing soil is present, if the concentration of asbestos in soil triggers the need for restricted works.

30. On completion of the works, contaminated reclamation fill will still be present beyond the excavated area. However, the basement walls and floor will prevent future building users from contacting the contaminated soil. Therefore, no validation testing is proposed, unless unexpected contamination is encountered. An example of unexpected contamination that would require further testing would be highly odorous material. The testing would be done to inform potential controls to manage volatile contaminants to protect future site users.

31. Because contaminated reclamation fill will remain in place beyond the excavation area, any future excavation works outside the basement would be subject to the same controls proposed for the basement excavation works.

SUBMISSIONS

32. Submissions 11 (Cullwick), 12 (Boardman), 13 (Swann), 14 (Greenwood), 15 (Underwood) and 29 (Ann Mitcalfe) concern matters within my area of expertise. I wish to address the following matters raised in the submissions:

(a) Five of the submissions (11, 13, 14, 15, and 29) describe concerns about the release of contaminants into the coastal waters during construction.

(b) Two of the submissions (12 and 15) describe concerns about disturbing contaminants in the ground.

33. The CSMP includes procedures to appropriately manage contaminated soil and water to minimise discharges into coastal waters and to minimise potential risks of disturbing contaminated soil on human health and the environment. The contaminants are commonly encountered on contaminated sites in Wellington and the procedures proposed are commonly used and well proven.

34. Implementing the CSMP will mean that discharges to coastal water cannot cause marine water quality to exceed water quality guidelines.

SECTION 87F REPORT

35. I have read the section 87F reports prepared for this matter.

36. I have the following comments on the “Contaminated Material” sections of Wellington City Council’s (**WCC**) report on Application One and Application Three, including paragraphs 150 to 154 and Annexure 6:

(a) I have no specific comments on WCC's summary of contaminated land at paragraphs 150 to 154, other than to note that Mr O'Leary accepts Mr Tearney's advice that the effects related to contaminated material will be minor and effects can be controlled through appropriate consent conditions.

(b) The conditions proposed by WCC are consistent with those recommended in Annexure 6. My comments on the proposed conditions are provided below.

(c) WCC has proposed that a final CSMP is submitted before the ground disturbance works start, and that a completion report is submitted after the earthworks are complete (refer conditions 17 and 21 for Application One and Conditions 28 and 25 for Application Three). I agree these are appropriate requirements.

(d) WCC has proposed that a Removal Plan for soil containing asbestos is prepared (refer condition 22 for Application One). I agree this is appropriate.

(e) WCC has proposed conditions for the disposal location, including testing to confirm the suitability of any soil for disposal as clean fill and recordkeeping (refer conditions 18 and 19 for Application One and conditions 27 and 26 for Application Three). I agree these conditions are appropriate.

(f) WCC has proposed validation testing is carried out on the walls and base of the basement excavation in the event that unexpected contaminated soil is encountered (refer Condition 20 for Application One). I agree this is appropriate.

37. I have the following comments on the parts of Greater Wellington Regional Council's (**GWRC**) report that relate to ground contamination, which include paragraphs 4.5.1, 9.1.2, 9.1.3 and 9.1.4, including specific comments on the proposed consent conditions dated 31 March 2015 for WGN150102 [33224] and [33226]:

(a) GWRC has proposed a Construction Management Plan is prepared before works begin setting out how groundwater shall be managed (refer paragraph 9.1.4 and [33224] condition 6 and [33226] condition 7). I agree this is appropriate.

(b) GWRC has proposed that water dewatered from Site 10 is tested for pH, total suspended solids concentration (TSS), total copper, total lead, and total zinc, and has proposed that compliance limits are set for any discharges (refer [33224] conditions 12 and 13). I address each of these in turn.

(i) I agree it is appropriate to monitor pH, but I consider the proposed compliance limit range for pH of 6 to 8.5 could potentially be broadened to include slightly higher pH without adverse effects, given that the discharge is to marine water. An upper value of 9.5 may be appropriate, however, this will depend on the volume of water discharged, and therefore should be reassessed when that is known, because it would not be appropriate to discharge large volumes of high pH water.

(ii) I agree it is appropriate to monitor TSS and I agree with the proposed approach of calculating the compliance limit for TSS when the volume of dewatering water is known. This approach will allow for dilution to be taken into account appropriately. I agree this approach would address Dr Oliver's comments (refer paragraph 9.1.2) that the treatment method, water quality of the treated water and the receiving environment should be considered in determining an appropriate compliance limit.

(iii) I agree it is appropriate to monitor copper, lead, and zinc, but I consider the proposed test method and compliance limits to be inappropriate. GWRC propose testing for **total** copper, lead, and zinc, and using the ANZECC guidelines for protection of 80% of marine species as compliance limits for total concentrations.

(iv) I note that in GWRC's discussion of Dr Bull's recommended trigger values, GWRC do not specify total or dissolved metals but do refer to the ANZECC guidelines (refer paragraph 9.1.2). The biologically relevant fraction of metals is the **dissolved** fraction, and the ANZECC guidelines for metals apply to the **dissolved** fraction. Therefore, I consider the test and compliance limit should be for the **dissolved** fraction.

(v) I consider it would be appropriate to apply a dilution factor when setting the compliance limit. This would be consistent with the approach GWRC propose for TSS. I consider it would be appropriate for the "Note" that is currently associated with Condition 13(b) to apply to each of conditions 13(b), (c), (d), and (e).

(c) GWRC has proposed that water quality results are reported (refer paragraph 9.1.4 and condition 14 of [33224]). I agree this is appropriate.

CONCLUSIONS

38. The contaminated soil at Site 10 is typical of fill in the Wellington reclamations of the same age.

39. Implementing the procedures set out in the Contamination Site Management Plan will minimise potential adverse effects of the works.

40. I consider the conditions relating to "Contaminated Material" proposed by Wellington City Council are appropriate.

41. I consider the conditions proposed by GWRC are generally appropriate, but I consider the approach GWRC has proposed for the TSS compliance limit should also be used for the metals compliance limits, and that the compliance limits for metals should apply to the dissolved fraction.

PE Kneebone

Penelope Emma Kneebone
3 July 2015

ATTACHMENT A: Curriculum Vitae

Tonkin & Taylor • CURRICULUM VITAE

Penelope Emma Kneebone

Qualifications

PhD, Environmental Engineering Science, Chemistry Minor, 2000
California Institute of Technology, Pasadena

BSc(Hons, 1st), Chemistry, 1994
University of Otago

Employment Record

Tonkin & Taylor Ltd **2006 To Present**	*Principal Environmental Scientist*
ENVIRON International Corp **Newark, New Jersey** **2004 To 2005**	*Manager*
BE&K/Terranext **New York, New York** **2002 To 2004**	*Environmental Scientist*
ENVIRON International Corp **Emeryville, California and Princeton, New Jersey** **2000 To 2002**	*Senior Associate*

Example Project Descriptions

Contaminated Site Assessment - Multiple Locations	Conducted and managed contaminated land investigations at multiple commercial and industrial sites throughout New Zealand. Reviewed historical information, council files, and conducted site walkover inspections to evaluate potential for contamination. Developed sampling and analysis plans for soil and ground water investigations to support pre-purchase assessments, development works, and to develop remedial actions. Sites include those contaminated by historical gasworks, fill, timber treatment, chemical manufacture, oil use and storage, laboratories, military activities, closed landfills.
Site Management Plans, multiple locations	Prepared site-specific Contaminated Site Management Plans for several developments in the Wellington region. Plans incorporate relevant controls for management of contaminated material, and are used to support resource consent applications or provide guidance to contractors.

CSRF Application Review Ministry for the Environment	Served as panel member to review applications to the Ministry for the Environment's Contaminated Sites Remediation Fund (CSRF). Role includes review of application information, completing a Scoring Sheet for each application, and attending a meeting of the assessment panel to discuss the applications and provide recommendations to MfE regarding funding.
Contaminated Sites Advice Wellington City Council	Provide peer review of ground contamination aspects of resource consent applications for Wellington City Council, on an as-required basis.
Environmental Management Guidelines, NZDF Small Arms Ranges, NZDF	Prepared guidelines for environmental management of NZDF's small arms ranges, including practices to manage an ongoing source of contamination and minimise future environmental liability. International best practice was reviewed and concepts applicable to the New Zealand situation were selected.
Landfill waste evaluations, Hutt City Council, Marlborough District Council, Wellington City Council	Review waste disposal applications for special wastes and contaminated soil. Advise on whether wastes are acceptable for disposal, or whether additional analytical data or process details are required to evaluate an application.
Contaminated Site Remediation, AgResearch	Managed remediation works at the former Animal Research Facility in Upper Hutt. Prepared Remedial Action Plan, resource consent applications, and Site Validation Report for the works. Sources of contamination on site included sheep dips, underground storage tanks, historical waste disposal sites, asbestos, and lead based paint residues around historical buildings.
Contaminated sediment assessment, CentrePort	Prepared staged sediment sampling programme to characterise sediment to be removed during dredging operations at wharves in Wellington Harbour.
Contaminated sediment disposal characterisation Hutt City Council and Marlborough District Council	Reviewed sediment quality data to determine disposal options for contaminated sediment excavated from Picton Harbour and Waiwhetu Stream. Assessed variability of sediment contamination and advised on sampling density to provide sufficient data for characterisation of contaminant levels.
Contaminated site assessment, Ardmore Military Training Area, NZDF	Carried out site investigation of soil, sediment, groundwater and surface water to characterise contamination in range redevelopment area. Prepared Remediation Action Plan and technical reports for resource consent application.
Site Subsurface Investigation, multiple sites United States Various	Developed sampling and analysis plans for soil and ground water investigations at industrial and institutional facilities for development and pre-purchase assessment. Conducted site investigations, liaised with relevant authorities, prepared sampling and analysis plans, engaged subcontractors, managed field geologists, and analysed results to prepare recommendations regarding site condition. Sites included proposed brownfield redevelopment on historical fill material on the East River in Manhattan; electronics manufacturer in Chicago; and metal fabrication plants in New York, Connecticut, Seattle, Washington, and Bielefeld Germany.
Litigation Support, hydrologist's expert report Freeport, Texas Dow Chemical	Evaluated historical chemical use, production processes, waste management, and ground water transport at a major chemical production facility on the Gulf Coast of Texas. Conducted chemical transport modelling, document review, literature research, and prepared sections of senior hydrologist's expert reports and technical briefs for environmental litigation related to insurance recovery.
Chromium and arsenic fate and transport, California Flow Science	Evaluated arsenic and chromium mobility in ground water with particular attention to the role of element speciation and redox potential. Resulting report formed the basis of a ground water remediation program at a Superfund site.

Feasibility Study, Superfund site, Hawaii **US Navy**	Performed vadose zone and groundwater modelling, screened remedial technologies for ground water cleanup, and developed remedial alternatives to address ground water contamination beneath a Superfund site impacted by chlorinated solvents.
Graduate Research, Caltech California **1996-2000**	Developed field and laboratory programmes to evaluate the potential for release of arsenic from sediments in the Los Angeles Aqueduct if upstream water were treated for arsenic removal. Lakes and rivers in three sections of the aqueduct were examined to elucidate the extent and controls on sediment-water exchange of arsenic. Designed, organized, and implemented field sampling expeditions in which surface water, sediment, and sediment pore waters were sampled and analysed using a range of novel and traditional techniques, including ion chromatography (IC), inductively coupled plasma mass spectrometry (ICPMS), coupled IC-ICPMS, selective chemical extraction, and x-ray absorption spectroscopy. Laboratory studies complementing the field measurements were designed and conducted to determine controls on sediment-water exchange of arsenic. Results were combined to provide a detailed report (Ph.D. thesis at Caltech) on the status of arsenic problems in the Los Angeles Aqueduct system.

Publications

Biogeochemical Controls on Arsenic Occurrence and Mobility in Water Supplies with J. G. Hering
The Environmental Chemistry of Arsenic, W. Frankenberger ed.; Marcel Dekker New York, 2002

Evolution of Arsenic Speciation in Reservoir Sediments Deposited by in situ Treatment of Surface Water for Arsenic Removal with P. A. O'Day, N. Jones, and J. G. Hering
Environmental Science and Technology, 2001

Behavior of Arsenic and Other Redox-Sensitive Elements in Crowley Lake, CA: A Reservoir in the Los Angeles Aqueduct System. with J. G. Hering.
Environmental Science and Technology, 2000

Arsenic Geochemistry in the Los Angeles Aqueduct System
Ph. D. Dissertation, California Institute of Technology, 2000

Evolution of Arsenic Speciation in Sediments Deposited by In Situ Treatment of a Surface Water Supply for Arsenic Removal. with J. Hering, N. L. Jones, and P. O'Day.
American Chemical Society, National Meeting.; Washington, DC, 2000

Redox cycling of Arsenic in Geothermally-Influenced Surface Waters. with Hering, J. G., J. A. Wilkie and T. Salmassi.
Geological Society of America, Annual Meeting.; Denver, CO., 1999

Redox Cycling of Arsenic in Lake Crowley, CA: Implications for Water Quality in the Los Angeles Aqueduct. with J. G. Hering.
American Society of Limnology and Oceanography, Annual Meeting.; Santa Fe, NM., 1999

Application of Electrospray Mass Spectrometry to the Characterisation of Tertiary Arsine Ligands with Fitzpatrick, M. G., L. R. Hanton, W. Henderson, E. G Levy, L. J. McCaffrey.
Inorganica Chimica Acta, 1998

ATTACHMENT B: Ground Contamination Assessment

REPORT

Willis Bond Ltd

Ground Contamination Assessment Wellington Waterfront Sites 8, 9, 10

Report prepared for:

WILLIS BOND LTD

Report prepared by:

Tonkin & Taylor Ltd

Distribution:

WILLIS BOND LTD	**1 pdf copy**
Tonkin & Taylor Ltd (FILE)	**1 pdf copy**

February 2014

T&T Ref: 85778.001

Table of contents

1 Introduction

Tonkin & Taylor (T&T) has been engaged by Willis Bond Ltd (WBL) to undertake a contamination investigation of Site 10, and to compile the results of that investigation with the results of an assessment of Sites 8 and 9 that was done in 2009 for Wellington Waterfront Ltd. Sites 8, 9, and 10 cover most of the area proposed to be developed (Figure 1). The results of assessments at Sites 8, 9, and 10 provide a basis for developing contamination management measures for the proposed development area.

1.1 Proposed site development

An overview of the site development is provided in Figure 1 (see Appendix A for larger version).

WBL proposes to develop Site 10 by constructing a multistorey building. The proposed works are likely to comprise of basement excavations to 3.7 m depth, and possibly deeper foundation excavations.

Landscaping works are proposed in the Landscape Areas (except Site 9 which will remain as a carpark) to create public open space areas (refer Figure 1). We understand approximately 1,000 m^3 of cut material may need to be removed from Site 8 (if it is geotechnically unsuitable), with cuts a maximum of 1 m deep. No significant cut is proposed elsewhere in the proposed Landscape Area, however, it is expected that limited soil disturbance will be required for surface preparation works. The public space areas shall be finished with either paving underlaid by imported fill or imported clean landscaping fill materials.

Previous desk studies at Site 10 (2008, 2011) and limited investigations at Sites 8 and 9 (2009) have identified potential sources of ground contamination (reclamation fill).

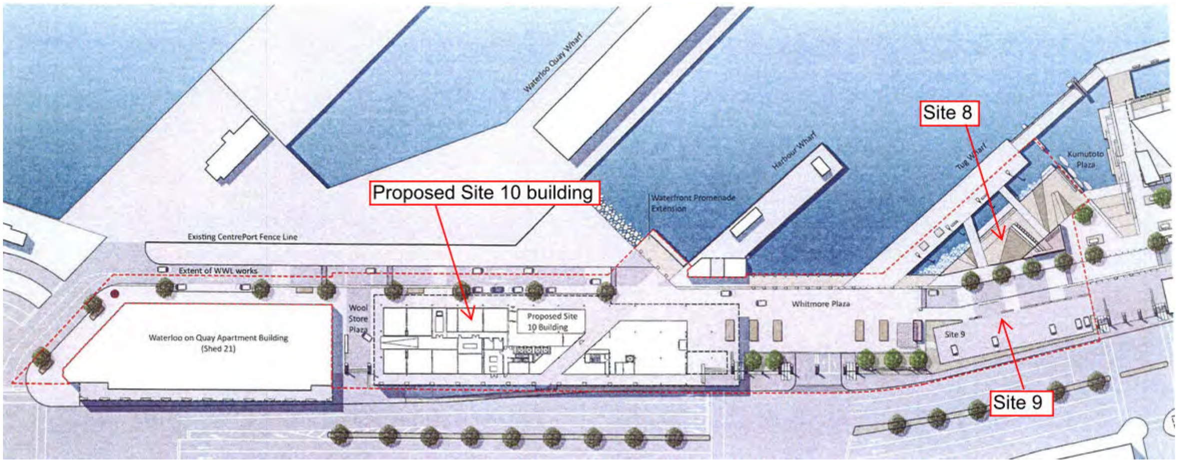

Figure 1: development master plan (Source: Isthmus)

1.2 Objective

The objective of this report is to combine the results of the Site 10 investigations with results from 2009 investigations at Sites 8 and 9 to develop a draft Contamination Site Management Plan (CSMP) for the works (see Appendix D). The objective of the Site 10 investigations is to characterise potentially contaminated material that is proposed to be excavated for the Site 10 building basement.

1.3 Scope of work

We have undertaken the following scope of works:

- Reviewed draft desk study report and limited site investigations carried out for Sites 8 and 9 in 2009 (T&T reference 84496.001, *Sites 8 and 9 Geotechnical and Ground Contamination Investigation: DRAFT*, prepared for Wellington Waterfront Ltd, July 2009).
- Requested information on historical pollution incidents for Sites 8, 9, and 10 from Greater Wellington Regional Council.
- Reviewed Wellington City Council (WCC) Archives files and historical aerial photographs to identify historical building locations at Site 10;
- Obtained underground service plans;
- Selected positions for 9 window sampler boreholes at Site 10;
- Collected soil samples to 3 m depth at each location to characterise the material that will be excavated to form the proposed basement;
- Tested selected samples for potential contaminants based on the site history;
- Compared laboratory results with expected background concentrations and landfill disposal criteria; and
- Provide recommendations on management and disposal method for excavated soil, including a draft Contamination Site Management Plan for the works (see Appendix D).

2 Site description

2.1 Site location

The outline of the proposed Landscape Area is shown in the development plan (Figure 1 Appendix A).

Site 10 is located to the east of Waterloo Quay in Wellington, as shown on Figure 2 (Appendix A). It is roughly rectangular in shape and has an area of approximately 0.25 ha. It covers most of Lot 102 DP 65083 and extends approximately 14.4 m into the northern end of Lot 1 DP 363596 and 3 m into the southern end of Lot 9 DP 65083.

2.2 Site description

The Landscape Areas are currently surfaced with asphalt and used as public open space, parking and access roads.

Site 10 is currently used as a car park and motor home park. It is essentially flat and entirely paved. An amenities block is located on the eastern boundary of Site 10. Access is via a paved road immediately to the south of the amenities block.

Waterloo Quay is west of the site, beyond a metal fence. To the east are access roads and further car parking areas. Shed 21 is located immediately to the north of Site 10.

2.3 Geology and hydrogeology

Based on published information, the land beneath Sites 9 and 10 and the areas between these two sites was reclaimed around 1900. Site 8 was reclaimed in the 1970s. The original seawall forms the boundary between Sites 8 and 9.

According to the published geological map[1], the site is described as reclaimed land, with fill consisting of domestic waste, sand, boulders and rock.

There are no surface water features on the site. Lambton Harbour is adjacent to Site 8, and approximately 11 m southeast of the proposed basement on Site 10 at its closest point. Based on the proximity to the harbour, general shallow groundwater flow direction is expected to be towards the southeast. Groundwater level is expected to fluctuate with the tide.

3 Site history

Site history information has been established from a variety of sources, including published information, T&T records, Wellington City Council (WCC) Archives files, Greater Wellington Regional Council records, and historical aerial photographs. All records viewed are summarised below. Key features for Site 10 are shown on Figure 2.

3.1 WCC Archives files

WCC Archives file for Site 10 was viewed on 28 May 2014. Key features are shown on Figure 2.

An 1892 survey plan indicates that the site location is unreclaimed in 1892. The closest wharf structure is referred to as Wool Wharf (currently known as Waterloo Wharf).

A 1901 contract document (titled *Contract 107*) contained the specification of the construction of a new building named Shed U to be erected on the site. A floor for a wool press was specified. A ground plan drawing for Shed U (Drawing 3) indicates that the wool press floor was located at ground level. This drawing also indicates a railway platform running along the full western length of the building. The purpose of the railway platform is unclear, however it is likely it would have included the movement of goods and cargo from the nearby shipping docks. An office block is located in the north western corner and public toilets in the south western corner.

A plan, dated 1902, titled *Arrangement of patent hydraulic working valves for U Store Wool Presses,* is located on the WCC Archives database. This plan was not viewed, but its title confirms that Shed U was likely to have been used as a wool shed.

In 1921, A Wellington Harbour Board notice was issued, which renumbered the sheds and stores along the Wellington Harbour. Shed U was renumbered Shed 17.

A 1947 contract document (titled *Demolition of Parapet and re-roofing of Shed 17*) contained the specifications for reroofing Shed 17 with asbestos cement roofing product. Super Six corrugated sheets were specified for the whole roof.

A building permit, dated 5 June 1986 is on the WCC Archives database. The building permit was not viewed, however its title *Waterloo Quay, Demolish Wharf Shed No 17,* indicates that the building was removed in 1986.

3.2 Historical certificates of title

Historical certificates of title dating back to 1894 indicate that the site was previously owned by the predecessors of Wellington Waterfront Limited (Lambton Harbour Overview Limited and Wellington Harbour Board).

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[1] Begg, J.G., Johnston, M. R., (compilers), 2000, Geology of the Wellington Area, Institute of Geological and Nuclear Sciences, 1:250,000 geological map 10. 1 sheet + 64p. Lower Hutt, New Zealand, Institute of Geological and Nuclear Sciences Limited.

3.3 Historical aerial photographs

Historical aerial photographs reviewed in 2009 indicate that Sites 8 and 9 have been paved and used for car parking and access roads since sometime after 1980.

For Site 10, historical aerial photographs from WCC's GIS, and Alexander Turnbull Library (online collection) were reviewed. The key observations of Site 10 and surroundings are summarised in Table 3.1.

Table 3.1: Summary of historical aerial photographs: Site 10

Date (Source)	Onsite features	Offsite features
1905 (Alexander Turnbull Library oblique)	The corner of a large building (inferred to be Shed 17) can be seen at the inferred site location. On the south side of the site, there appears to be a pedestrian walkway between Shed 17 and the adjacent building.	The wharf structure and Wellington harbour is located east of the site. A multistorey building is located south of the site.
1934 (Alexander Turnbull Library oblique)	The roof of one large building (Shed 17) occupies the entire site, except for a small area at the southern end (inferred to be a pedestrian walkway). The use of this building is unknown, but may have included a wool shed.	No significant change A main road (currently known as Waterloo Quay) is adjacent to the western boundary.
1951 (Alexander Turnbull Library oblique)	No significant change.	No significant change.
1996 (WCC GIS)	The building has been removed. The site is fully paved and is being used as a car park.	The land adjacent to the eastern site boundary has been reclaimed as the Wellington harbour no longer directly adjacent to the eastern site boundary.
2004 (WCC GIS)	No significant change.	No significant change.
2013 (WCC GIS)	The northern half of the site is being used as a motor home park. A small building is present at the eastern side of the site (inferred to be the amenities block).	No significant change.

3.4 Reclamation history

Based on published information[2], the majority of the land beneath Sites 9 and 10 and the area between these two sites was reclaimed in the early 1900s. The source of this reclamation fill is unknown. We understand Site 8 was reclaimed in the 1970s, using quarried gravel.

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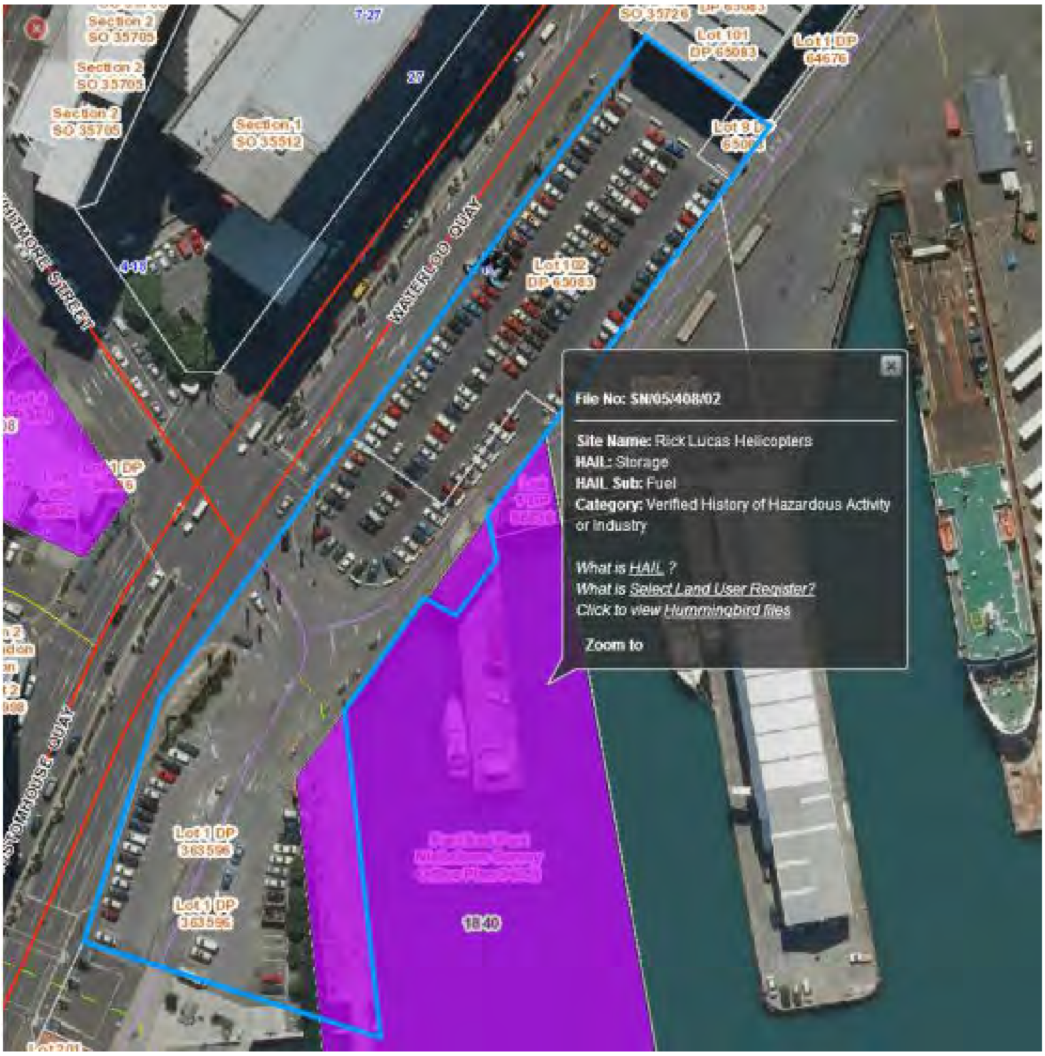
[2] S.B Semmens (2010). An Engineering Geological Investigation of the seismic subsoil classes in the Central Wellington Commercial Area. Volume One: Thesis.

3.5 Greater Wellington Regional Council files

Site 10 is not listed on GWRC's database of potentially contaminated sites (the Selected Land Use Register (SLUR)).

Small parts of the public space area intersect with part of a "Queens Wharf" area that is listed on GWRC's SLUR database (see purple area marked on Figure 3, below). The Queens Wharf area is listed on the SLUR due to a 10,000 litre aboveground fuel tank used by Rick Lucas Helicopters. No further information regarding the age or condition of the tank is held by GWRC. This is not expected to affect landscaping earthworks.

GWRC does not hold any records of pollution events or ground contamination at the site.



File No: SN/05/408/02

Site Name: Rick Lucas Helicopters
HAIL: Storage
HAIL Sub: Fuel
Category: Verified History of Hazardous Activity or Industry

What is HAIL ?
What is Select Land User Register?
Click to view Hummingbird files

Figure 3: parts of site that intersect the Queens Wharf SLUR listing (purple zone). Source: GWRC

4 Potential for contamination

The source of the reclamation fill at Sites 9 and 10 and the area between is unknown. Contaminants typically associated with reclamation fill encountered elsewhere on the Wellington waterfront include metals, polycyclic aromatic hydrocarbons (PAH) and asbestos.

Site 10 has been used as a wool store. There is potential for hydrocarbon contamination at the base of lift shafts. Asbestos-containing building material was identified in the Shed 17 re-roofing specifications (Super Six corrugated sheets). This building was demolished in 1986, and surface soil contamination from asbestos is possible resulting from the demolition.

4.1 Conceptual site model

For there to be an effect from the proposed activity there has to be a contamination source and a mechanism (pathway) for contamination to affect human health or the environment (receptor). Table 4.1 summarises potential sources, pathways, and receptors in order to assess possible environmental and human health risks associated with the known site conditions.

Table 4.1: Summary of potential effects of proposed site use

	Source	Pathway	Onsite Receptors	Offsite Receptors
During construction works	Contaminated fill	Inhalation (dust), dermal contact, incidental ingestion	Construction workers	Surrounding commercial workers General public –road, pedestrians Discharge via stormwater runoff
	Contaminated groundwater generated during dewatering	Discharge to harbour via stormwater network	Construction workers	Flora and fauna of Wellington Harbour Recreational harbour users
On completion of works	Contaminated soil beneath basement and beneath paving	Inhalation (dust), dermal contact, incidental ingestion	Maintenance workers No other receptors as site is likely to be fully paved.	None - site is likely to be fully paved.

4.2 Relevant guidelines

Guidelines are summarised in the results tables, included in Appendix C. Sources of all guideline values are provided in the footnotes to each table.

4.2.1 Soil

Based on the proposed site use (commercial – Site 10 and public open space – Landscape Areas), soil test results have been compared with:

- Expected background concentrations, selected from *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region*, August 2003, prepared by URS for GWRC (URS 2003). Because the source of fill is unknown, results have been compared with the full range of expected background concentrations for the Wellington Region.
- Human health guidelines for commercial site use (unpaved), selected in accordance with the hierarchy set out in the Ministry for the Environment (MfE)'s *Contaminated Land*

Management Guidelines No. 2 – Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011). The hierarchy requires use of New Zealand risk-based values where these exist. The Soil Contaminant Standards referred to in the *Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011* (the NES Soil) take precedence. International risk-based guidelines are used where no New Zealand guidelines exist. There is potential for construction workers to have direct exposure to contaminated material during the construction of building foundations and service trenches. The guidelines for commercial site use is considered appropriate for the period of construction.

Note: There are no guidelines for maintenance workers under the NES Soil. Instead, good health and safety practices are recommended.

- Guidelines for offsite soil disposal:
  - Clean fill: contaminant concentrations must be consistent with expected background concentrations. Greater Wellington Regional Council relies on the interpretation of clean fill provided in the MfE's *Guide to Management of Clean Fills* (2002); concentrations above background or the detection of PAHs precludes waste from disposal at clean fill. <u>We note that Wellington soils do contain a detectable background level of PAH (refer URS 2003).</u>
  - Landfill: MfE's *Waste Acceptance Criteria for Class A Landfills* (2003). If the landfill acceptance criteria are exceeded, material may require pre-treatment, either onsite or at a specialist waste treatment facility (e.g. Transpacific, Seaview) prior to being accepted at landfill.

We are not aware of any defined acceptance value for asbestos fibre in soil. To date no method has been formed that reliably predicts the concentration of asbestos in air given the concentration of asbestos in the source. The approach adopted is to implement health and safety controls when friable asbestos is present in soil and monitor for the presence of asbestos in air during works which could disturb the fibres. If surplus soil containing asbestos has to be disposed off-site, it must be disposed to an appropriately consented landfill. Landfills in the Wellington region that can accept asbestos-containing soil include Southern Landfill and Silverstream Landfill.

4.2.2 Groundwater

Groundwater results are assessed against the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Conservation Council (ANZECC) 2000, Volume 1; Marine water, 80% protection of species. This level of protection is considered appropriate as stormwater discharges to the Wellington Harbour, which is considered to be a moderately disturbed environment.

Based on expected dilution in the harbour, for the purposes of assessing the effects of discharge of groundwater to the harbour via stormwater (e.g., during dewatering), it would be appropriate to apply a dilution factor to results. An appropriate dilution factor can be developed by evaluation of discharge volumes and dispersion by a contaminated land specialist, once discharge volumes are known.

5 Previous investigations: Sites 8 and 9

Limited soil sampling and testing was conducted in 2009 to investigate the potential for contamination in fill material at Sites 8 and 9.

5.1 Sample locations

Samples were collected using clean gloves from SPT samples retrieved during geotechnical investigations. Boreholes for sampling were selected to provide coverage of the site. Sample depths were selected to target specific layers within the fill material. At Site 8, 2 soil samples were collected from 1 borehole (2 samples). At Site 9, 2 soil samples were collected from each of 2 boreholes and 2 window sampler holes (i.e., a total of 8 samples from Site 9). All samples were tested for a suite of 7 metals, and 3 samples were tested for polycyclic aromatic hydrocarbons (PAH).

5.2 Observations

No visual or olfactory evidence of contamination was noted in fill material on Site 8 (1970s fill). Fill materials in Site 8 were consistent across the site, which is consistent with the reclamation history of Site 8 (placement of quarried fill). Fill material on site 9 (1903 fill) was more variable, with some layers having a slight hydrocarbon odour.

5.3 Results: Sites 8 and 9

Results are provided in Table C1 in Appendix C.

All results for Sites 8 and 9 were well below guidelines for commercial use of the site. Therefore, there is no requirement to remove soil from the site due to contamination. However, if fill material is exported from the site, there are implications for management and disposal.

Fill material from Site 8 (1970s fill) can potentially be managed as clean fill. Concentrations of metals and PAH in the two samples of fill material on Site 8 (1970s fill) were consistent with expected background. These results and the consistency of materials observed across Site 8 indicates fill in Site 8 is likely to be suitable to be managed as clean fill. If fill material from Site 8 is to be excavated and disposed offsite, additional testing should be done on excavated material (or prior to excavation, when proposed excavation locations are known), to confirm this.

Fill material from Site 9 (1903 fill) is not clean and would need to be managed at a consented landfill. Metals and PAH exceeded expected background concentrations in 3 of the 6 samples of fill material from Site 9 (1903 fill material), and 2 of the samples exceeded landfill acceptance criteria. Because only limited testing was conducted in the area of 1903 fill, and because of the variability of the fill, it is possible that some of the fill is clean. However, we understand that Site 9 is to continue to operate as a car park and therefore no fill material from Site 9 will be disturbed nor removed from the site.

Remainder of Landscape Area (1903 fill): no testing has been done in the remainder of the Landscape Area, but based on the fill history (1903 fill), materials are expected to be variably contaminated, similar to Site 9. Testing of materials to be disturbed would be required to assess contamination. This testing could be done either before excavation begins, or on materials stockpiled before disposal offsite. If a large quantity of the 1903 fill is to be exported from the site, it may be worthwhile to carry out delineation testing to identify if any of the material is clean. In the absence of further testing, the 1903 fill must be presumed to be non-clean fill, and must be managed at a consented landfill (e.g., Southern Landfill). A formal application to the landfill would be required. Because some metals exceed landfill acceptance criteria, the landfill manager may require leaching testing to confirm that the fill is acceptable for landfill disposal

6 Site 10 investigations

6.1 Soil sample collection: Site 10

Intrusive investigations were carried out at Site 10 on 23-24 April 2014, at the locations shown on Figure 2 (Appendix A).

The investigations comprised 9 window sampler boreholes (WS1 – WS9) to a maximum depth of 3 m. Samples were collected from each layer of material encountered. WS1 and WS3 refused at depths of 1.2 m and 1.0 m respectively on what appeared to be concrete, and deeper fill was not tested. Window sampler logs are provided in Appendix B.

Samples were collected using a hand trowel and clean gloves. The hand trowel was cleaned between sample locations and fresh gloves were used for each sample. All samples were collected using clean latex gloves and placed into clean jars provided by Hill Laboratories. All samples were placed on ice and transferred to the laboratory under chain of custody documentation.

Based on site history and observations, selected samples of fill were tested for polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), asbestos, and metals.

6.2 Groundwater sample collection: Site 10

Groundwater was encountered at WS2 and in WS49. The depth to groundwater was approximately 1.6m – 2m. A standpipe was installed in WS2 (P2, refer Figure 2 in Appendix A). An existing standpipe (P1, refer Figure 2 in Appendix A) was also sampled.

Groundwater level was measured once the water level had been given time to stabilise. P1 was dipped at approximately high tide on 6 May 2014 at 1.72m and P2 was dipped at mid-tide on 12 May 2014 at 1.55m below ground level. Monitoring groundwater level at different tides would confirm the range of depths to groundwater.

A groundwater sample was collected from P1 on 6 May 2014. The standpipe was purged in 2L intervals using a peristaltic pump, until pH and conductivity stabilised for three consecutive readings. A total of 8L was purged prior to collecting a sample.

A groundwater sample was collected from P2 on 12 May 2014. The standpipe was purged in 2L intervals using a peristaltic pump, until pH and conductivity stabilised for three consecutive readings. A total of 10L was purged prior to collecting a sample.

The groundwater extracted for both samples was clear and no odour or surface sheen was noted.

All samples were placed into clean sample bottles prepared by the laboratory. The sample was sent to Hill Laboratories under chain of custody documentation.

Groundwater samples were filtered at the laboratory and tested for trace metals and PAH. The laboratory report is appended as Appendix C.

6.3 QA/QC: Site 10 sampling

Four duplicate soil samples and one groundwater sample were tested to check the variability of the samples. The results are provided in Tables C6 and C7 (Appendix C). In general, the results agreed well (most within 40%). Those results greater than 40% were generally low concentrations (typically less than 1 mg/kg), relative to which a large percentage difference was seen. This variability indicates heterogeneity in the fill material, and must be considered when interpreting the data.

For metals, the only duplicate pairs with relative percent difference greater than 50% were in the more highly contaminated layer of fill (WS5 2.65 m/Duplicate 2 and WS6 1.5 m/Duplicate 3). The variability in PAH concentrations was much higher, as expected in fill. The variability in the results does not have a material effect on the proposed management of this material (landfill disposal).

The variability in the duplicate pair of samples considered "clean" (WS9 2.75 m/ Duplicate 4) was less than 50% for metals, but ranged up to 67% for PAH. The PAH concentrations were low in both samples of the pair, and therefore the variability does not materially affect the proposed management of this material (disposal to landfill, or cleanfill only after testing confirms the material is clean).

6.4 Results and implications: Site 10 basement excavation

Soil results are summarised in Tables C2-C3 (Appendix C). Interpretation is based on selected samples from 9 window sampler holes, as shown on Figure 2 (Appendix A). The nature and continuity of subsoil away from the sample locations is inferred but it must be appreciated that actual ground conditions could vary from the assumed model.

Within the Site 10 basement excavation (0-3.7 m depth) we have identified potential zones with different contamination present (see Figure 2, Appendix A). Contamination management methods are provided in the draft Contamination Site Management Plan (Appendix D).

Zone 1:

- 0-1 m depth: potentially clean, pending confirmatory testing (before or after excavation) ~~if any unexpected material is encountered~~.
  - The upper 0.5 m of fill at WS8 and WS9 was visually consistent with material at the same depth at WS5, and the sample from 0.45 m depth at WS5 was consistent with expected background.
  - Below 0.5 m and to approximately 1.5 m, material at WS8 is sand with gravels and some silt, yellowish brown, and containing brick fragments (cement fragments become present only below 1.5 m). This fill at WS8 was tested at 1.2 m and was consistent with expected background.
  - The material at WS9 is similar to WS8 to 1.5 m depth. (Below 1.9 m depth at WS9 soil is sand with some gravel, and has elevated PAH, as characterised by WS9 1.5 m.)
  - We have therefore conservatively assumed that up to 1 m within this area is potentially clean.
- 1-2 m depth: contaminated (metals and PAH). This material cannot be disposed as clean fill. However, all results are within commercial use guidelines, and the material is expected to be acceptable for landfill disposal (at an appropriately consented landfill, e.g., Southern Landfill or Silverstream Landfill) without pre-treatment.
- 2-3 m depth: potentially clean, pending confirmatory testing (before or after excavation) ~~if any unexpected material is encountered~~.
- 3-3.7 m depth: unknown. Potentially clean, pending confirmatory testing.

Zone 2:

- 0-0.75 m depth: potentially clean, pending confirmatory testing (before or after excavation) ~~if any unexpected material is encountered~~.

  - This area has 0.1-0.2 m of asphalt and basecourse underlain by sand fill with some silt and greywacke gravel to 1.6-1.9 m deep. This fill is characterised by samples WS4 0.85 m and WS5 0.45 m. While some results were slightly higher than background, given the variability demonstrated by the QA results, the fill is considered to be generally consistent with background.
  - Some brick fragments are present in some of the fill (at WS2, WS4, and WS6). Sample WS2 0.6 m was collected from this material. PAH and zinc in this sample are higher than background (other metals are considered generally consistent with background).
  - Due to the presence of more brick material at WS6 below 0.75 m depth, we conservatively assigned a depth to this potentially clean layer of 0.75 m.
- 0.75-2.75 m depth: contaminated (metals and PAH). This material is expected to be suitable for disposal to landfill without pre-treatment (e.g., Southern or Silverstream). Most soil in this layer is within commercial use guidelines, with the exception of a layer approximately 50-100mm thick at 1.7-1.8m depth, which had a strong hydrocarbon odour and had the appearance of *cold-mix.* Although total PAH within this layer exceed preliminary landfill screening criteria, because PAH compounds bind strongly to soil, it is expected this material would be acceptable without pre-treatment. The PAH concentrations in this thin layer exceeded the commercial use guidelines. However, as it is to be removed from the site, this is not a constraint for site development.
- 2.75-3 m depth: potentially clean, pending confirmatory testing ~~if any unexpected material is encountered during excavation~~.
  - A yellow, coarse sand layer was present at depth at some locations (WS2 below 2.7 m, WS4 below 2.5 m; WS5 below 2.75 m). This material was also present at WS9 (from 2.55 m). Samples characterising this yellow sand are WS2 2.9 m, WS5 2.85 m, and WS9 2.75 m. All of these are generally consistent with background.
  - At WS4, a grey silty sand is present below 2.5 m, and at WS6, a coarse dark reddish brown sand is present below 1.9 m. These materials are characterised by WS4 2.7m and WS6 2.5 m, which are generally consistent with background.
  - At WS7, a dark silty sand with coarse brick fragments is present below 2.6 m. This material contains elevated PAH.
  - We have conservatively selected a depth of 2.75 m as the top of the potentially clean material.
- 3-3.7 m depth: unknown. Potentially clean, pending confirmatory testing.

Zone 3:

- 0-1.2 m depth: elevated metals, PAH, and asbestos. The asbestos is described as bundles and loose fibres, indicating it is friable. Metals and PAH are above expected background concentrations. This material is expected to be suitable for disposal to landfill, but would have to be disposed as special waste due to the presence of asbestos. Special waste requires special handling at a landfill, and typically attracts a higher disposal rate to reflect this.
- 1.2-3.7 m depth: unknown – could not be accessed, due to a concrete slab. Based on the nature of fill encountered at other locations of the site, we would expect fill below the concrete slab may contain contamination above background, but is unlikely to contain asbestos. This material is expected to be suitable for disposal to landfill. Further testing after removal below the concrete slab would be required to confirm this. It would be appropriate to do this testing during the works after the concrete slab has been removed. This testing is set out in the draft CSMP (Appendix D).

6.5 Groundwater results

Fill around and below groundwater level has elevated metal and PAH concentrations. Therefore there is the potential for elevated concentrations of metals and PAH in groundwater. If groundwater contamination is present on the site, there may be constraints on dewatering during earthworks and the discharge of groundwater to stormwater. PAH and the metals detected in fill are strongly adsorbed to soil, therefore removal of sediment from the water before discharge is typically effective in removing these contaminants. The draft CSMP (Appendix D) includes requirements for confirmatory testing and, if contaminants are potentially present, measures to treat discharges for sediment removal. Preliminary testing in one borehole on site indicates no significant contamination is present in groundwater: all PAHs and most metals are within the ANZECC (2000) guidelines for 80% protection of marine species. Copper and zinc detection limits were above the ANZECC guideline value, but the laboratory reported that lower detection limits were not possible due to the sample matrix.

Sulphate is below the WCC trade waste bylaw guidelines at P1, but exceeds these guidelines at P2. The variability of these results reflects the variability of the fill material located onsite. Further testing of groundwater would be required during dewatering if discharge to trade waste is to occur.

6.6 Groundwater management

Groundwater generated during dewatering at Site 10 is expected to be:

- Suitable for discharge to stormwater, however this would require resource consent from GWRC (for discharge of groundwater to stormwater) and a stormwater permit from WCC.
- Suitable for discharge to trade waste – permit required from WCC.

Controls for discharge of dewatering water are set out in the draft CSMP (Appendix D) and generally include:

- Sampling and testing groundwater collected from shallow piezometers prior to excavation to assess groundwater quality. Samples shall be tested for total and dissolved metals and PAH.
  - To identify appropriate controls for discharge to stormwater, initial results will be compared with ANZECC guidelines for protection of marine species, applying an appropriate dilution factor that should be developed by a contaminated land specialist once discharge volumes are known;
  - To assess whether dewatering discharge can be discharged to trade waste, results shall be compared with trade waste guidelines.
- Good erosion and sediment control measures to minimise:
  - Sediment entrained in dewatering discharge.
  - The amount of stormwater entering the excavation area (i.e., to minimise the volume of water requiring discharge to stormwater).
- Treatment for sediment removal (if required), which may include:
  - Detention to allow sediment to settle before water is decanted off for discharge.
  - Treatment with chemical flocculants (the need for chemical treatment to remove sediment can only be determined when the sediment load of dewatering water is known).
  - Monitoring of suspended sediment prior to discharge.
  - Depending on the results of groundwater testing carried out prior to works beginning, additional laboratory testing for metals and PAH may be required before discharge (this is considered unlikely based on groundwater results to date).

7 Soil management

7.1 Off-site disposal of soil

Material that is consistent with background and does not contain asbestos is expected to be suitable for disposal to clean fill. Material that exceeds background concentrations and/or contains asbestos must be managed as contaminated material. Details for management are set out in the draft CSMP (Appendix D).

At Site 8 (1970 fill) and in some layers within the Site 10 basement, testing indicates fill is clean. However, based on the variability within the fill at Site 10 and limited testing at Site 8, we recommend that if soil at Site 8 or outside the layers identified as clean at Site 10 is to be disposed to clean fill, additional testing (metals and PAH; 1 sample per 100 m^3) should be carried out on potentially clean material to confirm it is indeed clean. Testing could be done in situ before works begin, or on stockpiled material if space is available to hold material pending the results of testing (5-7 working days). Care would be needed to ensure clean material does not become mixed with contaminated material during stockpiling. Requirements for testing and controls are set out in the draft CSMP (Appendix D).

Material that exceeds background should be acceptable to an appropriately consented landfill (e.g., Southern or Silverstream) without pre-treatment. However, acceptance would be the decision of the landfill manager. Approval from the landfill manager should be sought before works begin, using the results of testing carried out as part of this investigation.

The material that contains asbestos should be acceptable at an appropriately consented landfill (e.g., Southern or Silverstream), but would have to be handled as special waste, which would attract a higher disposal fee. Approval from the landfill manager should be sought before works begin, using the results of testing carried out as part of this investigation.

7.2 On-site management

Due to the presence of contamination, procedures will be required during the excavation works to protect site workers, the public, and the environment. This would include works to minimise discharges and prevent contact with contaminants. Procedures are set out in the draft CSMP (Appendix D).

8 Regulatory requirements

8.1 Land use consents

Based on the presence of contamination and the volumes of earthworks required, resource consent is expected to be required from WCC under the National Environmental Standard for Contaminants in Soil to Protect Human Health (NES Soil), for disturbing soil and change of use. Resource consent is also likely required under the Wellington District Plan for works on a contaminated site. This is for both Site 10 (the proposed building) and for the Landscaping Areas.

The NES Soil either allows (as a permitted activity) or controls (through resource consents) these activities on land affected or potentially affected by soil contaminants. The focus of the NES Soil is to protect human health, and therefore only relates to the actual or potential adverse effects of contaminants on human health. It does not address the wider adverse effects of contaminants on the environment, or relate to assessing or managing the actual or potential adverse effects of contaminants on other receptors such as ecology, water and amenity values.

The activity status of activities is then set by the NES depending upon the nature and scale of the activity and its potential risks to human health, and ranges from permitted activities through to discretionary activities. In this instance, site investigations have shown that contaminant concentrations are mostly below guidelines for the proposed site use (commercial).

However at Site 10, a layer of soil exceeds the human health guidelines for polycyclic aromatic hydrocarbons. Therefore, the soil disturbance and change of use at Site 10 would be restricted discretionary activities under the NES Soil.

The investigations at Sites 8 and 9 completed in 2009 do not constitute a DSI for the earthworks in the public space areas. Therefore a discretionary activity consent would be required for the works on Site 8 and the rest of the Landscaping Areas.

Overall for the Project, a discretionary activity consent is required for earthworks under the NES.

The following plans are recommended as a condition of resource consent for the works:

- A Contamination Site Management Plan (CSMP). A draft CSMP is provided in Appendix D. It would sets out controls to minimise discharges during the works, health and safety procedures for site workers, and inspection/monitoring and reporting requirements (e.g., tracking loads of contaminated soil disposed to landfill).
- A Site Validation Report (SVR) to be provided to WCC (and GWRC) on completion of the works, documenting the works carried out, collating inspection and monitoring records, and landfill receipts.

8.2 Regional Council consents

A consent will be required for the potential discharge of contaminants to land, including to the reticulated stormwater system, and for the potential discharge of contaminants to ground water. Consent is required for a discharge permit for a Discretionary Activity under Rule 2 of the Regional Discharges to Land Plan, and Rule 5 of the Regional Freshwater Plan.

If any contaminated soil is discharged offsite anywhere other than a consented landfill, resource consent would be required from GWRC.

8.3 Trade waste and stormwater permits

If groundwater generated during dewatering is to be disposed to stormwater or trade waste, a permit will be required from WCC.

9 Conclusions

The proposed development involves excavation at Site 10 for a basement and foundations. Excavated fill and groundwater extracted during dewatering at Site 10 will be disposed off-site. Soil disturbance will also be required at Site 8 and possibly other parts of the Landscape Areas for landscaping works. We understand approximately 1,000 m^3 of cut material may need to be removed from Site 8 (if it is geotechnically unsuitable), with cuts a maximum of 1 m deep. No significant cut is proposed elsewhere in the public space areas, however, it is expected that limited soil disturbance will be required for surface preparation works. The public space areas shall be finished with either paving underlaid by imported fill or imported clean landscaping fill materials. There will be no earthworks on Site 9.

No contaminated material has been identified at Site 8 (1970s fill), but contaminated fill is present at Sites 9 and 10 (1903 reclamation: metals, polycyclic aromatic hydrocarbons). Similar material is expected to be present in the remainder of the Landscape Areas, which are also on the 1903 reclamation. In addition, asbestos has been identified in part of Site 10. A Contamination Site Management Plan (CSMP) will be implemented to control discharges of contaminants during the works to minimise potential effects on human health and the environment. A draft CSMP is appended (Appendix D).

Investigations have confirmed that *after* removal of the excavated basement material at Site 10, concentrations of contaminants will be below human health guidelines for the proposed site use (commercial, paved site).

As some of the fill to be excavated contains contaminants above background levels (metals, polycyclic aromatic hydrocarbons, asbestos), it must be disposed to an appropriately consented landfill (e.g., Southern Landfill or Silverstream Landfill). This investigation indicates that fill should be acceptable to landfill without pre-treatment, but this would have to be approved by the landfill manager. The draft CSMP (Appendix D) includes controls to minimise discharges during the works (e.g., dust, runoff in stormwater).

Some of the fill to be excavated from Site 10 is clean. If additional areas are to be checked for suitability as clean fill (either at Site 10 or in the Landscape Areas), additional testing would be needed to confirm it is clean. This testing can be done either in situ before excavation, or in stockpiled soil if the excavation programme and space permits. Controls will need to be in place during the works to ensure no cross-contamination of clean material occurs.

Because the excavated fill will be disposed off-site and the site will be paved on completion, there is minimal potential for exposure of future site users to contaminated fill at the site.

Preliminary groundwater testing at two boreholes on the site has not identified significant contamination in shallow groundwater, which is consistent with the type of contaminants present in the fill. Further groundwater testing is required to confirm this for the remainder of the site.

Preliminary groundwater testing at two boreholes on the site has not identified significant contamination in shallow groundwater, which is consistent with the type of contaminants present in the fill. Further groundwater testing is required to confirm this for the remainder of the site. Groundwater extracted during dewatering may need treatment before discharge to stormwater or trade waste. The type of treatment (if any) would be dependent on the results of further testing, as set out in the draft CSMP (Appendix D). Implementing appropriate controls (based on the results of testing) would ensure that effects of the discharge on harbour water quality are less than minor.

10 Applicability

This report has been prepared for the benefit of Willis Bond Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement. The work was undertaken in accordance with our proposal of 8 April 2014.

Tonkin & Taylor LTD

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Sharon Parackal	Stuart Palmer
Environmental Engineer	Project Director

Technical Review: Penny Kneebone, Senior Environmental Scientist

SPP

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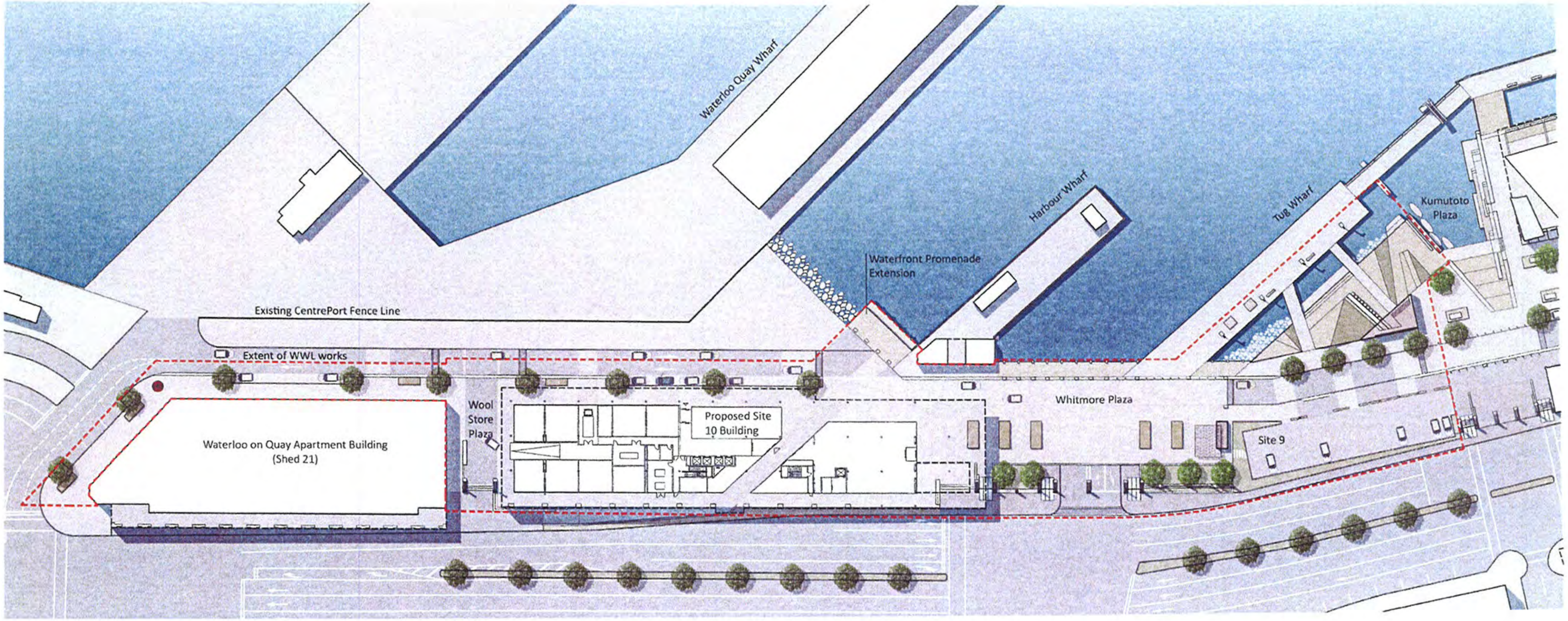
Appendix A: Figures

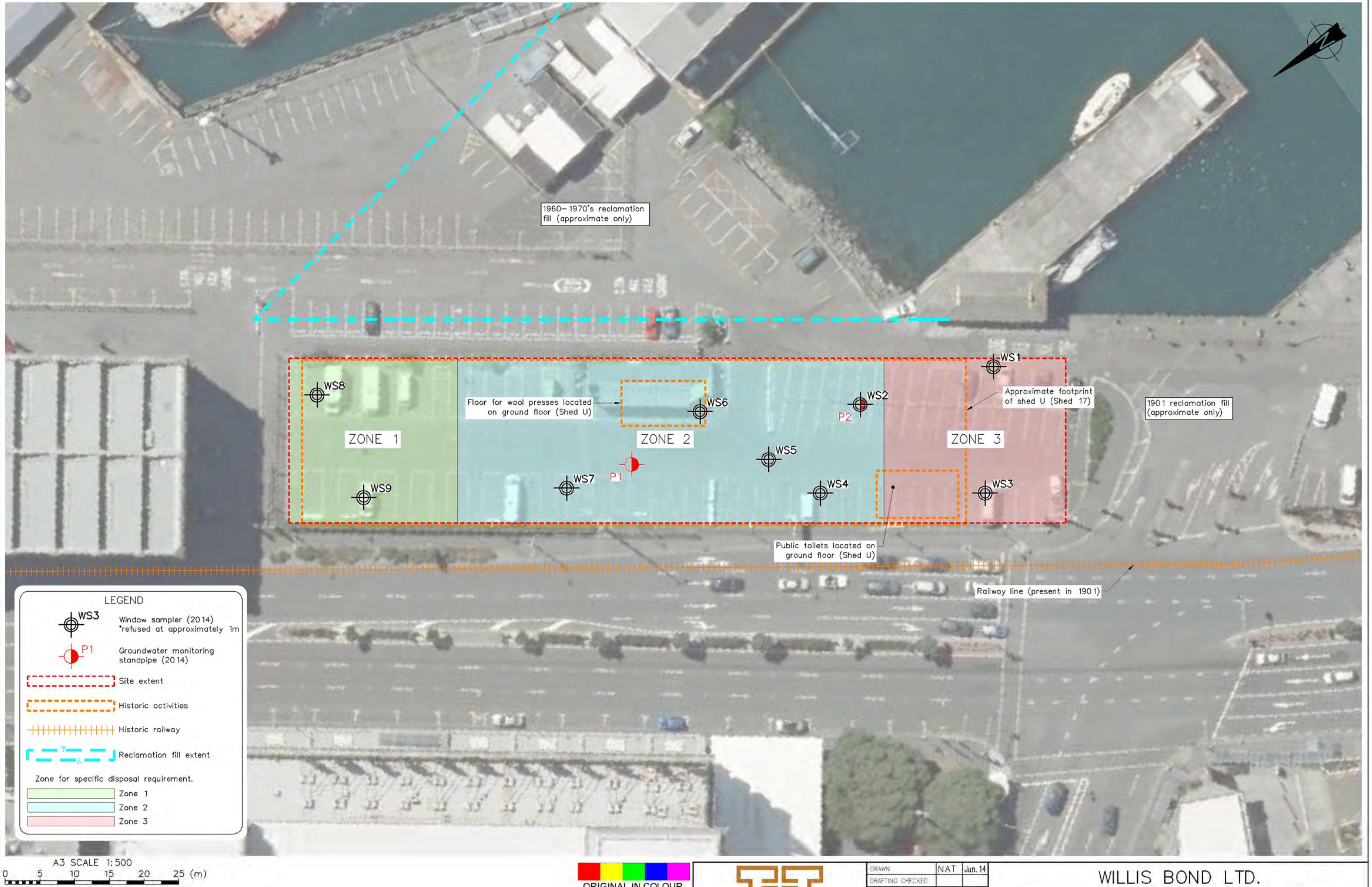
- **Figure 1: Development Masterplan (Isthmus)**
- **Figure 2: Site 10 Historic Activities, Sample location and Soil Contamination Characterisation**



KUMUTOTO MASTERPLAN

27.08.2014

isthmus



ORIGINAL IN COLOUR

NOTES:

1. Aerial photo sourced from Wellington City Council

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APPROVED		

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PROJECT No. 85778.001

WILLIS BOND LTD.

GROUND CONTAMINATION ASSESSMENT
WELLINGTON WATERFRONT SITE 10

Key Historic Activities, Sample Location and Soil Contamination Characterisation

FIG. No. Figure 2

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Appendix B: Window sampler logs

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BOREHOLE LOG

BOREHOLE No:WS1
Hole Location: Refer Figure 2

SHEET 1 OF 1

PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 23/4/14
HOLE FINISHED: 23/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
FILL	NA	Not encountered	NA	NA	NA	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	Asphalt Base course
RECLAMATION FILL									0.2							Silty coarse SAND with some angular gravels. Orange brown. Tightly packed. Dry. Fine to coarse gravel sized brick fragments and white plaster or cement material.
									1.0							Silty fine to coarse SAND. Dark brown. Moist. Medium to fine gravel size brick fragments present.
									1.2							Refusal at 1.2m depth

SHEAR STRENGTH (kPa): 10 25 50 100 200
COMPRESSIVE STRENGTH (MPa): 1 5 20 50 100 250
DEFECT SPACING (mm): 50 250 1000 2000

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

DEPTH (m): 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5

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BOREHOLE LOG

BOREHOLE No:WS2
Hole Location: Refer Figure 2

SHEET 1 OF 1

PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 23/4/14
HOLE FINISHED: 23/4/04
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL

ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

GEOLOGICAL UNIT	SOIL DESCRIPTION
FILL	Asphalt Base course
RECLAMATION FILL	Silty fine SAND with some angular medium to coarse greywacke gravel. Dark Brown. Dry. Fine to coarse gravel sized brick fragments. Crushed brick.
	Interbedded silty fine sand. Blue. At 0.75m: 150mm thick lense of organic silt.
	SILT with fine sand and fine gravel. Brownish yellow. Moist. Fine gravel sized brick fragments.
	SILT with some fine to medium greywacke gravel. Greyish orange and black. Wet
	Sandy SILT with fine to coarse gravel. Brown. Wet. Becoming coarse sand. Yellow. Wet.
	Target depth at 3.0m

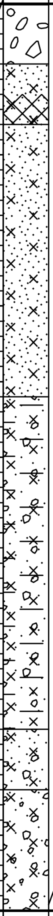
FLUID LOSS: NA

WATER: Inferred at time of drilling

TESTS / SAMPLES / R.L.: NA

CLASSIFICATION SYMBOL / MOISTURE CONDITION / STRENGTH: NA

DEPTH (m): 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5



TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS3
Hole Location: Refer Figure 2

SHEET 1 OF 1

PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
FILL	NA	Not encountered	NA								NA						Asphalt
																	Base course
RECLAMATION FILL																	Lost core
									0.5								Coarse silty SAND and coarse greywacke gravel with minor silt. Dark brown. Dry. Coarse to fine gravel sized brick fragments and white plaster or cement material.
									1.0								Refusal at 1.0m depth

Depth scale (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5

T+T DATATEMPLATE.GDT mjrb

Log Scale 1:25

BORELOG WS LOGS.GPJ 26-Feb-2015

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS4
Hole Location: Refer Figure 2

SHEET 1 OF 1

PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

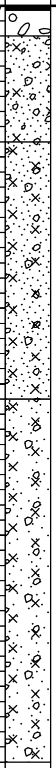
HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.



Geological unit	Depth (m)	Description
FILL	0.0	Asphalt
RECLAMATION FILL		Base course
		At 0.35m: Fine to medium angular gravel with fine to coarse sand. Grey.
		Interbedded fine to coarse angular greywacke GRAVEL and fine to coarse SAND. Some silt. Grey brown. Dry. Fine to medium gravel sized brick fragments.
		Coarse SAND with minor silt and greywacke gravel. Light Grey. Dry.
	1.3	SILT with fine to coarse sand and greywacke gravel. Brown with orange mottling. Fine gravel size crushed brick. Interbedded with fine sand lenses.
BEACH DEPOSITS	2.5	Silty fine to coarse SAND and some medium size greywacke gravel. Grey. Wet to saturated. Fine shell fragments present.
	3.0	Target depth at 3.0m

FLUID LOSS: NA

WATER: Inferred at time of drilling

TESTS: NA

CLASSIFICATION SYMBOL – DEFECT SPACING: NA

DEPTH (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5

T+T DATATEMPLATE.GDT mjrb

Log Scale 1:25

BORELOG WS LOGS.GPJ 26-Feb-2015

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS5
Hole Location: Refer Figure 2

SHEET 1 OF 1

PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL

ENGINEERING DESCRIPTION

GEOLOGICAL UNIT,
GENERIC NAME,
ORIGIN,
MINERAL COMPOSITION.

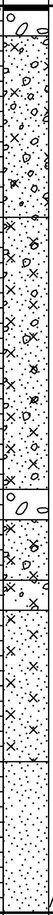
FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

Geological unit	Soil description
FILL	Asphalt
RECLAMATION FILL	Base course
	Silty fine SAND with some greywacke gravel. Yellowish brown and grey. Dry
	Silty medium SAND with medium greywacke gravel. Yellowish brown. Dry. Black organic matter (roots, twigs).
	Medium rounded gravel. Dark grey black. Moist. Strong hydrocarbon odour.
	Silty medium SAND with medium gravel. Yellowish brown. Moist. Black organic matter.
	SILT with some gravel. Grey. Moist to Wet.
	SILT with interbedded coarse sand and some greywacke gravel. Grey black. Wet.
	Coarse sand. Orange and mottled black. At 2.65m: Slight hydrocarbon odour.
	Coarse Sand. Yellow orange. Saturated.
	Target depth at 3.0m

Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5



FLUID LOSS: NA

WATER: Inferred at time of drilling (approx. 1.95 m)

TESTS / SAMPLES / R.L.: NA

CLASSIFICATION SYMBOL to DEFECT SPACING: NA

Log Scale 1:25

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS6
Hole Location: Refer Figure 2

SHEET 1 OF 1

PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

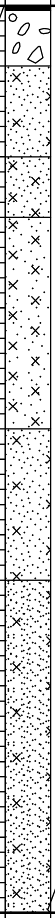
DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION \ WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.



GEOLOGICAL	DESCRIPTION
FILL	Asphalt
	Base course
RECLAMATION FILL	Fine SAND with silt and coarse greywacke gravel. Light grey. Dry.
	Silty SAND and fine greywacke gravel. Dark brown Dry.
	Sandy SILT and some medium greywacke gravel. Orange and mottled black. Dry to moist. Coarse sand sized brick fragments and black organic matter (twigs, roots).
	Coarse SAND with minor silt. Orange. Moist. At 1.5m: Fine powdered cement or plaster material. At 1.8m: Faint hydrocarbon odour
	Coarse SAND. Dark reddish brown. At 2.0m: Some coarse round greywacke gravel. Reddish brown with orange and light brown mottling. Saturated.
	Target depth at 3.0m

FLUID LOSS: NA

WATER: Inferred at time of drilling

CORE RECOVERY / METHOD / CASING / TESTS / SAMPLES / R.L.: NA

CLASSIFICATION SYMBOL / MOISTURE CONDITION / STRENGTH / SHEAR STRENGTH / COMPRESSIVE STRENGTH / DEFECT SPACING: NA

DEPTH (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS7
Hole Location: Refer Figure 2

SHEET 1 OF 1

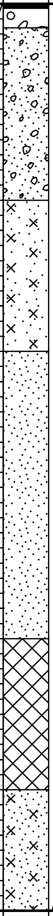
PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
FILL RECLAMATION FILL	NA	Inferred at time of drilling				NA									NA		Asphalt Base course Silty coarse SAND with fine to coarse greywacke gravels. Brownish yellow and grey. Dry. Sandy SILT with fine to medium graywacke gravel. Yellowish brown. Dry. At 1.0m: White cement or plaster material SAND with some silt and graywacke gravels. Yellowish dark brown. Moist Coarse sand and crushed brick. Red. Moist Silty SAND. Dark greyish blue. Wet to saturated. Coarse sand sized brick fragments. Target depth at 3m.

DEPTH (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5

Log Scale 1:25

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS8
Hole Location: Refer Figure 2

SHEET 1 OF 1

PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

FILL

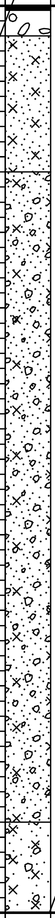
RECLAMATION FILL

NA

Inferred at time of drilling

NA

NA



Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5

Asphalt

Base course

SAND and silt with fine to coarse greywacke gravels. Dark Brown. Dry.

0.5

Silty SAND with fine to coarse greywacke gravels. Yellow brown. Dry. Fine to coarse gravel sized brick fragments.

1.0

1.5

White cement or plaster material. Becoming moist.

2.0

2.5

White cement or plaster material.

Becoming wet.

SILT with coarse sand and fine greywacke gravel. Blue grey and brown. Wet.

3.0

Target depth at 3m.

3.5

4.0

4.5

Log Scale 1:25

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS9
Hole Location: Refer Figure 2

SHEET 1 OF 1

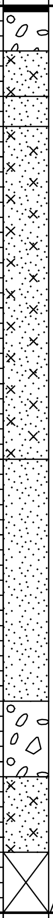
PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL		ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS / WATER / CORE RECOVERY (%) / METHOD / CASING / TESTS / SAMPLES / R.L. (m) / DEPTH (m)	GRAPHIC LOG / CLASSIFICATION SYMBOL / MOISTURE CONDITION \ WEATHERING / STRENGTH/DENSITY CLASSIFICATION / SHEAR STRENGTH (kPa) 10 25 50 100 200 / COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 / DEFECT SPACING (mm) 50 250 1000 2000 / SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.



Geological	Depth (m)	Soil description
FILL		Asphalt
RECLAMATION FILL		Base course. Some fine to medium gravel sized brick fragments present.
		Silty fine SAND with medium to coarse greywacke gravel. Brown. Dry
	0.5	Coarse SAND with medium greywacke gravel. Grey. Dry
		SAND with silt and medium angular and rounded greywacke gravels. Yellow and mottled black. Dry. Coarse sand sized brick fragments.
	1.0	
	1.5	SAND with some medium to coarse greywacke gravel. Orange and mottled black. Moist. Becoming wet.
	2.0	
		Wet.
		Cobble sized angular greywacke gravel. Weathered. Reddish brown. Wet.
	2.5	Coarse SAND and silt with fine to coarse greywacke gravel. Yellow, brown and black. Saturated.
		Lost core.
	3.0	Target depth at 3.0m.
	3.5	
	4.0	
	4.5	
	5	

FLUID LOSS: NA

WATER: Inferred at time of drilling

TESTS: NA

CLASSIFICATION / STRENGTH: NA

Log Scale 1:25

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:WS9
Hole Location: Refer Figure 2

SHEET 1 OF 1

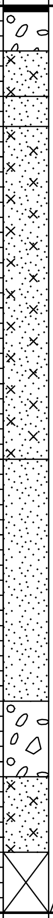
PROJECT: Site 10 Ground contamination assessment
LOCATION: Site 10, Wellington Waterfront
JOB No: 85778.001

CO-ORDINATES: Refer Figure 2 for approximate location
R.L.:
DATUM:

DRILL TYPE: Window Sampler
DRILL METHOD: Window Sampler
DRILL FLUID: N/A

HOLE STARTED: 24/4/14
HOLE FINISHED: 24/4/14
DRILLED BY: Geotechnics Ltd
LOGGED BY: SPP
CHECKED: NCP

GEOLOGICAL		ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS / WATER / CORE RECOVERY (%) / METHOD / CASING / TESTS / SAMPLES / R.L. (m) / DEPTH (m)	GRAPHIC LOG / CLASSIFICATION SYMBOL / MOISTURE CONDITION \ WEATHERING / STRENGTH/DENSITY CLASSIFICATION / SHEAR STRENGTH (kPa) 10 25 50 100 200 / COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 / DEFECT SPACING (mm) 50 250 1000 2000 / SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
FILL	NA	Asphalt
RECLAMATION FILL	NA	Base course. Some fine to medium gravel sized brick fragments present.
		Silty fine SAND with medium to coarse greywacke gravel. Brown. Dry
		Coarse SAND with medium greywacke gravel. Grey. Dry
		SAND with silt and medium angular and rounded greywacke gravels. Yellow and mottled black. Dry. Coarse sand sized brick fragments.
		SAND with some medium to coarse greywacke gravel. Orange and mottled black. Moist. Becoming wet. Wet.
		Cobble sized angular greywacke gravel. Weathered. Reddish brown. Wet.
		Coarse SAND and silt with fine to coarse greywacke gravel. Yellow, brown and black. Saturated.
		Lost core.
		Target depth at 3.0m.



DEPTH (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5

Appendix C: Laboratory results

Table C1: Laboratory results Sites 8 and 9 (mg/kg)

ID	BH3 (Site 8)		BH5 (Site 9)		BH9 (Site 9)		WS4 (Site 9)	WS3 (Site 9)	Wellington Background[2]	Commercial <1m/1-4m	Landfill Acceptance [5]
Sample depth	0.5m	2.5m	0.5m	4m	0.5m	4.5m	3.5m	2.1m			
Arsenic	**9.7**	**8.3**	6.2	6.1	2.9	3.8	6.3	**11**	7 | 7	70 [3]	100
Cadmium	< 0.10	< 0.10	< 0.10	**0.28**	< 0.10	< 0.10	0.11	**0.44**	0.1 | 0.2	1,300 [3]	20
Chromium	**24**	**21**	15	18	17	19	19	20	16 |21	6,300 [3]	100
Copper	21	25	22	**64**	12	20	21	**1,700**	25 |25	>10,000 [3]	100
Lead	**26**	18	**96**	120	31	46	160	**550**	79 |180	3,300 [3]	100
Nickel	**19**	**17**	13	13	10	**14**	13	**34**	13 | 21	990 [4]	200
Zinc	81	82	100	**250**	56	96	**120**	**900**	105 |201	31,000 [4]	200
Acenaphthene	< 0.026	< 0.027	-	-	-	-	0.035	0.19			
Acenaphthylene	< 0.026	< 0.027	-	-	-	-	0.14	0.21			
Anthracene	< 0.026	< 0.027	-	-	-	-	**0.25**	**0.68**	0.05 | 0.05		
Benzo[a]anthracene	< 0.026	< 0.027	-	-	-	-	0.63	1.5			
Benzo[a]pyrene (BAP)	< 0.026	< 0.027	-	-	-	-	**1.1**	**2.8**	0.27 | 0.033		
Benzo[b]+[j]fluoranthene	< 0.026	< 0.027	-	-	-	-	1.8	4.8			
Benzo[g,h,i]perylene	< 0.026	< 0.027	-	-	-	-	0.63	1.7			
Benzo[k]fluoranthene	< 0.026	< 0.027	-	-	-	-	0.83	1.8			
Chrysene	< 0.026	< 0.027	-	-	-	-	1.2	2.6			
Dibenzo[a,h]anthracene	< 0.026	< 0.027	-	-	-	-	0.28	0.64			
Fluoranthene	< 0.026	< 0.027	-	-	-	-	**2.1**	**3.6**	0.55 | 0.57		
Fluorene	< 0.026	< 0.027	-	-	-	-	0.084	0.14			
Indeno(1,2,3-c,d)pyrene	< 0.026	< 0.027	-	-	-	-	1	2.5			
Naphthalene	< 0.13	< 0.14	-	-	-	-	< 0.16	**0.43**	0.01 | 0.02		200
Phenanthrene	< 0.026	< 0.027	-	-	-	-	**1.1**	**2.1**	0.26 | 0.35		
Pyrene	< 0.026	< 0.027	-	-	-	-	**2.3**	**4.2**	0.57 | 0.60		
Total PAH	<0.52	<0.55					13	30			
BaP(eq) [1]	<0.06	<0.07					1.8	4.5		35 [3]	

Values in bold exceed expected background values. Shaded exceed landfill acceptance guidelines. 1. BaP_{eq} is sum of PAH multiplied by toxicity equivalence factors. 2. URS. 2003. *Determination of common pollutant background soil concentrations for the Wellington region*, Greywacke (applies to Site 8) | maximum in Wellington Region (Site 9; unknown fill source). 3. MfE, 2011, Soil Contaminant Standards, Commercial unpaved. 4. US EPA 2013, Regional Screening Level summary table. 5. MfE. 2004. Hazardous Waste Guidelines - Landfill Waste Acceptance Criteria and Landfill Classification

Table C2: Asbestos and Metals; Site 10

		Asbestos	Metals (mg/kg)							TCLP Extract (g/m^3)		
Site 10	**Depth (m)**		**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Nickel**	**Zinc**	**Zinc**	**Copper**	**Lead**
WS1	0.6	**Present**	< 2	0.18	13	9	166	17	104			
	1.1	-	4	< 0.10	9	7	161	11	110			
WS2	0.6	-	**8**	**0.23**	**23**	**38**	141	15	**300**			
	1.5	-	3	**0.42**	18	19	62	9	**520**	<0.021		
	2.9	-	5	0.18	17	**29**	116	14	**260**			
WS3	0.8	**Present**	7	**0.51**	13	24	**300**	12	**320**			
WS4	0.85	-	5	< 0.10	**22**	18	23	15	77			
	1.8	-	4	0.16	18	**26**	145	14	118			
	2.7	-	3	< 0.10	8	2	8.3	3	8			
WS5	0.45	-	5	< 0.10	15	14	19.1	12	63			
	1.7	-	7	0.16	14	**39**	**360**	11	**460**			
	2.65	-	**9**	**0.51**	17	**87**	**2,800**	13	**500**			
	2.85	-	< 2	< 0.10	< 2	2	14.8	< 2	15			
WS6	1.5	Absent	3	**0.33**	10	**51**	**290**	**21**	125			
	1.8	-	4	0.2	19	**36**	**260**	12	200			
	2.5	-	< 2	< 0.10	3	5	12.7	< 2	18			
WS7	1.25	Absent	6	**0.57**	14	**1,260**	**1,020**	**16**	**2,200**	7.6	2.5	0.062
	2.7	-	7	0.11	17	**35**	94	15	155			
WS8	1.2	-	6	0.12	17	**28**	**186**	14	200			
	1.6	Absent	6	0.14	14	**28**	**230**	**16**	**470**			
	2.5	Absent	5	0.14	12	16	43	13	123			
WS9	1.5	-	3	< 0.10	**22**	10	25	11	64			
	2.75	-	6	0.14	**24**	23	46	**16**	103			
Background [1]			7 | 7	0.1 | 0.2	16 | 21	25 | 25	79 | 180	13 | 21	105 | 201	-	-	-
Landfill Acceptance Criteria [2]			100	20	100	100	100	200	200	10	5	5
Commercial [3]			70	1300	>10,000	>10,000	3300	990 [4]	31000 [4]	-	-	-

Bold exceeds maximum background for Wellington Region. Shaded exceeds human health guidelines. Underline exceeds landfill screening criteria. 1. URS, 2003, *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region*, Greywacke (underlying reclamation) | maximum for Wellington Region (unknown fill source). 2. MfE, 2003, *Waste Acceptance Criteria for Class A Landfills.* 3. MfE, 2011, Soil Contaminant Standards, Commercial unpaved. 4. US EPA 2013, Regional Screening Level summary table

Table C3: PAH & TPH, Site 10

Site 10	**Depth (m)**	**PAH (mg/kg)**						**TPH (mg/kg)**			
		Anthracene	Benzo[a]pyrene	Fluoranthene	Naphthalene	Pyrene	BAP $_{(eq)}$	C_7 - C_9	C_{10} - C_{14}	C_{15} - C_{36}	Total (C_7 - C_{36})
WS1	0.6	**0.07**	**0.59**	**0.72**	< 0.13	**0.81**	0.9	-	-	-	-
	1.1	**6.1**	**33**	**60**	**1.2**	**67**	48	-	-	-	-
WS2	0.6	**0.29**	**0.84**	**1.52**	**0.12**	**1.6**	1.3	-	-	-	-
	1.5	0.03	0.16	0.23	< 0.14	0.29	< 0.25	-	-	-	-
	2.9	**0.17**	0.28	**0.73**	< 0.13	**0.77**	0.4	-	-	-	-
WS3	0.8	**0.89**	**10.2**	**11.1**	**0.72**	**11.5**	15	-	-	-	-
WS4	0.85	< 0.03	< 0.03	< 0.03	< 0.12	0.02	< 0.07	-	-	-	-
	1.8	**0.17**	**0.59**	**0.97**	< 0.13	**1.29**	0.9	-	-	-	-
	2.7	< 0.03	< 0.03	< 0.03	< 0.14	< 0.03	< 0.07	-	-	-	-
WS5	0.45	< 0.03	< 0.03	< 0.03	< 0.12	< 0.03	< 0.07	-	-	-	-
	1.7	**230**	**270**	**860**	**38**	**800**	406	< 8	163	12,800	**12,900**
	2.65	**0.15**	**0.41**	**0.99**	< 0.15	**0.79**	0.6	-	-	-	-
	2.85	**0.14**	0.18	**0.61**	< 0.14	0.51	< 0.28	-	-	-	-
WS6	1.5	**0.29**	**1.65**	**1.69**	< 0.13	**1.85**	2.4	-	-	-	-
	1.8	**5.9**	**10.1**	**16**	**1.61**	**18**	15	< 8	< 20	320	**320**
	2.5	< 0.03	< 0.03	0.03	< 0.14	0.04	< 0.07	-	-	-	-
WS7	1.25	**0.16**	0.31	**0.79**	< 0.14	**0.75**	0.5	-	-	-	-
	2.7	**0.19**	**0.61**	**1.16**	**0.14**	**1.16**	0.9	-	-	-	-
WS8	1.2	**0.08**	**0.36**	**0.59**	< 0.12	0.55	0.5	-	-	-	-
	2.5	< 0.03	0.05	0.07	< 0.13	0.08	< 0.097	-	-	-	-
WS9	1.5	**0.13**	**1.11**	**1.49**	< 0.13	**1.44**	1.7	-	-	-	-
	2.75	< 0.03	0.07	0.09	< 0.13	0.13	< 0.12	-	-	-	-
Background [1]		0.05 | 0.05	0.27 | 0.33	0.55 | 0.57	0.01 | 0.02	0.57 | 0.60	-	-	-	-	190
Landfill [2]		-	300	-	200	-	300	-	-	-	-
Commercial		-	-	-	270 [4]	NL [4]	35 [3]	500[5]	1,700 [5]	>20,000 [5]	>20,000 [5]

Bold exceeds maximum background for Wellington Region. Shaded exceeds human health guidelines. Underline exceeds landfill screening criteria. 1. URS, 2003, *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region*, Greywacke (underlying reclamation) | maximum for Wellington Region (unknown fill source). 2. MfE, 2003, *Waste acceptance criteria for Class A Landfills*. 3. MfE 2011. Soil Contaminant Standards for commercial use. 4. MfE, 2011, *Guidelines for assessing and managing petroleum hydrocarbon contaminated sites in NZ;* Commercial/Industrial, sandy silt. 5. MfE. 1999. *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*, industrial/commercial site use, silty/sand soil, <1m deep

Table C4: Groundwater inorganics: Site 10 (mg/L; dissolved concentrations)

Site 10	pH	Sulphate	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
P1	7.2	750	<0.10	<0.005	<0.05	<0.05 *	<0.010	<0.05	<0.10 *
P2	7.2	3400	<0.10	<0.005	<0.05	<0.05 *	<0.010	<0.05	<0.10 *
ANZECC Guidelines [1]	-	-	0.0045	0.036	0.0906	0.008 *	0.012	0.56	0.043 *
Trade waste [2]	-	1500	-	-	-	-	-		-

Bold exceeds ANZECC guidelines. Underline exceeds trade waste guidelines. *Detection Limits could not be lowered due to matrix effects.

1. ANZECC 80% species protection for marine water. 2. WCC (2004). Trade waste bylaw Table 1 – Sulphate with good mixing.

Table C5: Groundwater organics: Site 10 (mg/L; dissolved concentrations)

Site 10	Anthracene	Benzo(a)pyrene	Fluoranthene	Naphthalene	Phenanthrene
P1	<0.00010	0.00014	0.00022	<0.0005	<0.0004
P2	<0.00010	<0.00010	<0.00010	<0.0005	<0.0004
ANZECC Guidelines: protection of 80% of marine species	0.007	0.0007	0.002	0.05	0.008

Table C6: QA/QC results: Site 10 groundwater

Site 10	pH	Sulphate	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Anthracene	Benzo(a)pyrene	Fluoranthene	Naphthalene	Phenanthrene
P1 (mg/L)	7.2	750	<0.10	<0.005	<0.05	<0.05	<0.010	<0.05	<0.10	<0.00010	0.00014	0.00022	<0.0005	<0.0004
Dup (mg/L)	7.2	740	<0.10	<0.005	<0.05	<0.05	<0.010	<0.05	<0.10	<0.00010	<0.00010	<0.00010	<0.0005	<0.0004
Relative % difference	0	1.3%	-	-	-	-	-	-	-	-	33%	75%	-	-

Table C7: QA/QC results: Site 10 inorganics in soil (mg/kg)

	Arsenic	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Nickel**	**Zinc**	**Asbestos**
WS1 - 0.6m (mg/kg)	< 2	0.18	13	9	166	17	104	Present
Duplicate 1 (mg/kg)	2	0.21	10	9	196	11	144	Present
Relative % difference	*0%*	*15%*	*26%*	*0%*	*17%*	*43%*	*32%*	*0%*
WS5 - 2.65m (mg/kg)	9	0.51	17	87	2,800	13	500	-
Duplicate 2 (mg/kg)	7	0.29	18	60	1,590	11	450	-
Relative % difference	*25%*	*55%*	*5.7%*	*37%*	*55%*	*17%*	*11%*	-
WS6 - 1.5m (mg/kg)	3	0.33	10	51	290	21	125	Absent
Duplicate 3 (mg/kg)	< 2	0.4	8	26	240	18	88	Absent
Relative % difference	*40%*	*19%*	*22%*	*65%*	*19%*	*15%*	*35%*	*0%*
WS9 - 2.75m (mg/kg)	6	0.14	24	23	46	16	103	-
Duplicate 4 (mg/kg)	5	0.2	29	21	34	16	100	-
Relative % difference	*40%*	*35%*	*19%*	*9.1%*	*30%*	*0%*	*3%*	-

Table C8: QA/QC results: Site 10 organics in soil (mg/kg)

	WS1 0.6 m	**Dup 1**	***RPD (%)***	**WS5 2.65 m**	**Dup 2**	***RPD (%)***	**WS6 1.5 m**	**Dup 3**	***RPD (%)***	**WS9 2.75 m**	**Dup 4**	***RPD (%)***
Acenaphthene	< 0.03	< 0.03	-	0.04	< 0.04	-	< 0.03	< 0.03	-	< 0.03	< 0.03	-
Acenaphthylene	0.07	0.04	*55%*	0.03	< 0.04	-	0.08	0.06	*29%*	< 0.03	< 0.03	-
Anthracene	0.07	0.16	*78%*	0.15	0.11	*31%*	0.29	0.16	*58%*	< 0.03	< 0.03	-
Benzo[a]anthracene	0.41	0.81	*66%*	0.42	0.26	*47%*	1.16	0.49	*81%*	0.06	0.03	*67%*
Benzo[a]pyrene	0.59	0.99	*51%*	0.41	0.23	*56%*	1.65	0.74	*76%*	0.07	0.04	*55%*
Benzo[b]fluoranthene + Benzo[j]fluoranthene	0.66	1.15	*54%*	0.5	0.3	*50%*	1.76	0.83	*72%*	0.08	0.05	*46%*

	WS1 0.6 m	**Dup 1**	***RPD (%)***	**WS5 2.65 m**	**Dup 2**	***RPD (%)***	**WS6 1.5 m**	**Dup 3**	***RPD (%)***	**WS9 2.75 m**	**Dup 4**	***RPD (%)***
Benzo[g,h,i]perylene	0.54	0.91	*51%*	0.28	0.17	*49%*	1.31	0.61	*73%*	0.09	0.07	*25%*
Benzo[k]fluoranthene	0.27	0.47	*54%*	0.2	0.12	*50%*	0.7	0.34	*69%*	0.03	< 0.03	-
Chrysene	0.41	0.72	*55%*	0.39	0.24	*48%*	1.03	0.41	*86%*	0.06	0.03	*67%*
Dibenzo[a,h]anthracene	0.09	0.2	*76%*	0.07	0.05	*33%*	0.3	0.12	*86%*	< 0.03	< 0.03	-
Fluoranthene	0.72	1.47	*68%*	0.99	0.58	*52%*	1.69	0.65	*89%*	0.09	0.05	*57%*
Fluorene	< 0.03	< 0.03	-	0.07	0.03	*80%*	0.03	0.05	*50%*	< 0.03	< 0.03	-
Indeno(1,2,3-c,d)pyrene	0.55	0.69	*23%*	0.22	0.13	*51%*	1.07	0.46	*80%*	0.04	0.03	*29%*
Naphthalene	< 0.13	< 0.13	-	< 0.15	< 0.16	-	< 0.13	< 0.14	-	< 0.13	< 0.12	-
Phenanthrene	0.21	0.51	*83%*	0.76	0.43	*55%*	0.36	0.32	*12%*	0.05	0.03	*50%*
Pyrene	0.81	1.38	*52%*	0.79	0.46	*53%*	1.85	0.78	*81%*	0.13	0.08	*48%*

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ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1267739 SPv2
Contact:	Sharon Parackal C/- Tonkin & Taylor PO Box 2083 WELLINGTON 6140	**Date Registered:**	29-Apr-2014
		Date Reported:	29-May-2014
		Quote No:	
		Order No:	85788.001
		Client Reference:	85788.001
		Submitted By:	Sharon Parackal

Amended Report

This report replaces an earlier report issued on the 08 May 2014 at 4:10 pm
TCLP testing has been added to 2 samples as requested by the client.

Sample Type: Soil

Sample Name:		WS1 - 0.6m 23-Apr-2014 2:10 pm	WS1 - 1.1m 23-Apr-2014 2:25 pm	WS2 - 0.6m 23-Apr-2014 3:00 pm	WS2 - 1.5m 23-Apr-2014 3:10 pm	WS2 - 2.9m 23-Apr-2014 3:20 pm
Lab Number:		1267739.2	1267739.3	1267739.4	1267739.6	1267739.8
Individual Tests						
Dry Matter	g/100g as rcvd	88	89	87	80	87
TCLP Weight of Sample Taken	g	-	-	-	100	-
TCLP Initial Sample pH	pH Units	-	-	-	7.5	-
TCLP Acid Adjusted Sample pH	pH Units	-	-	-	1.5	-
TCLP Extractant Type*		-	-	-	NaOH/Acetic acid at pH 4.93 +/- 0.05	-
TCLP Extraction Fluid pH	pH Units	-	-	-	4.9	-
TCLP Post Extraction Sample pH	pH Units	-	-	-	5.0	-
Qualitative Identification of Asbestos		See attached report	-	-	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	< 2	4	8	3	5
Total Recoverable Cadmium	mg/kg dry wt	0.18	< 0.10	0.23	0.42	0.18
Total Recoverable Chromium	mg/kg dry wt	13	9	23	18	17
Total Recoverable Copper	mg/kg dry wt	9	7	38	19	29
Total Recoverable Lead	mg/kg dry wt	166	161	141	62	116
Total Recoverable Nickel	mg/kg dry wt	17	11	15	9	14
Total Recoverable Zinc	mg/kg dry wt	104	110	300	520	260
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	0.21	0.05	< 0.03	0.03
Acenaphthylene	mg/kg dry wt	0.07	5.9	0.11	< 0.03	0.03
Anthracene	mg/kg dry wt	0.07	6.1	0.29	0.03	0.17
Benzo[a]anthracene	mg/kg dry wt	0.41	28	0.79	0.14	0.30
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.59	33	0.84	0.16	0.28
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.66	34	1.01	0.17	0.30
Benzo[g,h,i]perylene	mg/kg dry wt	0.54	30	0.61	0.14	0.22
Benzo[k]fluoranthene	mg/kg dry wt	0.27	11.8	0.41	0.08	0.13
Chrysene	mg/kg dry wt	0.41	20	0.65	0.13	0.26
Dibenzo[a,h]anthracene	mg/kg dry wt	0.09	3.4	0.11	< 0.03	0.03
Fluoranthene	mg/kg dry wt	0.72	60	1.52	0.23	0.73
Fluorene	mg/kg dry wt	< 0.03	0.57	0.11	< 0.03	0.05
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.55	30	0.66	0.13	0.22
Naphthalene	mg/kg dry wt	< 0.13	1.20	0.12	< 0.14	< 0.13
Phenanthrene	mg/kg dry wt	0.21	27	0.79	0.09	0.70

Sample Type: Soil

	Sample Name:	WS1 - 0.6m 23-Apr-2014 2:10 pm	WS1 - 1.1m 23-Apr-2014 2:25 pm	WS2 - 0.6m 23-Apr-2014 3:00 pm	WS2 - 1.5m 23-Apr-2014 3:10 pm	WS2 - 2.9m 23-Apr-2014 3:20 pm
	Lab Number:	1267739.2	1267739.3	1267739.4	1267739.6	1267739.8
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Pyrene	mg/kg dry wt	0.81	67	1.60	0.29	0.77

	Sample Name:	WS3 - 0.8m 24-Apr-2014 9:35 am	WS4 - 0.85m 24-Apr-2014 10:10 am	WS4 - 1.8m 24-Apr-2014 10:30 am	WS4 - 2.7m 24-Apr-2014 10:30 am	WS5 - 0.45m 24-Apr-2014 12:15 pm
	Lab Number:	1267739.9	1267739.11	1267739.13	1267739.14	1267739.15
Individual Tests						
Dry Matter	g/100g as rcvd	88	96	86	81	97
Qualitative Identification of Asbestos		See attached report	-	-	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	7	5	4	3	5
Total Recoverable Cadmium	mg/kg dry wt	0.51	< 0.10	0.16	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	13	22	18	8	15
Total Recoverable Copper	mg/kg dry wt	24	18	26	2	14
Total Recoverable Lead	mg/kg dry wt	300	23	145	8.3	19.1
Total Recoverable Nickel	mg/kg dry wt	12	15	14	3	12
Total Recoverable Zinc	mg/kg dry wt	320	77	118	8	63
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	0.07	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	mg/kg dry wt	0.75	< 0.03	0.06	< 0.03	< 0.03
Anthracene	mg/kg dry wt	0.89	< 0.03	0.17	< 0.03	< 0.03
Benzo[a]anthracene	mg/kg dry wt	7.9	< 0.03	0.57	< 0.03	< 0.03
Benzo[a]pyrene (BAP)	mg/kg dry wt	10.2	< 0.03	0.59	< 0.03	< 0.03
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	13.3	< 0.03	0.66	< 0.03	< 0.03
Benzo[g,h,i]perylene	mg/kg dry wt	9.0	< 0.03	0.43	< 0.03	< 0.03
Benzo[k]fluoranthene	mg/kg dry wt	4.2	< 0.03	0.28	< 0.03	< 0.03
Chrysene	mg/kg dry wt	6.5	< 0.03	0.46	< 0.03	< 0.03
Dibenzo[a,h]anthracene	mg/kg dry wt	1.45	< 0.03	0.07	< 0.03	< 0.03
Fluoranthene	mg/kg dry wt	11.1	< 0.03	0.97	< 0.03	< 0.03
Fluorene	mg/kg dry wt	0.08	< 0.03	0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	9.0	< 0.03	0.46	< 0.03	< 0.03
Naphthalene	mg/kg dry wt	0.72	< 0.12	< 0.13	< 0.14	< 0.12
Phenanthrene	mg/kg dry wt	2.7	< 0.03	0.26	< 0.03	< 0.03
Pyrene	mg/kg dry wt	11.5	0.02	1.29	< 0.03	< 0.03

	Sample Name:	WS5 - 2.85m 24-Apr-2014 12:40 pm	WS5 - 2.65m 24-Apr-2014 12:30 pm	WS5 - 1.7m 24-Apr-2014 12:25 pm	WS6 - 1.5m 24-Apr-2014 11:40 am	WS6 - 1.8m 24-Apr-2014 11:45 am
	Lab Number:	1267739.17	1267739.18	1267739.19	1267739.22	1267739.23
Individual Tests						
Dry Matter	g/100g as rcvd	82	73	90	82	85
Qualitative Identification of Asbestos		-	-	-	See attached report	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	< 2	9	7	3	4
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	0.51	0.16	0.33	0.20
Total Recoverable Chromium	mg/kg dry wt	< 2	17	14	10	19
Total Recoverable Copper	mg/kg dry wt	2	87	39	51	36
Total Recoverable Lead	mg/kg dry wt	14.8	2,800	360	290	260
Total Recoverable Nickel	mg/kg dry wt	< 2	13	11	21	12
Total Recoverable Zinc	mg/kg dry wt	15	500	460	125	200
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	0.04	0.04	78	< 0.03	0.48
Acenaphthylene	mg/kg dry wt	0.03	0.03	76	0.08	0.82
Anthracene	mg/kg dry wt	0.14	0.15	230	0.29	5.9

Sample Type: Soil

Sample Name:		WS5 - 2.85m 24-Apr-2014 12:40 pm	WS5 - 2.65m 24-Apr-2014 12:30 pm	WS5 - 1.7m 24-Apr-2014 12:25 pm	WS6 - 1.5m 24-Apr-2014 11:40 am	WS6 - 1.8m 24-Apr-2014 11:45 am
Lab Number:		1267739.17	1267739.18	1267739.19	1267739.22	1267739.23
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Benzo[a]anthracene	mg/kg dry wt	0.22	0.42	300	1.16	9.3
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.18	0.41	270	1.65	10.1
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.22	0.50	290	1.76	10.9
Benzo[g,h,i]perylene	mg/kg dry wt	0.13	0.28	159	1.31	7.7
Benzo[k]fluoranthene	mg/kg dry wt	0.09	0.20	122	0.70	4.7
Chrysene	mg/kg dry wt	0.20	0.39	240	1.03	9.4
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	0.07	34	0.30	1.89
Fluoranthene	mg/kg dry wt	0.61	0.99	860	1.69	16
Fluorene	mg/kg dry wt	0.05	0.07	101	0.03	0.21
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.10	0.22	200	1.07	6.4
Naphthalene	mg/kg dry wt	< 0.14	< 0.15	38	< 0.13	1.61
Phenanthrene	mg/kg dry wt	0.58	0.76	1,170	0.36	1.74
Pyrene	mg/kg dry wt	0.51	0.79	800	1.85	18
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	-	-	< 8	-	< 8
C10 - C14	mg/kg dry wt	-	-	163	-	< 20
C15 - C36	mg/kg dry wt	-	-	12,800	-	320
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	12,900	-	320

Sample Name:		WS6 - 2.5m 24-Apr-2014 11:55 am	WS7 - 1.25m 24-Apr-2014 2:20 pm	WS7 - 2.7m 24-Apr-2014 2:35 pm	WS8 - 1.2m 24-Apr-2014 3:15 pm	WS8 - 1.6m 24-Apr-2014 3:20 pm
Lab Number:		1267739.24	1267739.26	1267739.28	1267739.30	1267739.31
Individual Tests						
Dry Matter	g/100g as rcvd	83	83	85	92	-
TCLP Weight of Sample Taken	g	-	45 [#1]	-	-	-
TCLP Initial Sample pH	pH Units	-	9.2	-	-	-
TCLP Acid Adjusted Sample pH	pH Units	-	1.7	-	-	-
TCLP Extractant Type*		-	NaOH/Acetic acid at pH 4.93 +/- 0.05	-	-	-
TCLP Extraction Fluid pH	pH Units	-	4.9	-	-	-
TCLP Post Extraction Sample pH	pH Units	-	6.4	-	-	-
Qualitative Identification of Asbestos		-	-	-	-	See attached report
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	< 2	6	7	6	6
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	0.57	0.11	0.12	0.14
Total Recoverable Chromium	mg/kg dry wt	3	14	17	17	14
Total Recoverable Copper	mg/kg dry wt	5	1,260	35	28	28
Total Recoverable Lead	mg/kg dry wt	12.7	1,020	94	186	230
Total Recoverable Nickel	mg/kg dry wt	< 2	16	15	14	16
Total Recoverable Zinc	mg/kg dry wt	18	2,200	155	200	470
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	0.05	0.04	0.02	-
Acenaphthylene	mg/kg dry wt	< 0.03	0.05	0.03	< 0.03	-
Anthracene	mg/kg dry wt	< 0.03	0.16	0.19	0.08	-
Benzo[a]anthracene	mg/kg dry wt	< 0.03	0.32	0.52	0.31	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03	0.31	0.61	0.36	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.03	0.38	0.70	0.43	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03	0.23	0.48	0.27	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03	0.16	0.27	0.17	-
Chrysene	mg/kg dry wt	< 0.03	0.27	0.44	0.29	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	0.06	0.10	0.06	-
Fluoranthene	mg/kg dry wt	0.03	0.79	1.16	0.59	-

Sample Type: Soil

Sample Name:		WS6 - 2.5m 24-Apr-2014 11:55 am	WS7 - 1.25m 24-Apr-2014 2:20 pm	WS7 - 2.7m 24-Apr-2014 2:35 pm	WS8 - 1.2m 24-Apr-2014 3:15 pm	WS8 - 1.6m 24-Apr-2014 3:20 pm
Lab Number:		1267739.24	1267739.26	1267739.28	1267739.30	1267739.31
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Fluorene	mg/kg dry wt	< 0.03	0.07	0.05	< 0.03	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03	0.18	0.37	0.21	-
Naphthalene	mg/kg dry wt	< 0.14	< 0.14	0.14	< 0.12	-
Phenanthrene	mg/kg dry wt	< 0.03	0.91	0.57	0.30	-
Pyrene	mg/kg dry wt	0.04	0.75	1.16	0.55	-

Sample Name:		WS8 - 2.5m 24-Apr-2014 3:25 pm	WS9 - 1.5m 24-Apr-2014 4:00 pm	WS9 - 2.75m 24-Apr-2014 4:10 pm	Duplicate 1 24-Apr-2014	Duplicate 2 24-Apr-2014
Lab Number:		1267739.32	1267739.34	1267739.35	1267739.36	1267739.37
Individual Tests						
Dry Matter	g/100g as rcvd	86	88	87	88	74
Qualitative Identification of Asbestos		See attached report	-	-	See attached report	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	5	3	6	2	7
Total Recoverable Cadmium	mg/kg dry wt	0.14	< 0.10	0.14	0.21	0.29
Total Recoverable Chromium	mg/kg dry wt	12	22	24	10	18
Total Recoverable Copper	mg/kg dry wt	16	10	23	9	60
Total Recoverable Lead	mg/kg dry wt	43	25	46	196	1,590
Total Recoverable Nickel	mg/kg dry wt	13	11	16	11	11
Total Recoverable Zinc	mg/kg dry wt	123	64	103	144	450
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.03	0.06	< 0.03	0.04	< 0.04
Anthracene	mg/kg dry wt	< 0.03	0.13	< 0.03	0.16	0.11
Benzo[a]anthracene	mg/kg dry wt	0.04	1.02	0.06	0.81	0.26
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.05	1.11	0.07	0.99	0.23
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.06	1.23	0.08	1.15	0.30
Benzo[g,h,i]perylene	mg/kg dry wt	0.04	0.63	0.09	0.91	0.17
Benzo[k]fluoranthene	mg/kg dry wt	0.03	0.53	0.03	0.47	0.12
Chrysene	mg/kg dry wt	0.04	0.94	0.06	0.72	0.24
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	0.20	< 0.03	0.20	0.05
Fluoranthene	mg/kg dry wt	0.07	1.49	0.09	1.47	0.58
Fluorene	mg/kg dry wt	< 0.03	< 0.03	< 0.03	< 0.03	0.03
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.03	0.57	0.04	0.69	0.13
Naphthalene	mg/kg dry wt	< 0.13	< 0.13	< 0.13	< 0.13	< 0.16
Phenanthrene	mg/kg dry wt	0.03	0.29	0.05	0.51	0.43
Pyrene	mg/kg dry wt	0.08	1.44	0.13	1.38	0.46

Sample Name:		Duplicate 3 24-Apr-2014	Duplicate 4 24-Apr-2014			
Lab Number:		1267739.38	1267739.39			
Individual Tests						
Dry Matter	g/100g as rcvd	81	89	-	-	-
Qualitative Identification of Asbestos		See attached report	-	-	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	< 2	5	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.40	0.20	-	-	-
Total Recoverable Chromium	mg/kg dry wt	8	29	-	-	-
Total Recoverable Copper	mg/kg dry wt	26	21	-	-	-
Total Recoverable Lead	mg/kg dry wt	240	34	-	-	-
Total Recoverable Nickel	mg/kg dry wt	18	16	-	-	-
Total Recoverable Zinc	mg/kg dry wt	88	100	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						

Sample Type: Soil

Sample Name:		Duplicate 3 24-Apr-2014	Duplicate 4 24-Apr-2014			
Lab Number:		1267739.38	1267739.39			
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	< 0.03	-	-	-
Acenaphthylene	mg/kg dry wt	0.06	< 0.03	-	-	-
Anthracene	mg/kg dry wt	0.16	< 0.03	-	-	-
Benzo[a]anthracene	mg/kg dry wt	0.49	0.03	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.74	0.04	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.83	0.05	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.61	0.07	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	0.34	< 0.03	-	-	-
Chrysene	mg/kg dry wt	0.41	0.03	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	0.12	< 0.03	-	-	-
Fluoranthene	mg/kg dry wt	0.65	0.05	-	-	-
Fluorene	mg/kg dry wt	0.05	< 0.03	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.46	0.03	-	-	-
Naphthalene	mg/kg dry wt	< 0.14	< 0.12	-	-	-
Phenanthrene	mg/kg dry wt	0.32	0.03	-	-	-
Pyrene	mg/kg dry wt	0.78	0.08	-	-	-

Sample Type: Miscellaneous

Sample Name:	WS3 - 0.5m Brick 24-Apr-2014				
Lab Number:	1267739.40				
Individual Tests					
Qualitative Identification of Asbestos	See attached report	-	-	-	-

Sample Type: Aqueous

Sample Name:		WS2 - 1.5m [TCLP extract]	WS7 - 1.25m [TCLP extract			
Lab Number:		1267739.41	1267739.42			
Individual Tests						
Total Copper	g/m^3	-	2.5	-	-	-
Total Lead	g/m^3	-	0.062	-	-	-
Total Zinc	g/m^3	< 0.021	7.6	-	-	-

Analyst's Comments

[#1] It should be noted that the TCLP extraction has been scaled down because of small sample size. The ratio of solid to extractant has been kept constant (1:20).

Appendix No.1 - Dowdell & Associates Report

Appendix No.2 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	2-4, 6, 8-9, 11, 13-15, 17-19, 22-24, 26, 28, 30-32, 34-39
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	2-4, 6, 8-9, 11, 13-15, 17-19, 22-24, 26, 28, 30, 32, 34-39

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	2-4, 6, 8-9, 11, 13-15, 17-19, 22-24, 26, 28, 30-32, 34-39
Composite Environmental Solid Samples*	Individual sample fractions mixed together to form a composite fraction.	-	18, 37
Qualitative Identification of Asbestos	150-200g, sealed plastic bag. Polarised Light Microscopy and dispersion staining techniques. Subcontracted to Dowdell & Associates, 4 Cain Road, Penrose, Auckland. AS 4964 (2004) - Method for the Qualitative / Semi-Quantitative Identification of Asbestos in Bulk Samples.	-	2, 9, 22, 31-32, 36, 38, 40
TPH Oil Industry Profile + PAHscreen	Sonication in DCM extraction, SPE cleanup, GC-FID & GC-MS analysis. Tested on as received sample. US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:5786,2805,10734;2695]	0.010 - 60 mg/kg dry wt	19, 23
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	2-4, 6, 8-9, 11, 13-15, 17-19, 22-24, 26, 28, 30-32, 34-39
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	2-4, 6, 8-9, 11, 13-15, 17-18, 22, 24, 26, 28, 30, 32, 34-39
TCLP Profile*	Extraction at 30 +/- 2 rpm for 18 +/- 2 hours, (Ratio 1g sample : 20g extraction fluid). US EPA 1311	-	6, 26
TCLP Profile			
TCLP Weight of Sample Taken	Gravimetric. US EPA 1311.	0.1 g	6, 26
TCLP Initial Sample pH	pH meter. US EPA 1311.	0.1 pH Units	6, 26
TCLP Acid Adjusted Sample pH	pH meter. US EPA 1311.	0.1 pH Units	6, 26
TCLP Extractant Type*	US EPA 1311.	-	6, 26
TCLP Extraction Fluid pH	pH meter. US EPA 1311.	0.1 pH Units	6, 26
TCLP Post Extraction Sample pH	pH meter. US EPA 1311.	0.1 pH Units	6, 26

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Total Digestion of Extracted Samples*	Nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	41-42
Total Copper	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.011 g/m^3	42
Total Lead	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.0021 g/m^3	42
Total Zinc	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.021 g/m^3	41-42

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Carole Rodger-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division

DOWDELL & ASSOCIATES LTD

OCCUPATIONAL HEALTH ANALYSTS & CONSULTANTS

4 Cain Rd, Penrose, PO Box 112-017 Auckland 1642, Phone (09) 5260-246. Fax (09) 5795-389.

5th May 2014

Hill Laboratories
Private Bag 3205
Waikato Mail Centre
Hamilton 3240

Dear Sir/Madam

Re: **Bulk Fibre Analysis**

Sampled by : Client
Date received : 5th May 2014
Laboratory no. : 55358
Description : 9x soil sample(s)
Reference : 1267739
Purchase order : 138209
Method : AS 4964 (2004) - Method for the Qualitative Identification of Asbestos in Bulk Samples

We examined the following sample(s) using Low Powered Stereomicroscopy followed by ‘Polarised Light Microscopy’ including Dispersion Staining Techniques. The following result(s) relate(s) to the sample(s) as received**:**

Reg no: J1405 **Labelled as:** 2
Sample size: 51g
Result: Chrysotile *(White Asbestos)* detected (loose bundles).

Reg no: J1406 **Labelled as:** 9
Sample size: 50g
Result: Chrysotile *(White Asbestos)* detected (loose bundles + large clumps).

Reg no: J1407 **Labelled as:** 22
Sample size: 38g
Result: Asbestos **NOT** detected.

Reg no: J1408 **Labelled as:** 26
Sample size: 50g
Result: Asbestos **NOT** detected.

Reg no: J1409 **Labelled as:** 31
Sample size: 50g
Result: Asbestos **NOT** detected.

Reg no: J1410 **Labelled as:** 32
Sample size: 49g
Result: Asbestos **NOT** detected.

Reg no: J1411 **Labelled as:** 36
Sample size: 50g
Result: Chrysotile *(White Asbestos)* detected (loose fibre bundles).

Reg no: J1412 **Labelled as:** 38
Sample size: 29g
Result: Asbestos **NOT** detected.

Reg no: J1413 **Labelled as:** 40
Sample size: 45g
Result: Asbestos **NOT** detected.

Yours faithfully
DOWDELL & ASSOCIATES LTD

E.Sheldon BSc (Hons)
Analyst

Imtiaz Damani MSc
Analyst

Q.E. Dowdell NZCS MNZMS
Director

586

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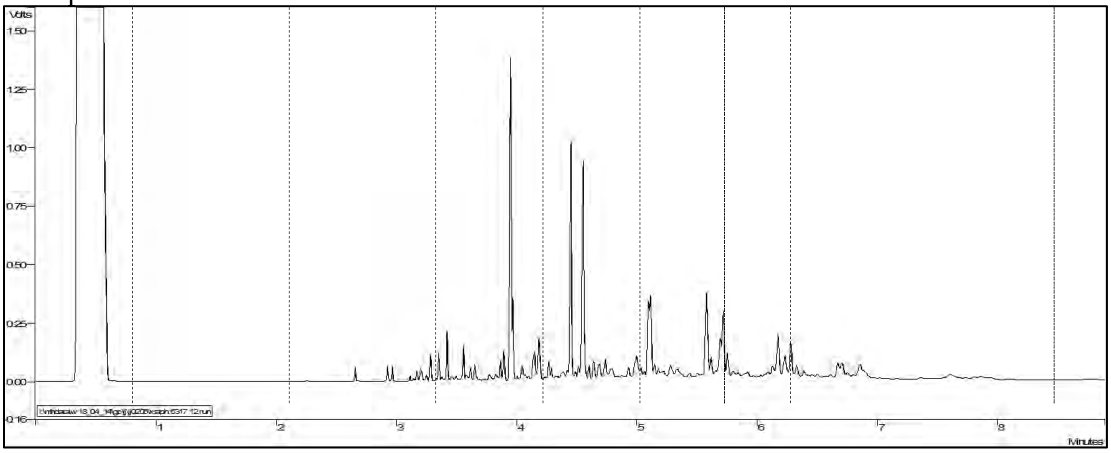
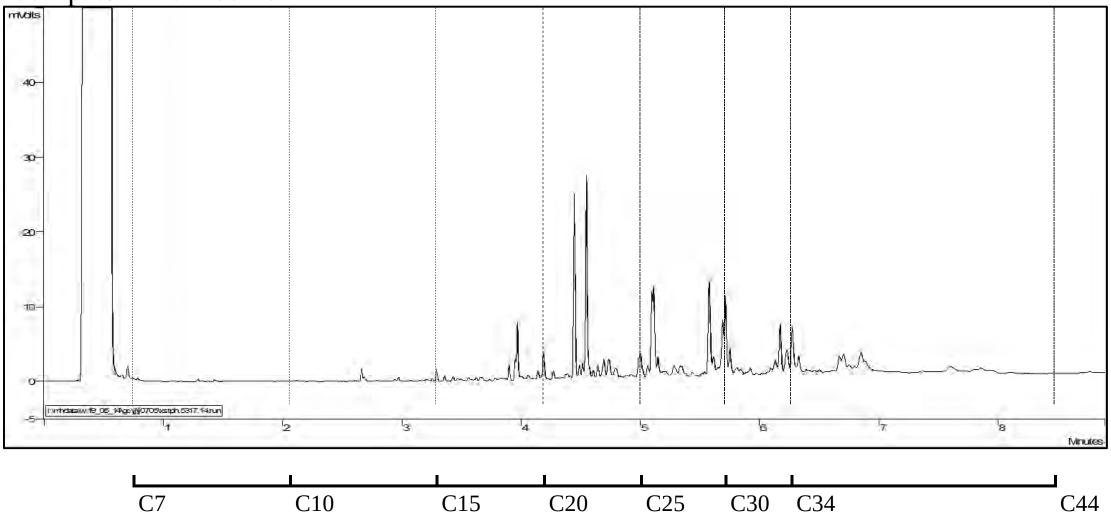
Sample: 1267739.19



Sample: 1267739.23



Hill Laboratories
BETTER TESTING **BETTER RESULTS**

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ANALYSIS REPORT

SPv1

Client:	Tonkin & Taylor	**Lab No:**	1274242
Contact:	Sharon Parackal C/- Tonkin & Taylor PO Box 2083 WELLINGTON 6140	**Date Registered:**	13-May-2014
		Date Reported:	20-May-2014
		Quote No:	
		Order No:	85778.001
		Client Reference:	85778.001
		Submitted By:	Sharon Parackal

Sample Type: Aqueous

Sample Name:		P1 06-May-2014 3:20 pm	WS2-P2 12-May-2014 2:15 pm	Dup		
Lab Number:		1274242.1	1274242.2	1274242.3		
Individual Tests						
pH	pH Units	7.2	7.7	7.2	-	-
Sulphate	g/m^3	750	3,400	740	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	< 0.10	< 0.10	< 0.10	-	-
Dissolved Cadmium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Chromium	g/m^3	< 0.05	< 0.05	< 0.05	-	-
Dissolved Copper	g/m^3	< 0.05	< 0.05	< 0.05	-	-
Dissolved Lead	g/m^3	< 0.010	< 0.010	< 0.010	-	-
Dissolved Nickel	g/m^3	< 0.05	< 0.05	< 0.05	-	-
Dissolved Zinc	g/m^3	< 0.10	< 0.10	< 0.10	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Acenaphthylene	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[a]anthracene	g/m^3	0.00014	< 0.00010	< 0.00010	-	-
Benzo[a]pyrene (BAP)	g/m^3	0.00014	< 0.00010	< 0.00010	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m^3	0.00024	< 0.00010	< 0.00010	-	-
Benzo[g,h,i]perylene	g/m^3	0.00011	< 0.00010	< 0.00010	-	-
Benzo[k]fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Chrysene	g/m^3	0.00010	< 0.00010	< 0.00010	-	-
Dibenzo[a,h]anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Fluoranthene	g/m^3	0.00022	< 0.00010	< 0.00010	-	-
Fluorene	g/m^3	< 0.0002	< 0.0002	< 0.0002	-	-
Indeno(1,2,3-c,d)pyrene	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Naphthalene	g/m^3	< 0.0005	< 0.0005	< 0.0005	-	-
Phenanthrene	g/m^3	< 0.0004	< 0.0004	< 0.0004	-	-
Pyrene	g/m^3	0.0003	< 0.0002	< 0.0002	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00005 - 0.0010 g/m^3	1-3

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis [KBIs:4736,2695]	0.00010 - 0.0005 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1-3
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m^3	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Peter Robinson

Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Appendix D: Draft Contamination Site Management Plan

REPORT

Willis Bond Ltd

Sites 8, 9, and 10
DRAFT Contamination Site Management Plan

Report prepared for:

Willis Bond Ltd

Report prepared by:

Tonkin & Taylor Ltd

Distribution:

Willis Bond Ltd	2 copies
RCP	1 copy
Tonkin & Taylor Ltd (FILE)	1 copy

February 2015

T&T Ref: 85778.001 (rev 1)

Document control

Report Date	Version	Prepared by:
September 2014	1	Penny Kneebone

Report certified by a suitably qualified and experienced practitioner as prescribed under the NES Soil.

....

Penny Kneebone
Principal Environmental Scientist

Authorised for Tonkin & Taylor Ltd by:

....

Stuart Palmer
Project Director

pek

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Table of contents

1 Introduction

Tonkin & Taylor Ltd (T&T) has been commissioned by Willis Bond Ltd to prepare a Contamination Site Management Plan for earthworks in contaminated soil at Site 10, 10 Waterloo Quay Wellington (**Site 10**) and the other open space areas shown within the red line in Figure 1 below (referred to collectively as **Landscape Areas** in this Plan).

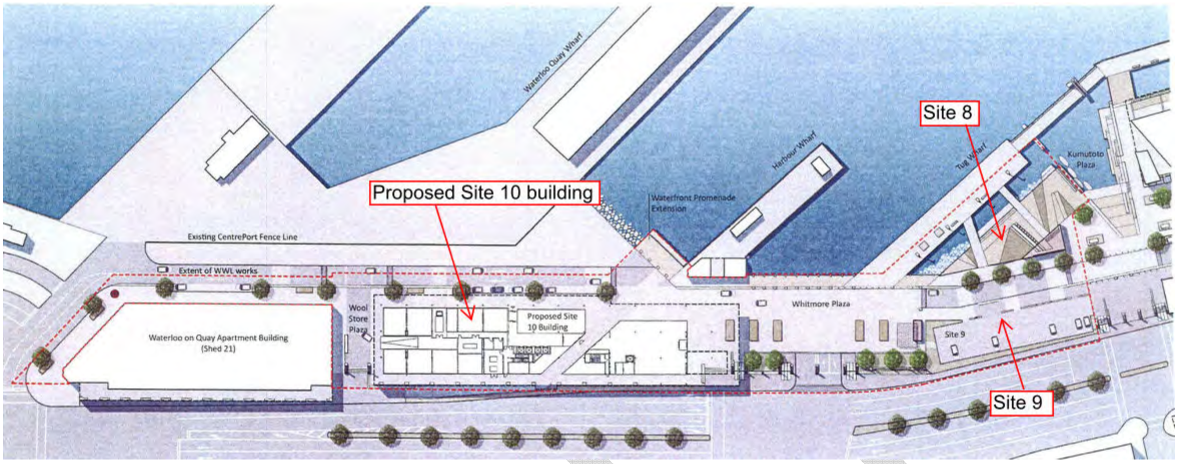

Figure 1: proposed development master plan (Source: Isthmus)

This Contamination Site Management Plan (CSMP) provides Willis Bond and their Contractors with procedures that must be implemented during earthworks in contaminated soil.

1.1 Background

WBL proposes to develop Site 10 by constructing a multistorey building. The proposed Site 10 works are likely to comprise of basement excavations to 3.7 m depth, and possibly deeper foundation excavations. The basement excavation works will generate groundwater which will require disposal offsite (dewatering).

Wellington Waterfront Limited proposes to carry out earthworks and landscaping works within the Landscape Areas (with the exception of the Site 9 space which will not be developed through the Open Space works and will remain as a carpark) to create public open space areas. We understand approximately 1,000 m^3 of cut material may need to be removed from Site 8 (if it is geotechnically unsuitable), with cuts to a maximum of 1 m deep. No significant cut is proposed elsewhere in the public space areas, however it is expected that limited soil disturbance will be required for surface preparation. The public space areas shall be finished with either paving underlaid by imported fill or imported clean landscaping fill materials.

The development area is on reclaimed land, and historical structures were formerly present on some parts of the site. Site investigations have identified some of the material used for the reclamation is contaminated, and asbestos is present in soil on part of Site 10.

This CSMP has been prepared to document excavation procedures, monitoring, management and health and safety requirements during earthworks in contaminated soil at Site 10 and the Landscape Areas.

1.2 Scope of report

It sets out procedures for:

- establishing Site 10 and the Landscape Areas and associated management structures/systems;
- handling and managing contaminated materials, including soil that contains asbestos;
- health and safety controls to augment the Contractor health and safety plans;
- monitoring of the effectiveness of mitigation measures implemented during the works; and
- validation of the site following removal of material containing asbestos.

1.3 Regulatory compliance

Resource consents are required from Wellington City Council (WCC) and Greater Wellington Regional Council (GWRC). It is anticipated that a CSMP would be a requirement of these consents. This draft CSMP has been prepared to support the application for consents, and would need to be updated to reflect any additional requirements of the resource consents.

This CSMP has been prepared in general accordance with Ministry for the Environment Contamination Land Management Guidelines No.1 – *Guidelines for Reporting on Contaminated Sites in New Zealand*. Sampling procedures provided in the plan generally comply with the MfE Contamination Land Management Guidelines No.5 – *Site Investigation and Analysis of Soils*.

The plan is also prepared in general accordance with the soil disturbance related controls referred to in the National Environmental Standards for Contaminants in Soil to Protect Human Health Regulations (NES Soil). The persons preparing and certifying this CSMP are suitably qualified and experienced practitioners as required by the NES Soil and defined in the NES Soil Users' Guide.

1.4 Applicability

This CSMP provides a framework for managing contamination hazards on site by identifying potential hazards and suggesting mitigation measures relevant to site conditions at the time of writing. This CSMP provides information and recommendations to augment this process but is not intended to relieve the controller of the place of work of either their responsibility for the health and safety of their workers, contractors and the public, or their responsibility for protection of the environment.

The provisions of this CSMP are mandatory for all persons (employees, contractor and sub-contractors) who will be involved in undertaking any of the proposed works.

It is recommended that any persons undertaking controlled activities develop a site-specific health and safety plan (SSSP) to complement this CSMP and to address other health and safety requirements that may be applicable to their particular works. This document should also be modified to address any specific health, safety or environmental issues that may arise during the works.

From time to time, statutory requirements, site ownership or occupation, operating procedures or site conditions may vary and will require that this plan be amended or updated.

The plan has been prepared on the basis of information available at the date of preparation, principally data from samples collected by Tonkin & Taylor and based on our observations during investigations in 2009 (Sites 8 and 9) and 2014 (Site 10). The nature and continuity of subsoil away from sample locations are inferred and it must be appreciated that actual conditions could vary from the assumed model.

This report has been prepared for the benefit of Willis Bond Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement. This draft CSMP has been prepared in accordance with our proposal of 8 April 2014.

2 Roles and Responsibilities

2.1 Distribution

A copy of the CSMP shall be kept onsite at all times. It is Willis Bond's responsibility to distribute the plan to their Contractor, the person holding a certificate of competence for restricted work involving asbestos under the Health and Safety in Employment (Asbestos) Regulations 1998 (approved asbestos remover), Worksafe, WCC, and GWRC.

It is Willis Bond's responsibility for distribution of the CSMP to any other sub-contractors or parties carrying out the remedial works.

2.2 Review and update

Any variations to the CSMP proposed by the Contractor shall be approved by Willis Bond, WCC and GWRC prior to works commencing, or the variation being implemented if works have already commenced.

It is the responsibility of Willis Bond to distribute any changes to the plan to the relevant parties involved in the remedial works and update the site copy.

2.3 Implementation

Responsibility for the implementation of the CSMP lies with Willis Bond's appointed Contractor.

A contaminated land specialist (i.e., a "suitably qualified and experienced practitioner" as required by the NES Soil regulations) will be required to carry out inspections and provide advice as required during the works (refer Section 5).

The approved asbestos remover must supervise all asbestos management works on Site 10.

2.4 Personnel contact details

Contact details for key staff involved in the works are provided in Table 1. These contact details shall also be provided on the site hazard board as per Section 5.2 and 8.

Table 1: Personnel contact details

Person (Organisation)	Role	Contact number
TBC (Willis Bond)	Project Director	
TBC (TBC)	Project Manager	
TBC (TBC)	Contractor Site Manager	
TBC (TBC)	Operations Manager Managing site and project Certificate of Competence holder (Asbestos Regulations (1998))	
TBC (TBC)	Air monitoring	
TBC (TBC)	Contaminated Land Specialist -Site observation and sampling	

3 Site Condition

The condition of the site described in the following sections has been compiled based on investigations in 2009 (on Sites 8 and 9) and 2014 (Site 10).

3.1 Site identification

The outline of the proposed Landscape Area is shown in the development plan (Figure 1).

The proposed Site 10 basement excavation is roughly rectangular in shape and has an area of approximately 0.25 ha. (as can also be seek on Figure 1)

3.2 Site layout

The Landscape Areas are currently surfaced with asphalt and used as public open space, parking and access roads.

Site 10 is currently used as a car park and motor home park. It is essentially flat and entirely paved. An amenities block is located on the eastern boundary of Site 10. Access is via a paved road immediately to the south of the amenities block.

3.3 Contamination

Contamination has been characterised at Site 10. This CSMP includes detailed requirements for excavation, management and disposal of soil from the Site 10 basement.

Only limited testing has previously been done at Sites 8 and 9, and no testing has been completed specifically in other public space areas (ie, Whitmore Plaza). When the location (area and depth) of earthworks for the Landscape Areas are confirmed, further testing will be carried out in these areas to characterise soil and assess appropriate soil management measures.

Site 8 was reclaimed in the 1970s using quarried fill. Geotechnical investigations in 2009 indicated relatively consistent material across Site 8. Limited laboratory testing indicated the fill is clean, however due to the limited scope of testing in 2009, additional testing is required to confirm this.

Site 9 and Site 10 were reclaimed in the early 1900s. Investigation in Site 9 (2009) and Site 10 (2014) indicate variable fill materials, with variable levels of contamination (metals, polycyclic aromatic hydrocarbons) present. Results from many samples exceed expected background concentrations. Some samples also exceeded human health guidelines for commercial site use, however these were either from deep, subsurface soil (Site 9) that will not be exposed during the works (as Site 9 is to remain as a carpark), or from soil that will be excavated and disposed offsite during construction of the Site 10 basement. Furthermore, some fill at Site 10, where historical buildings were present, contains asbestos.

The Site 10 basement has been divided into three “zones” (see Figure 2 and Table 2).

- Limited testing in Zone 3 indicates asbestos containing fill in the upper 1.2 m. Deeper soil has not been tested (and so may also contain asbestos), and further testing may decrease (or increase) the northward extent of Zone 3.
- A contaminated layer is present in Zones 1 and 2. Limited testing above and below this layer indicates fill is potentially clean. If material is to be disposed as clean fill, it ~~should~~ must be tested to confirm it is clean (either before excavation or on stockpiled material).

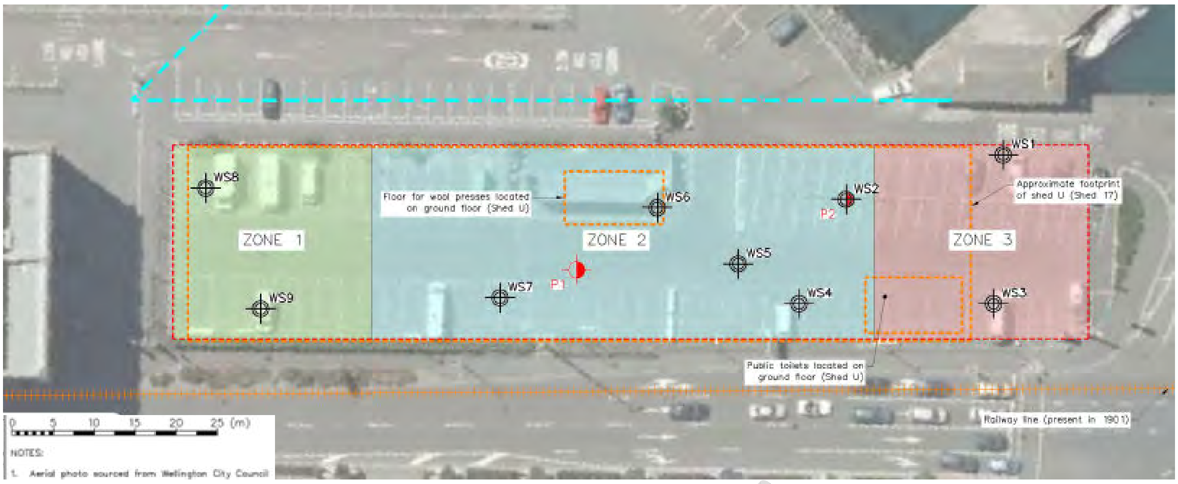

Figure 2: excavation zones within Site 10 basement

Table 2: excavation zones within Site 10 basement

Site 10 zone	Depth to top of layer (m)	Depth to bottom of layer (m)	Thickness of layer (m)	Contamination present?
Zone 1	0	1	1	Potentially clean~~no~~
	1	2	1	Yes – elevated metals and PAH
	2	3	1	Potentially clean~~no~~
Zone 2	0	0.75	0.75	Potentially clean~~no~~
	0.75	2.75	2	Yes – elevated metals and PAH
	2.75	3	0.25	Potentially clean~~no~~
Zone 3	0	1.2	1.2	Yes – metals, PAH, and asbestos
	1.2	3	1.8	Unknown – not yet tested

4 Proposed works

Proposed earthworks in contaminated (or potentially contaminated) material include excavation of a basement to 3.7 m depth for the Site 10 building and earthworks for landscaping within the public space Landscape Area.

Cut to a maximum of 1 m deep are anticipated on Site 8. The specific areas and depths of earthworks within other parts of the Landscape Area will be finalised at the detailed design stage.

4.1 Removal of asbestos containing material (Site 10)

Willis Bond's appointed Contractor is to remove the asbestos-containing fill from the Site 10 basement. The removal of the asbestos-containing fill and disposal at a licensed landfill will remove the potential for future asbestos related health effects on workers and users of the site. Commercial premises and public walkways are adjacent or close to the site and thus monitoring shall be undertaken to confirm effects are being managed in respect of offsite receptors.

Approximately 700 m^3 of fill has been confirmed to contain asbestos. Deeper soil underlying this was inaccessible (beneath a concrete slab). It is assumed this material does not contain asbestos, but testing must be carried out to confirm this.

The following sets out the method to be used for identification and removal of asbestos containing soil at Site 10. Procedures for undertaking the works are set out in Sections 5 – 9. In summary the materials will be removed by:

- Following removal of the asphalt surface, a visual inspection shall be carried out for potential asbestos containing materials. Suspected asbestos-containing material shall be sampled and tested to confirm the extent of asbestos contaminated surface soil.
- Excavating materials to the concrete slab at 1.2 m depth.
- Following removal of the fill:
  - if intact the underlying concrete slab shall be water blasted; or
  - if the concrete slab is not intact the underlying surface shall be skimmed, with the excavator taking around 50 mm from the underlying surface (the excavator shall not track back onto the cleaned surface); and
- Disposing the excavated materials to a consented landfill (e.g., Southern Landfill) as asbestos-containing waste.

The works will be observed by a person holding an appropriate certificate of competence under the Asbestos Regulations 1998.

4.2 Excavation of remainder of Site 10 basement

Soil beneath the concrete slab in Zone 3 must be tested (metals, asbestos, PAH) and the appropriate disposal location selected based on the results of testing.

The remainder of the Site 10 basement (Zones 1 and 2) shall be excavated and managed based on the contamination identified in Section 3. A contaminated layer is present across Zones 1 and 2. This has been conservatively estimated as 1 m thick in Zone 1 and 2 m thick in Zone 2. The contaminated soil must be disposed to an appropriately consented landfill (e.g., Southern or Silverstream). If clean material either side of the contaminated layer is to be segregated for clean fill disposal, it must be tested before disposal to confirm it is indeed clean. ~~clean material outside the contaminated layer may be disposed to clean fill without further testing, unless any unusually stained or odorous material is encountered that was not encountered during the investigations~~.

Material from 3 to 3.7 m has not been tested. Based on results for soil from 2.75 to 3 m, this deeper material is potentially clean. It may only be disposed to clean fill if testing is done (before or after excavation) that confirms it is clean.

4.3 Excavations in public space area

When details of the proposed earthworks in the public space Landscape Areas are confirmed at the detailed design stage, testing shall be carried out to assess the appropriate management controls for the earthworks and disposal location for any surplus soil (if any).

- Samples shall be collected by the contaminated land specialist in the soil to be disturbed.
- Samples shall be tested for potential contaminants in the fill material (metals and PAH).
- Results shall be compared to expected background concentrations, guidelines for the proposed site use (commercial), and disposal criteria.
- An updated site plan shall be prepared (analogous to Figure 2 for the Site 10 basement) setting out the extent and depth of contaminated material (if any) and any additional management controls (if any) required.

5 Site Management Procedures

The procedures below are procedures for managing dust, sediment and surface water during removal of asbestos-containing fill and contaminated soil from the Site 10 basement excavation, and earthworks in fill at the Landscape Areas. The procedures below include actions to be taken by the Contractor.

These procedures have been developed to provide a framework for managing potential contamination related effects at the site, however, these protocols are not intended to relieve the owner or controller of the place of work of either their responsibility for the health and safety of their workers, contractors and the public, or their responsibility for protection of the environment. The key requirements of site management are summarised on the Contractor checklist in Appendix B.

All procedures employed by the Contractor shall comply with conditions of existing (if any) resource consent(s) held by Willis Bond Ltd.

5.1 Site establishment

The following shall be established prior to works commencement:

- Stabilised site access shall be maintained for the duration of removal of contaminated materials;
- Site sheds containing worker amenities, decontamination facilities and PPE equipment stores shall be as described in Section 8.2.
- Surface water containment on the western and northern sides of the excavation and any material temporarily stockpiled on site.
- Establishment of a bin loading and unloading area in a designated area of the site. The bin loading area shall be maintained so that trucks do not contact contaminated materials. Geotextile bidim cloth shall be lain over the loading area to capture spilt materials.
- A site Hazard Board with information pertaining to the presence of asbestos as detailed in Section 8. The contact details of the contaminated land specialist shall also be provided on the Hazard Board.

WCC and GWRC shall be advised on the works programme, and shall be updated if the programme duration extends beyond the estimated duration.

Willis Bond shall advise staff on the adjacent properties prior to works commencement.

5.2 Unforeseen contamination procedures

Investigations to date have identified layers of contaminated material between <u>potentially</u> clean material in Zones 1 and 2 of Site 10 (and in Site 9 – although no works are proposed on this site). It is possible (albeit unlikely) that unforeseen contamination may be encountered in areas that are assumed to be clean. Visual and olfactory indicators of contamination could include the following:

- Odour (petroleum hydrocarbons, oil);
- Discoloured soil (black, green staining most common);
- <u>Potentially asbestos containing materials (e.g., plasterboard, cement board, lagging);</u>

- Inclusions of deleterious materials not included in Table 4.1 of the MfE Cleanfill Guidelines[1] (refer Appendix C).

The following is a “first response” checklist for the Contractor to follow should visual or olfactory evidence of contamination be encountered during the works onsite to ensure contamination is appropriately contained while decisions about its management are being made by Willis Bond.

First Response Checklist:	
Stop work in the immediate vicinity of the contamination discovery and isolate the area by taping, coning or fencing off.	☐
Advise the Contractor’s Site Manager.	☐
Update the site Hazard Board and prevent unnecessary access to the area by personnel.	☐
The Contractor’s Site Manager is to contact a contaminated land specialist to inspect, sample and advise of specific controls if appropriate.	☐
The Contractor’s Site Manager is to contact Willis Bond.	☐
Contain surface water/ sediment and dust as per **Section 6.**	☐

5.3 Plant and equipment use

Plant and equipment utilised onsite shall be kept to a minimum to minimise post-works decontamination, to lower the potential for tracking and fragmentation of asbestos and contaminated soil around the site and to minimise generation of dust.

5.4 Asbestos-containing soil removal procedures ~~(Zone 3)~~

The removal of asbestos containing soil shall be carried out using an excavator operated by the Contractor. The following shall be adhered in Zone 3, and anywhere else on site where visual inspection (following removal of asphalt) indicates potential presence of asbestos containing materials in surface soil:

- An approved asbestos remover shall inspect the works methods during excavation of asbestos.
- Procedures for handling asbestos-contaminated material (Section 8.1) shall be implemented at all times.
- Project-relevant earthworks controls, including dust control procedures, shall be in place during excavation per Section 6.
- The swale/surface water bund shall be skimmed on a daily basis to remove any asbestos that may have accumulated in it.
- Excavated materials shall be placed directly into clip-bins, loaded and positioned end facing towards the loading zone.
- The bin sides shall be brushed down and covered by well secured tarps before being positioned adjacent to the truck loading area.

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[1] Ministry for the Environment, 2002: A Guide to Management of Cleanfills.

- If the bin loads are dry they shall be sprayed with water before securing the tarps.

5.5 Contaminated soil removal

These controls apply to Zones 1 and 2 in the Site 10 basement, and anywhere in the Landscape Area where testing (refer Section 4.3) shows contaminated soil will be disturbed. Additional controls are required for Zone 3 (i.e., wherever asbestos-contaminated soil is encountered).

- Excavated materials shall be placed directly into trucks.
- Loads shall be covered by well secured tarps before transport.
- If the loads are dry they shall be sprayed with water before securing the tarps, taking care not to generate runoff water.

5.6 Transportation procedures

The following procedure shall be used during transportation of contaminated soil and asbestos containing soil:

- Trucks shall be loaded within the loading area of the site. Spills during loading shall be controlled and contained.
- Trucks shall remain within the loading zone or alternatively a vehicle wash can be established for wheel washing if trucks are required to drive onto the site for the purposes of loading.
- Trucks shall have their wheels maintained clean of debris and there shall be no tracking of material (including soil) onto public roads.
- Each truck shall have a tracking document signed out onsite and collected at the landfill to track each load of material. Onsite records shall include the truck registration number, the number of bins per load and the time the truck left site.

5.7 Disposal procedures

All asbestos-containing material and material contaminated with metals and hydrocarbons shall be disposed of offsite at a licensed landfill (e.g., Southern Landfill).

Authority to dispose of the contaminated materials must be obtained from the receiving landfill prior to the works commencing. The landfill may request that further testing is carried out.

5.8 Plant and equipment decontamination

Plant and equipment utilised within the site shall be decontaminated prior to its removal from site and following removal of bidim from the loading area.

A vehicle wash shall be established within the loading area utilising the following method:

- Sweeping of the asphalt surface to remove sharp objects that may rip the geotextile;
- Laying a suitably sized pad of bidim (of sufficient thickness to prevent ripping by the machinery) on the swept surface, minimum of 2.5m wide by 3 m long.
- Placement of sandbags around the perimeter of the geotextile and lapping the geotextile over and fix under the sandbag on the outside to secure the geotextile.
- Placement of two steel plates or timber planks for driving the excavator onto.
- Establishment of a high pressure misting spray truck unit.

The operation of the machinery wash shall be as follows:

- The wash shall only operate in conditions where no or only very light wind prevails.
- The tracks and tyres of machinery entering the ramp shall be inspected for asbestos fragments by Contactor staff and if found removed and bagged for disposal offsite.
- The high pressure water blaster truck shall operate with as little water as possible to prevent overflow of the wash area.
- Cleaned machinery shall drive onto the seal and directly onto awaiting transporters.

On completion of vehicle washing the geotextile shall be bagged and disposed to a suitably consented landfill (e.g., Southern Landfill).

5.9 Reinstatement

Any material imported to the site for the purposes of reinstatement shall be shown to be appropriate for use as cleanfill. Testing at a rate of 1 sample for every 100 m^3, sampled by a contaminated land specialist shall be provided with in-coming material. Hard fill, if sourced directly from a quarry, does not require testing.

5.10 Excavation sampling procedures

There are sufficient test results to characterise the materials for disposal permitting to landfill. However, should additional testing be required by the landfill operator then the methodology indicated in Appendix A shall be used by the contaminated land specialist.

The contaminated land specialist shall report the results of any testing to Willis Bond, WCC, GWRC, and the receiving landfill.

As noted in Section 3.3 (bullet 2), if potentially clean soil is to be segregated for cleanfill disposal, it must be tested to confirm it is clean before it is taken off site. Sampling shall be done at a rate of 1 for every 100 m^3. Results shall be compared with clean fill acceptance criteria.

6 Earthworks Controls

The following earthworks controls shall be put in place by the Contractor prior to and for the duration of the proposed works.

6.1 Dust control procedures

From a human health perspective, any dust generated in Zone 3 (and anywhere else that asbestos containing soil is identified, if anywhere) may have the potential to contain friable asbestos. If not suppressed during windy conditions or during vehicular movement over contaminated soil, discharge of airborne asbestos fibres may occur. In works in contaminated soil, ~~Zones 1 and 2,~~ generation of dust could transport contaminants offsite.

To avoid dust generation in dry conditions and to mitigate against dust generation associated with vehicle movement, the following control and monitoring systems shall be put in place by the Contractor:

- Frequent spraying of water over the excavation and truck loading area to ensure the working surfaces remain damp;
- Wetting of the loaded material once placed in the bins (Zone 3) or trucks (Zones 1 and 2);
- Use of a water truck or portable water sprays in trafficked areas to dampen dust;
- Mesh shall be secured on site fencing to reduce the impact of wind. The contractor shall be responsible for maintaining the fencing for the duration of the contract;
- Works shall cease if the contaminated land specialist deems wind conditions to be too strong to continue in a safe manner;
- Stockpiles awaiting removal of material (if any) shall be covered or wetted; and
- Air monitoring devices shall be monitored as per Section 7.

6.2 Erosion and sediment control

Erosion and sediment control during construction shall be in accordance with the GWRC "*Erosion and Sediment Control Guidelines for the Wellington Region*" (2002). Erosion and sediment control measures shall include:

- Avoid work in heavy rain.
- Keeping the site clean.
- Temporary stockpiles shall be dampened or covered (with bidum geotextile or similar) if left overnight. Any stockpiles shall not be placed in an area where runoff cannot be controlled.
- A stabilised entry/exit point, shall be established so sediment is not tracked on and off the site. This will be made of aggregate and shall be removed off site once work has been completed.
- Bunding shall be placed to prevent clean stormwater running into contaminated areas, and to contain runoff from contaminated areas. Silt fences and runoff diversion bunds shall be utilised where appropriate to capture sediment in surface water runoff. Excess ponded water shall be removed by sucker truck and disposed to an appropriate liquid waste processing facility.

Erosion and sediment controls shall be checked regularly and made sure that are in good working condition.

To ensure good practice:

- The entry/exit point shall be reapplied with aggregate if excessive sediment build up occurs.
- Erosion and sediment control measures shall be upgraded/ modified where necessary. Sediment fences shall be replaced if the fabric is ripped or otherwise damaged. They shall be retrenched if needed.
- The weather conditions along with the performance of the erosion and sediment control measures shall be monitored.

Erosion and sediment control measures shall remain in place until surface reinstatement cover is established.

6.3 Groundwater management

Groundwater extracted during dewatering of the Site 10 basement may require treatment prior to disposal. Preliminary testing from 2 piezometers indicates no contaminants are present in groundwater. If groundwater is to be disposed to stormwater, follow resource consent (GWRC) and stormwater permit (WCC) conditions for discharge of groundwater to stormwater. If groundwater is to be disposed to trade waste, follow conditions of WCC trade waste permit.

The following steps are required before works begin:

- Install 2 additional piezometers to the depth of the proposed basement excavation.
- Collect groundwater samples and test for metals (total and dissolved) and PAH.
- Compare results (dissolved metals only) with ANZECC guidelines for protection of 80% of marine species, applying an appropriate dilution factor, to assess whether treatment is required before discharge. The dilution factor should be determined by the contaminated land specialist once discharge volumes are known.
- Compare results with trade waste guidelines to assess whether discharge can be discharged to trade waste.

If treatment for removal of sediment is required before discharge, it may comprise one or more of the following:

- Good erosion and sediment control to prevent clean stormwater entering the excavation, thereby minimising the volume of water requiring dewatering.
- Appropriate detention to remove sediment. This may be a series of decanting sedimentation containers.
- Chemical treatment with flocculants.
- Monitoring the decant (discharge) for total suspended solids, prior to discharge.
- Laboratory testing for potential contaminants (dissolved metals, PAH) prior to discharge.

7 Air quality monitoring

This section shall be reviewed and updated, if necessary, when the conditions and method to remove ACM from the site are known. This will be after removal of asphalt from the site, visual inspection of surface soil, and targeted testing for potential ACM.

There are workers on site and on adjacent properties in close proximity to the remediation area, thus activity-based sampling shall be undertaken at intervals during the earthworks to confirm asbestos fibre mobilisation in air is negligible.

7.1 Collection method

Stationary air monitoring shall be undertaken on a daily basis for the first 3 days of earthworks involving asbestos materials to establish baseline conditions. Additional monitoring shall be carried out if conditions change significantly on site (e.g., higher winds, larger areas of asbestos contaminated material exposed).

The sampling shall be undertaken at two locations on the perimeter of the site (upwind and downwind).

The monitoring shall utilise a Gilian® BDX-II personal sampling pump calibrated by the laboratory prior to being installed in the field. The before and after flow rates shall be collected and used to determine an average flow rate. The average flow rate shall be recorded on field data documentation.

The sampling shall be undertaken by the contaminated land specialist and shall be in general accordance with *USEPA (5 October 2007) Standard Operating Procedures: Activity-Based Air Sampling for Asbestos, Rev 0.0, SOP 2084.*

7.2 Analytical method

The personal and stationary air monitoring cassettes shall be analysed by Dowdell & Associates (Dowdell). Dowdell shall use an analytical method developed by the National Occupational Health and Safety Commission Australia - NOHSC: 3003(2005) *Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres* 2nd Edition.

7.3 Reporting

Air monitoring results shall be evaluated on receipt. If asbestos fibres are detected works shall cease until dust and other earthworks controls are reviewed and modified where necessary. Amendments to the earthworks procedures shall be reported to Willis Bond, WCC, and GWRC.

All air monitoring results shall be reported in the validation report (refer Section 10).

8 Health and Safety Plan – Asbestos and contaminated soil

8.1 Introduction

This section provides suggested health and safety plan procedures for Contractor staff removing contaminated soil, including soil containing asbestos, and has been prepared in general accordance with:

- Department of Labour Health and Safety Guidelines on the Cleanup of Contaminated Sites (March 1994);
- Asbestos Regulations (1998); and
- New Zealand Demolition and Asbestos Association (NZDAA), March 2011: *New Zealand Guidelines for the Management and removal of Asbestos*, 3rd Edition.

These procedures have been developed to provide a framework for managing potential asbestos contamination related effects at the site; however, these protocols are not intended to relieve the owner or controller of the place or work of either their responsibility for the health and safety of their workers, contractors and the public, or their responsibility for protection of the environment.

General health & safety procedures based on the requirements of the *Health and Safety in Employment Act*, 1992 are to be covered by the Contractor and Willis Bond's Health and Safety Plans.

The purpose of these contaminated land-related Health and Safety procedures are to:

- Provide and maintain a safe working environment for workers during removal of asbestos contaminated soil and contaminated fill.
- Document safety facilities and procedures to prevent exposure to contaminated material by workers and visitors to the site;
- Identify and ensure awareness of potential contaminated land-related hazards; and
- Describe emergency procedures.

The contaminated land-related Health & Safety procedures shall be implemented while contaminated material is exposed on the site.

8.2 Site establishment (health and safety)

The Contractor shall include the following with respect to contamination-related health and safety during site establishment works set out in Section 5.1:

- Hazard identification signage (hazard board and on eastern access point) to warn sub-Contractors that asbestos containing materials are present; and
- Establishing a change and washing facility for workers;
- Establishing a personal protective equipment (PPE) store for workers; and
- Establish a personnel decontamination process/unit. The decontamination process shall include provision of:
  - Boot wash bins;
  - Hand held spray bottle for wetting down tyvek suits;
  - Bin for disposal of masks and tyvek suits; and
  - Mat for stepping out of the decontamination process onto.

The person holding the certificate of competence under the Asbestos regulations shall ensure the workers are familiar with the decontamination unit and process, and that the process is adequate.

The Contractor is responsible for the implementation these Health and Safety procedures. The key requirements of this plan are summarised on the Contractor checklist in Appendix B.

The health and safety procedures outlined below have been prepared based on differing work areas being established. These are defined as the following:

"Exclusion zone"	Works areas that contain contamination, including a clear area around them; and
"Support zone"	Designated areas including site offices, washing/decontamination areas, toilet facilities, designated lunch and smoking areas and loading area.

8.3 Identification of hazards

Asbestos fragments or free fibres may be identified in soils on site. There is no odour indicator of asbestos contamination.

Hydrocarbon contaminated soils are discoloured (black, blue/green staining) and odorous.

8.3.1 Identification of new hazards

Further hazards may be identified during the course of the works. Potential hazards could include, but are not limited to, contaminated materials with characteristics such as an oily sheen, odours (petroleum, oil), discolouration (black, green/blue staining most common), and/or inclusions of non-cleanfill allowable (refer Appendix C) deleterious materials (i.e. plastic, rubber, metal).

The Contractor is responsible for reviewing any new work element and assessing whether there are any new associated hazards, and whether these can be eliminated, isolated or minimised. The contractor shall advise Willis Bond, the approved asbestos remover and seek review by the contaminated land specialist if necessary. The Contractor shall then instruct all staff on the health and safety procedures associated with the new hazard.

8.3.2 Hazard management

The asbestos, metals, and hydrocarbon contamination hazards shall be managed by the minimisation methods set out in **Section 5**. The primary hazard management method is minimising exposure to contaminated materials and dust during the removal. Maintenance of earthworks controls (**Section 6**) is a key component of contaminated material hazard management.

8.4 General safety requirements and training

8.4.1 Health and safety officer

The Contractor's Site Manager shall be appointed the role of environmental health and safety officer (HSO) for the duration of the works to ensure that contaminated land-related health and safety procedures are adhered to, alongside of those required under the Contractors and Willis Bond's Health and Safety Plans.

The Contractor's Site Manager shall have basic first aid training.

8.4.2 Site induction

All relevant staff shall be required to undergo a contaminated soil safety induction before commencing work. The induction shall be conducted by the Contractor Site Manager/ HSO.

The purpose of the safety induction is to make sure the worker is aware of the hazards related to contaminated soil (asbestos, metals, and hydrocarbons), safe working procedures, safety equipment and requirements, and the action plan in case of an emergency.

The HSO shall ensure that all relevant personnel are familiar with the application and use of the PPE and procedures specified in this CSMP before commencement of site work.

8.4.3 General requirements

The following general safety procedures shall be followed by all staff entering and/or working in the "exclusion zone" (refer Section 8.2 for definition):

- Any incidents shall be reported to the HSO;
- Site workers shall avoid unnecessary contact with contaminated soil or potential contaminated soil; and
- Site workers shall wear gloves, Tyvek suits and dust masks at all times.

8.5 Hazard minimisation procedures

8.5.1 Inhalation of dust

Dust controls shall be in place throughout the works. Dust shall be managed according to procedures set out in Section 6.1.

8.5.2 Inhalation of asbestos fibres

Respiratory protection shall be worn at all times as there is a constant risk of asbestos exposure during the excavation works. The minimum requirement is a P2 dust mask. Half face respirators with asbestos fibre filters may also be required depending on review of the nature and extent of asbestos present by the contaminated land specialist.

P2 dust masks shall be worn within the clean (backfill) zone whilst contaminated soil remains on the balance of the site.

Work involving the excavation of asbestos shall be observed by a person certified under the Asbestos Regulations (1998).

8.5.3 Dermal contact and ingestion

The following shall be implemented to ensure skin contact and ingestion of contaminants is minimised:

- Disposable gloves shall be worn by workers who need to have contact with contaminated material during their work. Gloves shall be replaced regularly.
- Tyvek suits shall be worn to prevent contaminated material contacting other parts of the body, i.e. legs and arms, and preventing asbestos fibres collecting within the folds of clothing.
- Boot covers shall be used to prevent asbestos fibres being tracked offsite on the soles of workers/ visitors boots, or alternatively a boot wash shall be established at the entrance to the contaminated area from the loading area.

- No eating, drinking or smoking in the works area to prevent contaminated material contacting food or being ingested directly via soiled hands.

A key factor in controlling dermal contact and ingestion of contaminated soil is through maintaining good personal hygiene. The following shall be observed for works involving contaminated materials:

- Hand to mouth and hand to face contact shall be avoided during work.
- Hands shall be washed before eating, drinking and smoking.
- Eating, drinking and smoking shall only be permitted where site personnel are offsite or in designated areas.
- Tyvek suits worn within the "works area" shall be removed onsite and disposed of at the end of the working day and replaced with new ones the following day.

8.5.4 Personal protective equipment (PPE) provisions

Based on the hazard minimisation procedures above the Contractor shall ensure availability and supply of the following contaminated land-related PPE:

- P2 dust masks.
- Half face respirators (if required following review by the ccontaminated land sspecialist).
- Tyvek suits.
- Boot covers (or use boot wash as per Section 8.5.3 above).
- Disposable latex/rubber gloves.

Protective equipment shall be replaced as appropriate.

8.6 Emergency procedures

The following procedures apply for incidents involving contaminated soil or groundwater:

- Any incident or potential emergency situation shall be reported to the HSO for immediate assessment and action. To minimise the impact of an emergency situation at least one other field personnel besides the HSO shall have immediate access to a first aid kit.
- If an incident occurs within a contaminated site, immediately isolate and immobilise the relevant equipment.

9 Contingency Measures

In the event that unforseen contamination is identified during the works the first response procedures outlined in Section 5.2 shall be followed. In the event of an uncontrolled discharge of other contaminants or potentially contaminated soil/ hardfill or water to the environment, the following notification process shall be used:

- Cease work immediately and take all practical steps to contain the discharge and prevent further discharge.
- The Contractor shall notify Willis Bond and the contaminated land specialist.
- Willis Bond shall notify WCC and GWRC.
- A strategy to remedy the situation is to be determined by the contaminated land specialist in consultation with Willis Bond, WCC, and GWRC. The agreed strategy shall be implemented by the Contractor.
- All details of the discharge (volume, type, location), and procedures taken to remedy the situation, are to be recorded and included with the SVR to be submitted to all parties at the completion of works.

If there is any doubt as to whether or not a discharge of contaminants has occurred, the Contractor shall contact the contaminated land specialist for further advice.

10 Validation

Validation is the process of confirming the objectives of the works have been achieved, being:

- Contaminated soil from the Site 10 basement is disposed at an appropriate location.
- Potential contamination in earthworks carried out in the Landscape Areas is identified and managed appropriately.
- Confirmation from the Contractor that works were undertaken according to agreed procedures.
- Reporting on any incidents.

10.1 Remediation monitoring requirements

The contaminated land specialist will need to visit the site once daily during the removal of asbestos contaminated soil to check this CSMP is being implemented, to undertake monitoring, and respond to contamination-related queries.

On completion of the works, the contaminated land specialist shall include a log of all visits to the site and actions taken in the validation report described in Section 10.3.

The Contractor shall record all off-site deliveries of contaminated soil, including time, destination, and truck registration, and will perform a cross check against landfill weighbridge receipts to ensure all contaminated material reached the appropriate destination.

10.2 Post-remediation validation

Validation is to be undertaken progressively as asbestos containing fill is removed as follows:

- Before removal: additional testing in north half of Zone 3 to confirm the extent of asbestos contaminated soil, and whether the extent of Zone 3 can be decreased.
- On reaching the concrete slab: testing beneath the concrete slab after it has been removed. If no asbestos is detected, sampling shall be carried out on a 15 x 15 m grid across Zone 3. If asbestos is detected beneath the concrete slab, samples will be collected at depth.
- On reaching the depth where no further asbestos has been detected in pre-excavation samples: sampling on a 15 m x 15 m grid across Zone 3. In the event that a sample returns a positive test for asbestos a further 50 – 100 mm thickness of material shall be removed from the surface of the grid square containing the positive sample (if asphalt is absent) and a second (B) sample collected.

Samples shall be collected from the approximate centre of the grid square and the location confirmed by GPS. Sample locations shall be plotted on a site validation plan. Samples shall be tested for asbestos presence/absence at Dowdell & Associates laboratory.

No validation testing is proposed on the walls and base of the basement excavation, unless unexpected conditions are encountered. Contaminated reclamation fill is expected to remain in place around the excavation, and the proposed works will pave and prevent exposure to the contaminated fill. Validation sampling may be needed if unexpected conditions are encountered. The need for this would be assessed by the contaminated land specialist (see Section 9).

10.3 Validation reporting

The contaminated land specialist shall provide a validation report which includes the following:

- Confirmation that the asbestos removal works are complete.

- Confirmation that works were completed according to this CSMP and documenting any variations to the procedures during the works.
- Confirmation that there were no environmental or human health incidents during the works. If there were any incidents then the letter shall detail the nature of the incidents and the measures taken to mitigate effects.
- Confirmation of the disposal destination of contaminated materials, based on documentation provided by the Contractor.
- Verification test results undertaken for disposal permitting.
- Record of daily site visits and actions taken (as described in Section 7.1).

The validation report shall be provided to Willis Bond, WCC, and GWRC within one month after receipt of the final validation data.

10.4 Ongoing monitoring and management

All asbestos will be removed from the excavation and the site will be paved or covered with imported landscaping fill on completion. Therefore, there will be no ongoing requirement for monitoring or management with respect of ground contamination pertaining to these materials.

11 Applicability

This report has been prepared for the benefit of Willis Bond Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement. The work was undertaken in accordance with our proposal of 8 April 2014.

Tonkin & Taylor LTD

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Sharon Parackal	Stuart Palmer
Environmental Engineer	Project Director

Technical Review: Penny Kneebone, Senior Environmental Scientist

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Appendix A: Soil sampling method

- **Methodology**

A.1 Soil sampling procedures

Sampling undertaken by the contaminated land specialist shall be in accordance with requirements of the NES (Soil) Regulations, the Western Australian Guidelines, the "*Australian/ New Zealand Standard AS/NZS 5667 11:1998*" and the MfE Contaminated Land Management Guidelines No.5[2].

This method applies to:

- Potentially asbestos contaminated soil: pre-works delineation and post-works confirmation.
- Potentially clean soil: either in situ before excavation or stockpiled soil pending disposal.
- Soil from below 3 m depth: to confirm appropriate for disposal to landfill.

Samples ~~of potentially asbestos contaminated soil (Zone 3)~~ shall be collected according to the following procedure:

- The materials encountered were described in accordance with the NZ Geotechnical Society "*Guidelines for the classification and field description of soils and rocks for engineering purposes*".
- Visual inspection of the sample and the fill material for the presence of fragments of asbestos containing material.
- Freshly gloved hands shall be used to collect samples and place them immediately into double bagged zip lock plastic bags.
- Samples of fines shall be a 1/3 cup measure in volume for ease of testing by Dowdell & Associates and maintain a consistent sample size.
- The sample position will be recorded using a GPS.
- Equipment used to collect the samples are to be decontaminated between sample locations using clean water and Decon 90 (a phosphate-free detergent) rinses.
- Samples will be shipped to IANZ certified Dowdell & Associates laboratory under chain of custody documentation.
- Samples will be tested for the presence of asbestos.

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[2] MfE, revised 2011: Contaminated Land Management Guideline No. 5 – *Site Investigation and Sampling*.

Appendix B: Contractor Checklist

Contractor Checklist:

Sites 8, 9, and 10 - Summary of key CSMP requirements

The Contractor shall undertake the following during the earthworks in potentially contaminated soil at Sites 8, 9, and 10, Waterloo Quay, Wellington:

Timing	**Key task**	**Details**
Prior to works commencing	Site set up	• Provide WCC and GWRC and neighbouring property owners notice of works commencement date. • Establish works controls (dust, erosion, sediment, stormwater, groundwater management, odour) controls as per CSMP Section 5 and 6. • Establish fencing site structures, site sheds as per Section 5.1. • Hazard board to state contaminated soil may be present and indicating health and safety requirements for workers. • Obtain PPE: disposal gloves, tyvek suits and P2 dust masks. • Establish the personnel decontamination unit. • Establish air monitoring units. • Arrange disposal permits. • Sweep surface of loading area prior to establishment of site sheds, loading areas and site facilities.
During the works	General CSMP compliance	• Maintain works controls (dust, erosion, sediment, stormwater, groundwater) controls as per CSMP Section 6; • Implement health and safety procedures in Section 8 as required; • Retain all weighbridge and disposal dockets and provide to Willis Bond and the contaminated land specialist.
	Alert contaminated land specialist	If any of the following situations arise: • Contaminated soil is encountered that includes: - Odours (petroleum, oil) - Discolouration (black, green/blue staining most common) - Inclusions of non-cleanfill allowable (refer Table 4.1 MfE Cleanfill Guidelines, Appendix C) deleterious materials (i.e. plastic, rubber, metal) • Materials with an oil sheen, odour or discolouration is encountered. • To collect validation samples <u>before</u> reinstatement.
Within one month of completion of the relevant works	Provide contaminated land-related Information to Willis Bond and contaminated land specialist	• Details of any complaints relating to dust received during the works. • Details of unexpected encounters/events and the action taken. • Details of additional sampling undertaken to characterise materials during the works (if any). • Details of visits made by Council representatives. • Summary of weighbridge information for disposal verification.

Appendix C: MfE Cleanfill Guidelines (acceptable and unacceptable materials)

Table 4.1: Acceptable materials

Material	Discussion
Asphalt (cured)	Weathered (cured) asphalt is acceptable: After asphalt has been exposed to the elements for some time, the initial oily surface will have gone and the asphalt is considered inert.
Bricks	Inert – will undergo no degradation.
Ceramics	Inert.
Concrete – un-reinforced	Inert material. Ensure that other attached material is removed.
Concrete – reinforced	Steel reinforcing bars will degrade. However, bars fully encased in intact concrete will be protected from corrosion by the concrete. Reinforced concrete is thus acceptable provided protruding reinforcing steel is cut off at the concrete face.
Fibre cement building products	Inert material comprising cellulose fibre, Portland cement and sand. Care needs to be taken that the product does not contain asbestos, which is unacceptable.
Glass	Inert, and poses little threat to the environment. May pose a safety risk if placed near the surface in public areas, or if later excavated. The safety risk on excavation should become immediately apparent, so glass is considered acceptable provided it is not placed immediately adjacent to the finished surface.
Road sub-base	Inert.
Soils, rock, gravel, sand, clay, etc	Acceptable if free of contamination (see 4.3.2 for definition of contaminated soil in this context).
Tiles (clay, concrete or ceramic)	Inert.

Table 4.2: Unacceptable waste

Material	Discussion
Abrasive blasting sand/agents	May contain metals, paint and other contaminants.
Asbestos (including asbestos sheeting)	Potentially hazardous. Although an inert compound, future excavation could cause significant health effects.
Asphalt (new)	New asphalt or asphalt that has been ground or pulverised may release oily substances that could leach into the environment.
Bark	Degradable; leaches tannins.
Cables	Metal cables will degrade (see Metals).
Car bodies	Contain metals, oils, plastics, asbestos and other potential contaminants.
Carpet	Degradable. May also contain formaldehyde residue from flooring.
Cesspit/stormwater sump cleanings	Contain various metal contaminants and organics.

Material	Discussion
Containers	To avoid any potential confusion, all containers are considered unacceptable. Containers may degrade or be punctured, releasing their contents or the remnants of their contents. The containers themselves may be detrimental to the environment (see plastics and metal).
Cork tiles	Degradable.
Corrugated iron	Degradable steel and zinc.
Electrical equipment and insulation	For example, fluorescent light tubes could contain PCBs (also see Plastics).
Formica	Generally stable (it is a melamine-formaldehyde polymer), but may be bonded with urea formaldehyde. This is water soluble and may leach formaldehyde compounds into groundwater. Often attached to particleboard.
Foundry sand	Contains metals.
Greenwaste (e.g. grass clippings, tree trimmings)	Will degrade and release contaminants such as ammonia and nitrates into the soil and groundwater, and may generate gases such as methane and carbon dioxide. The resulting leachate may mobilise other contaminants in the fill.
Hardboard	Degradable; contains phenol resorcinol formaldehyde.
Household waste	Typically contains large amounts of putrescible and degradable waste that will degrade and cause odour problems, and create soluble compounds causing leachate. Also contains some hazardous components.
MDF (medium-density fibreboard – customwood)	Degradable; may use urea formaldehyde as a bonding agent. This is water soluble and may leach formaldehyde compounds into groundwater (see Particleboard). Some modern MDF boards use phenol formaldehydes and other resins that may be acceptable, but the board itself is unacceptable.
Medical and veterinary waste	Unsafe if excavated (health hazard); may generate leachate.
Metals	For example, structural steel, roofing, window frames, building components, etc; degradable, can leach into the ground or groundwater. Soluble metals may be toxic depending on the concentration.
Paint	Hazardous waste. Liquid paints may contain significant quantities of volatile organic carbon compounds. These will contaminate soils and groundwater, causing detrimental effects to the environment (e.g. killing aquatic life) and human health. Some paints contain metals. Water-based paints contain preservatives and biocides which may include mercury, or other compounds that can cause dermatological problems.
Painted materials	Lead-based paint is hazardous and must be taken to a hazardous waste facility. Once paint has dried, the potential for contaminants in the paint to migrate through the soil is minimised, so all dried paint other than lead-based is relatively inert. However, to avoid any doubt all painted materials should be rejected.
Paper and cardboard	Paper and cardboard are degradable and present a fire hazard.

Material	Discussion
Particleboard (chipboard)	Contains urea formaldehyde as a bonding agent. This is water soluble and may leach formaldehyde compounds into the groundwater. Formaldehyde is known to cause many adverse health reactions and has been classified as a "probable human carcinogen" by the USEPA.
Plywood – structural / external grade	Uses phenol resorcinol formaldehyde as a bonding agent. This is not water-soluble and is relatively inert. However, the board itself is degradable and the difference between internal and external grade may not be apparent to the cleanfill operator.
Plywood – internal grade	Uses urea formaldehyde glue as a bonding agent. This is water-soluble and may leach formaldehyde compounds into groundwater (see Particleboard).
Road sweepings	Contain various metal contaminants and organics.
Sawdust	Degradable and could contain timber treatment chemicals.
Tar	Can contain a variety of compounds, many of which have been found to be carcinogenic. Many of the compounds do not bind to soil and can migrate directly to groundwater; potential for groundwater contamination with hydrocarbon compounds.
Timber (processed)	All sawn, gauged or dressed timber is considered unacceptable, as the cleanfill operator will not be able to determine easily if it is treated or untreated. Chemicals used for timber treatment can leach out and contaminate soils and groundwater. The chemicals used include copper-chrome-arsenic (CCA), light organic solvent preservatives (LOSP), creosote, boron and pentachlorophenol (PCP). These can all have a detrimental effect on human health and the environment.
Wood chips	Degradable.

ATTACHMENT C: Groundwater and Contamination Assessment and Basement Dewatering Effects

Tonkin & Taylor

Job No: 85778.003
20 February 2015

Willis Bond & Co Ltd
PO Box 24137
Wellington 6142

Attention: Rosalind Luxford

Dear Rosalind

Wellington Waterfront Site 10 - Groundwater and Contamination Assessment and Basement Dewatering Effects

1. Introduction

This report summarises the following for the Site 10 development along Wellington waterfront (refer Figure 1):

- Likely hydrogeology of the site based on available information from nearby sites and the recent site investigation;
- Predicted settlement due to groundwater drawdown and the impact to nearby buildings and services;
- Likely volumes of water to be discharged due to dewatering based on results of seepage modelling;
- Potential cofferdam defects;
- Potential that the groundwater to be discharged is contaminated.

The work was done in accordance with our engagement dated 10 December 2014 (Variation V03).

Figure 1. Site location plan

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2. Site Hydrogeology

Based on available information, the inferred site ground profile for the purpose of groundwater assessment and seepage is shown in Table 2.1 below. Sampling and testing was undertaken at three piezometer standpipes, P1, P2 and P3 (refer Figure 2 for location plan). Two falling head tests were carried out within the upper zone of the Fill in P1 and P3 and yielded permeability of $3x10^{-4}$ m/s and $1x10^{-2}$ m/s respectively. The inferred permeability based on current and historic available data is summarised in Table 2.1.

Continuous groundwater monitoring was carried out in P1 and P3 between 09/01/2015 and 16/01/2015 and groundwater plot is attached in Appendix A. It is clear from the monitoring that there is direct hydraulic connectivity between the site and the sea. The site groundwater variation ranges from 0.5m to 0.7m between the high and low tide. The tide variation ranges from 0.9m to 1.0m. Therefore the groundwater level is slightly higher than the sea level. The highest and lowest measured groundwater level is approximately 1.6m below ground level (mbgl) and 2.4mbgl. For groundwater seepage into excavation assessment, a groundwater level of 1.5mbgl is adopted.

Figure 2. Investigation location plan

Table 2.1 Summary of Ground Hydrogeology

Soil Type	Thickness (m)	Permeability (m/s)
Fill	5	$1x10^{-2}$ to $1x10^{-6}$
Beach Deposit	1	$1x10^{-2}$ to $1x10^{-4}$ (1)
Alluvium	-	$1x10^{-6}$ to $1x10^{-9}$ (1)

Note:

1. Lower bound represents silty sand beds and upper bound represents clay beds.

3. Seepage Analyses and Groundwater Discharge

Seepage analyses were carried out to assess the amount of inflow into the excavation and an estimate of groundwater discharge may be evaluated. Additionally the seepage models may be used to predict likely groundwater drawdown (and hence settlement – see Section 4.0 below) outside the cofferdam. As the mass permeability of the ground can be highly variable particularly in the Fill and between the sand and clay fractions within the Alluvium, sensitivity analyses were carried out to assess the effects of permeability. Additionally, it is common to expect that the deep soil mixing cofferdam can achieve a permeability in the order of 10^{-8}m/s but the performance of the cut-off wall in the event of possible hydro-fracture (fracturing of cofferdam due to water pressures) and/or excavation effects is unknown. Therefore sensitivity of the cofferdam permeability was also carried out. Given the relatively small head difference across the cofferdam and the low permeability of the Alluvium, the most likely flow into the excavation will be through the cut-off wall in the event of a fracture although this is likely to be a low risk. The cut-off wall is modelled with a toe level 7.5mbgl to allow 1.5m toe in to the less permeable Alluvium to ensure an adequate cut-off. Also this toe level is likely to be needed for the stability of the wall (to be assessed separately).

The results of the analyses are summarised in Table 3.1 below. It should be noted that the results presented are due to seepage into the cofferdam. The amount of water already present in the basement footprint (i.e. non-seepage effects) to be discharged depends on the porosity of the Fill. Assuming a porosity in the order of 30% to 40%, the amount of water discharge is in the order of 1600m^3 to 2200m^3 with a basement footprint approximately 2700m^2 and 2m of groundwater contained within. The perimeter of the basement is approximately 260m.

Table 3.1 Summary of Seepage Analyses

No.	Fill and Beach Deposit Permeability (m/s)	Alluvium Permeability (m/s)	Cut-off Wall Permeability (m/s)	Seepage (m^3/day) [litres/day]	Drawdown Immediately Behind Wall (m)
1	1×10^{-2}	1×10^{-8}	1×10^{-8}	4 [4000]	0.0
2	1×10^{-6}	1×10^{-8}	1×10^{-8}	4 [4000]	0.2
3	1×10^{-2}	1×10^{-8}	1×10^{-6}	300 [300,000]	0.0
4	1×10^{-2}	1×10^{-6}	1×10^{-6}	360 [360,000]	0.0
5	1×10^{-4}	1×10^{-7}	1×10^{-7}	35 [35,000]	0.0
6	1×10^{-6}	1×10^{-7}	1×10^{-7}	16 [16,000]	0.9

The most onerous scenario in terms of seepage into excavation would be a very high permeability Fill coupled with a high permeability cut-off wall (possibly due to fracture) and this is demonstrated in Analysis 4. A more probable or “average” permeability analysis is shown in Analysis 5. As demonstrated above, the amount of seepage into excavation is highly dependent on the permeability and performance of the cofferdam water tightness. At this stage, it can be assumed that water inflow is likely to be in the region of 35m3/day to 350m3/day (0.4 litres/s to 4 litres/s) and the upper bound related to poor performance of cofferdam in the unlikely event of hydro fracture and/or other unexpected leakage.

Drawdown is highly dependent on the permeability of the soil and in general, the lower the permeability, the higher the drawdown due to the lower rate of recharge. As demonstrated above when the permeability of the Fill is low, drawdown is recorded. In summary, as the head difference is small (approx. 2m), together with fairly permeable Fill, drawdown is expected to be small. In the event that low permeability Fill is encountered with a slightly higher than expected permeability of cofferdam (probably due to defects in cofferdam), drawdown in the order of 1m can be expected.

In view of the seepage results there is no real benefit to increase the length of the cofferdam from groundwater control standpoint. The current toe level is expected to penetrate 1.5m into the less permeable Alluvium to form a good water cut-off. The permeability of the cofferdam wall will be specified to achieve a minimum of 1x10-8m/s and shall be verified through testing cored samples. Hydro-fracture and cracking of wall due to excavation remains a low risk since the water head difference is small and the depth of excavation is modest. However poor construction of the cofferdam remains a risk and can be mitigated through best practice and quality control on site. Another significant risk is the variability of the Fill material causing local defects in the cofferdam in a band of highly permeable fill. In such cases, flow rates in the order of 15litres/s to 20litres/s can be expected.

4. Impact Assessment

The effect of basement dewatering is potential groundwater drawdown outside the cut-off wall. As demonstrated in Section 3 above, limited drawdown may be expected. For settlement calculation purposes, effective stresses increase due to 1m groundwater drawdown has been assumed. It is worth noting that this is a conservative estimate as lowest measured groundwater level is approx. 2.4mbgl and excavation level is 3.5mbgl and a 1m drawdown will be on the assumption that the cofferdam is poorly performing.

The settlement due to 1m groundwater drawdown is estimated to be between 10mm and 15mm at the cofferdam position and decreases almost linearly away from the cofferdam to a distance of approximately 10m from the cofferdam. No settlement is expected 10m away from the cofferdam. Minimal impact is expected on services for such magnitude of settlement. Existing buildings are sufficiently far (approx. 10m or more away) to be affected by the predicted settlement.

5. Groundwater quality assessment

Soil testing indicates that fill within the proposed basement excavation at and below groundwater level has elevated concentrations of metals and polycyclic aromatic hydrocarbons (PAH). Therefore there is the potential for elevated concentrations of metals and PAH in groundwater. If the water to be extracted is contaminated, there will be constraints on disposal of the water.

5.1 2014 groundwater testing

Preliminary groundwater testing was undertaken at 2 standpipes (P1 and P2) within the proposed basement footprint in 2014 (refer *Ground contamination assessment, Wellington Waterfronts Sites 8,9,10,* dated October 2014, T&T ref: 85778.001).

All PAH were well below the Australian and New Zealand Environment Conservation Council (ANZECC) 2000 guidelines for protection of 95% of marine species (refer Table 5.1).

All metals were below detection limits (refer Table 5.2). Copper and zinc detection limits were above the ANZECC guidelines for protection of 80% of marine species. The laboratory was unable to achieve lower detection limits for these samples.

Sulphate exceeded the Wellington City Council (WCC) trade waste limits at one standpipe.

Table 5.1: PAH (mg/L)

Sample location	**Anthracene**	**Benzo[a]pyrene (BAP)**	**Fluoranthene**	**Naphthalene**	**Phenanthrene**
P1	< 0.00010	0.00014	0.00022	< 0.0005	< 0.0004
P2	< 0.00010	< 0.00010	< 0.00010	< 0.0005	< 0.0004
Guidelines					
ANZECC 95% [1]	0.004 [2]	0.0007 [2]	0.002 [2]	0.07	0.008 [2]

Only PAH with ANZECC guidelines are reported in this summary table. **Bold** exceeds ANZECC guidelines.

1. ANZECC 95% species protection for marine water.

2. ANZECC Guidelines Vol 2. Section 8.3.7 - Interim working levels for 99% species protection for marine water.

Table 5.2: Inorganics (mg/L)

Location	pH	Sulphate	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
P1	7.2	750	< 0.10	< 0.005	< 0.05	**< 0.05**	< 0.010	< 0.05	**< 0.10**
P2	7.7	<u>3400</u>	< 0.10	< 0.005	< 0.05	**< 0.05**	< 0.010	< 0.05	**< 0.10**
Guidelines									
ANZECC 80% [1]	-	-	0.0045 [2]	0.036	0.0906	0.008	0.012	0.56	0.043
ANZECC 95% [3]	-	-	-	0.0055	0.0274	0.013	0.0044	0.07	0.015
WCC trade waste [4]	-	1500	-	-	-	-	-	-	-

Bold exceeds ANZECC guidelines. <u>Underline</u> exceeds trade waste guidelines.

1. ANZECC 80% species protection for marine water.
2. ANZECC Guidelines Vol 2. Section 8.3.7 - Interim working levels for 80% species protection for marine water.
3. ANZECC 95% species protection for marine water.
4. WCC (2004). Trade waste bylaw Table 1 – Sulphate with good mixing.

5.2 Follow up groundwater testing

Due to the potential for elevated metals, additional groundwater samples were collected from 3 locations (P1, P2 and P3) on 16 January 2015 (hide tide) and 2 locations (P1, P3) on 5 February 2015 (low tide). Tide conditions and times were obtained from the MetService website.

Each standpipe was purged in 2L intervals using a peristaltic pump, until pH and conductivity stabilised for three consecutive readings. P2 was dry at low tide. All groundwater samples was clear and no odour or surface sheen was noted.

All samples were placed into clean sample bottles prepared by the laboratory. The samples were sent to Hill Laboratories under chain of custody documentation. All samples were tested for metals. Given that the 2014 results showed PAH concentrations were well below the guideline values, the follow up samples were not tested for PAH.

The laboratory reports are in Appendix B.

5.3 QA/QC

Two groundwater duplicate samples were tested to check the variability of the samples, one for the high tide sampling (16 January 2015), and one for low tide (5 February 2015). The results are provided in Table 5.3.

In general, the results agreed well, with the exception of total zinc in the high tide sample. This indicates some variability in the total metals results. Dissolved metals are used for the purpose of assessing potential effects of the discharge on the receiving environment. The dissolved metal results compared well with their duplicates.

Table 5.3: QA/QC results (mg/L)

	High Tide (16 January 2015)			**Low Tide (5 February 2015)**		
	P1	Duplicate	Relative % difference[1]	P3	Duplicate	Relative % difference[1]
pH	7.7	7.7	0.0%	7.6	7.7	1.3%
Dissolved Copper	< 0.0010	0.0012[2]	-	0.001	< 0.0010	-
Total Copper	< 0.0011	< 0.0011	-	0.0012	< 0.0011	-
Dissolved Lead	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	-
Total Lead	0.0063	0.0051	21%	< 0.0011	< 0.0011	-
Dissolved Zinc	< 0.004	< 0.004	-	0.006	< 0.004	-
Total Zinc	0.0123	< 0.00422	-	0.0046	0.0046	0.0%
Sulphate	178	185	3.9%	2,500	2,600	3.9%

Notes:

1. Where a result is less than the laboratory detection limit, the RPD is not calculated.

2. The copper result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the analysis methods.

5.4 Results

The results of the groundwater testing undertaken in 2015 are included in Table 5.4. The results indicate the following:

- Groundwater quality varies across P1, P2 and P3.
- Groundwater quality varies between high and low tide conditions. Lead and zinc concentrations were higher at high tide than at low tide.
- Metals are mostly adsorbed to sediment.
- For both high and low tide conditions, most metals are within ANZECC guidelines for protection of 95% of marine species. On one occasion at one location, copper exceeds ANZECC guidelines for protection of 80% of marine species.
- Sulphate is within the trade waste limit at P1, however exceeds the limit at P2 and P3.

Table 5.4: Inorganics (mg/L)

				Copper		Lead		Zinc	
Location	**Tide**	**pH**	**Sulphate**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**
P1	High	7.7	178	< 0.0011	< 0.0010	0.0063	< 0.0010	0.0123	< 0.004
	Low	7.5	230	0.0014	0.0012	0.0018	< 0.0010	0.0057	< 0.004
P2	High	7.7	2700	0.0055	0.0044	0.0018	< 0.0010	< 0.0042	< 0.004
	Low	-	-	-	-	-	-	-	-
P3	High	7.6	2600	0.10	**0.08**	0.0026	< 0.0010	0.0108	0.005
	Low	7.6	2500	0.0012	0.001	< 0.0011	< 0.0010	0.0046	0.006*
Guidelines									
ANZECC 80% [1]		-	-	-	0.008	-	0.012	-	0.043
ANZECC 95% [2]		-	-	-	0.013	-	0.0044	-	0.015
WCC trade waste [3]		-	1500	-	-	-	-	-	

Bold exceeds ANZECC guidelines. Underline exceeds trade waste guidelines. * The zinc result for the dissolved fraction was greater than that for the total fraction, but the laboratory reported this was within analytical error.

1. ANZECC 80% species protection for marine water.

2. ANZECC 95% species protection for marine water.

3. WCC (2004). Trade waste bylaw Table 1 – Sulphate with good mixing.

5.5 Implications

The groundwater in the monitoring wells has variable spatial and temporal quality. Therefore, the composition of the actual bulk water that would be extracted during dewatering is not known. However, the limited data collected to date allow preliminary assessment of the feasibility of potential disposal options.

5.5.1 Discharge to stormwater

If the extracted groundwater is discharged to stormwater, it would then discharge to Wellington harbour.

The groundwater quality measured at P1, P2 (three occasions) and P3 (two occasions) are generally below ANZECC guidelines for protection of 80% of marine species.

Because the metals are largely associated with the sediment (i.e., the total concentrations are higher than dissolved concentrations), good sediment control will help improve the quality of groundwater discharge.

Dilution within the Wellington Harbour would be significant. Based on these limited data, discharge of the dewatering water to the harbour is not expected to have a significant effect on the water quality of the Wellington Harbour.

Discharge to stormwater would require resource consent from GWRC (for discharge of groundwater to stormwater) and a stormwater permit from WCC. GWRC and/or WCC may require additional testing to support an application.

5.5.2 Discharge to trade waste

Sulphate is within WCC trade waste guidelines at P1, however exceeds guidelines at P2 and P3. The bulk concentration of the discharge may meet the trade waste criteria.

Discharge to trade waste will require a permit from WCC. WCC would likely also require assessment of other water quality parameters (e.g., total suspended solids concentration) in order to assess an application for disposal to trade waste. The total suspended solids concentration of the groundwater to be extracted cannot be estimated from the borehole data.

5.5.3 Aggressiveness for concrete design

The exposure classification for concrete piles in soil was assessed in accordance with Table 6.2.4 (c) of the *Australian Standard for Piling – Design and Installation AS 2519 -2009*.

Assuming soil condition A (high permeability soils which are in groundwater), Table 6.2.4 (C) indicates the measured sulphate concentration in samples P2 and P3 may result in a moderate exposure classification. At P1, the measured sulphate concentration may result in a mild exposure classification.

6. Summary

Dewatering requirements

- Estimated discharge volume (non-seepage) = 1600m^3 to 2200m^3
- Estimated discharge volume (seepage) = 35m^3/day to 350m^3/day (0.4 litres/s to 4 litres/s) with upper bound related to poor performance of cofferdam in the unlikely event of hydro fracture and/or other unexpected small leakage
- Estimated discharge volume (local major defects in cofferdam) = 15 litres/s to 20 litres/s
- Risk of hydro-fracture of cofferdam = Low
- Risk of cofferdam damage due to basement excavation = Low
- Risk of cofferdam defects due to poor construction = Moderate and can be significantly reduced to Very Low through the use of experience Contractors and implementing strict quality control
- Risk of poor/highly unfavourable ground conditions leading to major local defects in cofferdam = Moderate/High
- Estimated groundwater drawdown outside cofferdam = up to 1m (conservatively)
- Estimated ground settlement due to groundwater drawdown = 10mm to 15mm at outside face of cofferdam and 0mm at 10m distance
- Impact of induced settlement on existing services and structures = Low
- Depth of cofferdam = 7.5mbgl to ensure 1.5m toe in to less permeable Alluvium to ensure water tightness. There is no additional benefit deepening this.

Groundwater quality assessment

Groundwater quality varies spatially and temporally (with tides). Although the bulk composition of groundwater that would be extracted is not known, the preliminary testing indicates:

- Discharge of groundwater to the harbour is not expected to have a significant effect on water quality in Wellington harbour. However, resource consent from and a stormwater permit from WCC would be required, and additional testing may be needed to support an application.
- Good sediment control will help improve the quality of groundwater discharge.

- Discharge to trade waste would require a permit from WCC. WCC may require testing of the actual water to be extracted to confirm sulphate and total suspended solids concentrations are acceptable.
- Groundwater may carry a mild to moderate exposure classification in terms of Table 6.2.4 (c) of the *Australian Standard for Piling – Design and Installation AS 2519 -2009* due to the presence of sulphate.

7. Applicability

This report has been prepared for the benefit of Willis Bond & Co Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

The ground model and design ground parameters have been developed by inferring from nearby sites and actual conditions at the site may vary, particularly in the fill material. Such variations can have a significant impact in the predictions of seepage flow, volumes of water to be discharged and settlements especially when such adverse ground conditions cause major defects in the cofferdam which will null the current predictions.

Recommendations and opinions in this report are based on date from discrete samples. The nature and continuity of subsoil away from the sample locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Eng Chin	Stuart Palmer
Senior Geotechnical Engineer	Project Director

....

Sharon Parackal

Environmental Engineer

Technical review of groundwater quality assessment by: Penny Kneebone (senior environmental scientist).

ELC

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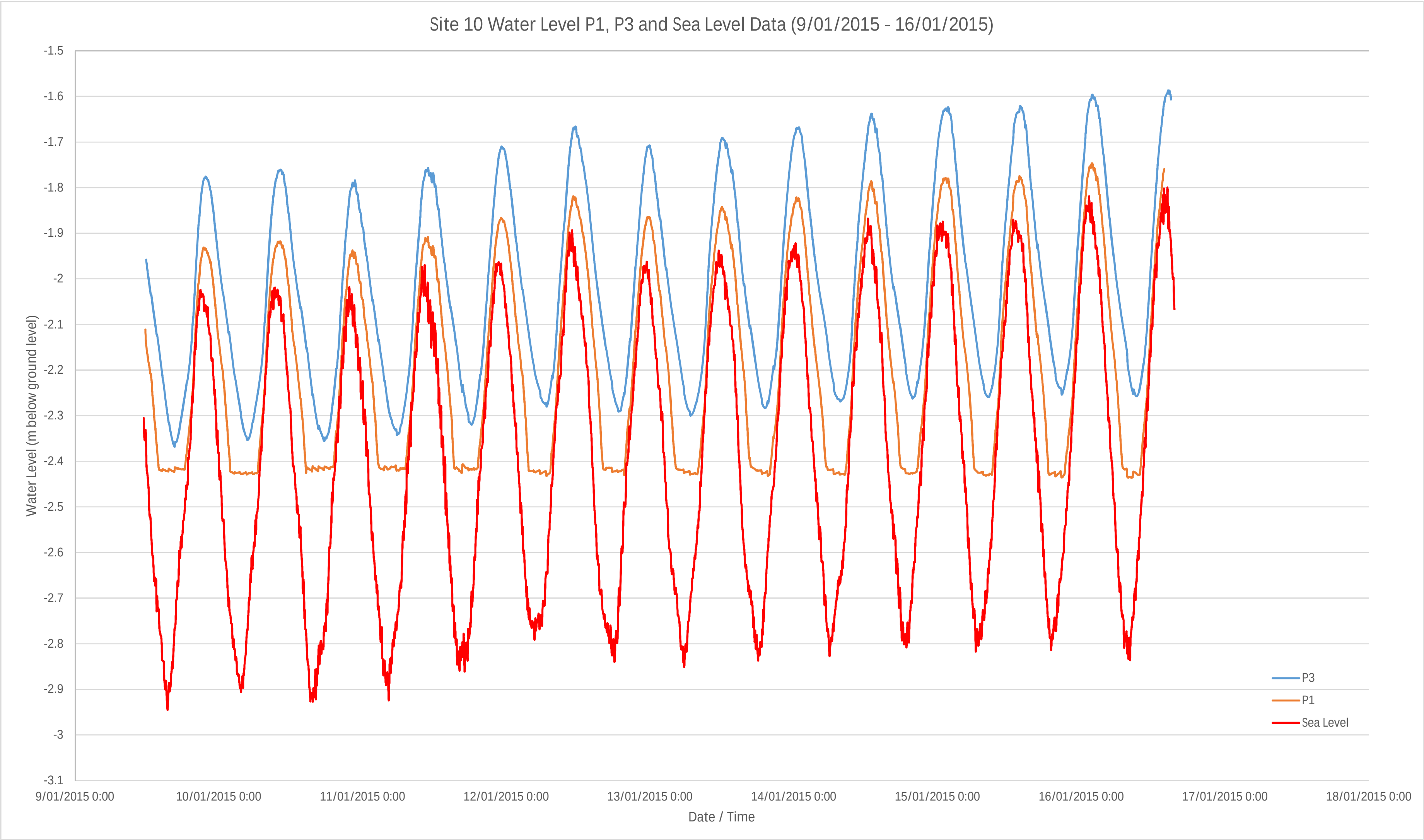
Appendix A: Groundwater Monitoring Plot

- **Groundwater Monitoring Plot**



Site 10 Water Level P1, P3 and Sea Level Data (9/01/2015 - 16/01/2015)

Appendix B: Laboratory reports

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

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Private Bag 3205
Hamilton 3240, New Zealand

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Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1375764	SPv1
Contact:	Sharon Parackal C/- Tonkin & Taylor PO Box 2083 WELLINGTON 6140	**Date Registered:**	22-Jan-2015	
		Date Reported:	12-Feb-2015	
		Quote No:	66224	
		Order No:		
		Client Reference:		
		Submitted By:	Sharon Parackal	

Sample Type: Saline

	Sample Name:	P1 Borehole 16-Jan-2015 2:35 pm	P2 Borehole 16-Jan-2015 2:00 pm	P3 Borehole 16-Jan-2015 3:05 pm	Duplicate 16-Jan-2015	
	Lab Number:	1375764.1	1375764.2	1375764.3	1375764.4	
pH	pH Units	7.7	7.6	7.6	7.7	-
Dissolved Copper	g/m^3	< 0.0010	0.0044	0.080	0.0012 [#2]	-
Total Copper	g/m^3	< 0.0011	0.0055	0.100	< 0.0011 [#2]	-
Dissolved Lead	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	-
Total Lead	g/m^3	0.0063	0.0018	0.0026	0.0051	-
Dissolved Zinc	g/m^3	< 0.004	< 0.004	0.005	< 0.004	-
Total Zinc	g/m^3	0.0123 [#1]	< 0.0042	0.0108	< 0.0042	-
Sulphate	g/m^3	178	2,700	2,600	185	-

Analyst's Comments

[#1] Confirmed by repeat analysis.

[#2] It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Saline

Test	Method Description	Default Detection Limit	Sample No
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-4
Total Digestion of Saline Samples	Nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	1-4
pH	Saline water, pH meter. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1-4
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-4
Dissolved Copper	Filtered sample, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1-4
Total Copper	Nitric acid digestion, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0011 g/m^3	1-4
Dissolved Lead	Filtered sample, ICP-MS, ultratrace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m^3	1-4
Total Lead	Nitric acid digestion, ICP-MS, ultratrace level. APHA 3125 B 22nd ed. 2012.	0.0011 g/m^3	1-4
Dissolved Zinc	Filtered sample, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.004 g/m^3	1-4
Total Zinc	Nitric acid digestion, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0042 g/m^3	1-4
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m^3	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Carole Rodgers-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

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Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1382012	SPv2
Contact:	Sharon Parackal C/- Tonkin & Taylor PO Box 2083 WELLINGTON 6140	**Date Registered:**	07-Feb-2015	
		Date Reported:	18-Feb-2015	
		Quote No:	66224	
		Order No:		
		Client Reference:		
		Submitted By:	Sharon Parackal	

Sample Type: Saline

	Sample Name:	P1-Low Tide 05-Feb-2015	P3-Low Tide 05-Feb-2015	Dup 05-Feb-2015		
	Lab Number:	1382012.1	1382012.2	1382012.3		
pH	pH Units	7.5	7.6	7.7	-	-
Dissolved Copper	g/m³	0.0012	0.0010	< 0.0010	-	-
Total Copper	g/m³	0.0014	0.0012	< 0.0011	-	-
Dissolved Lead	g/m³	< 0.0010	< 0.0010	< 0.0010	-	-
Total Lead	g/m³	0.0018	< 0.0011	< 0.0011	-	-
Dissolved Zinc	g/m³	< 0.004	0.006 #1	< 0.004	-	-
Total Zinc	g/m³	0.0057	0.0046 #1	0.0046	-	-
Sulphate	g/m³	230	2,500	2,600	-	-

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

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Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-3
Dissolved Copper	Filtered sample, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0010 g/m³	1-3
Total Copper	Nitric acid digestion, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0011 g/m³	1-3
Dissolved Lead	Filtered sample, ICP-MS, ultratrace level. APHA 3125 B 22nd ed. 2012.	0.0010 g/m³	1-3
Total Lead	Nitric acid digestion, ICP-MS, ultratrace level. APHA 3125 B 22nd ed. 2012.	0.0011 g/m³	1-3
Dissolved Zinc	Filtered sample, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.004 g/m³	1-3
Total Zinc	Nitric acid digestion, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0042 g/m³	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m³	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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