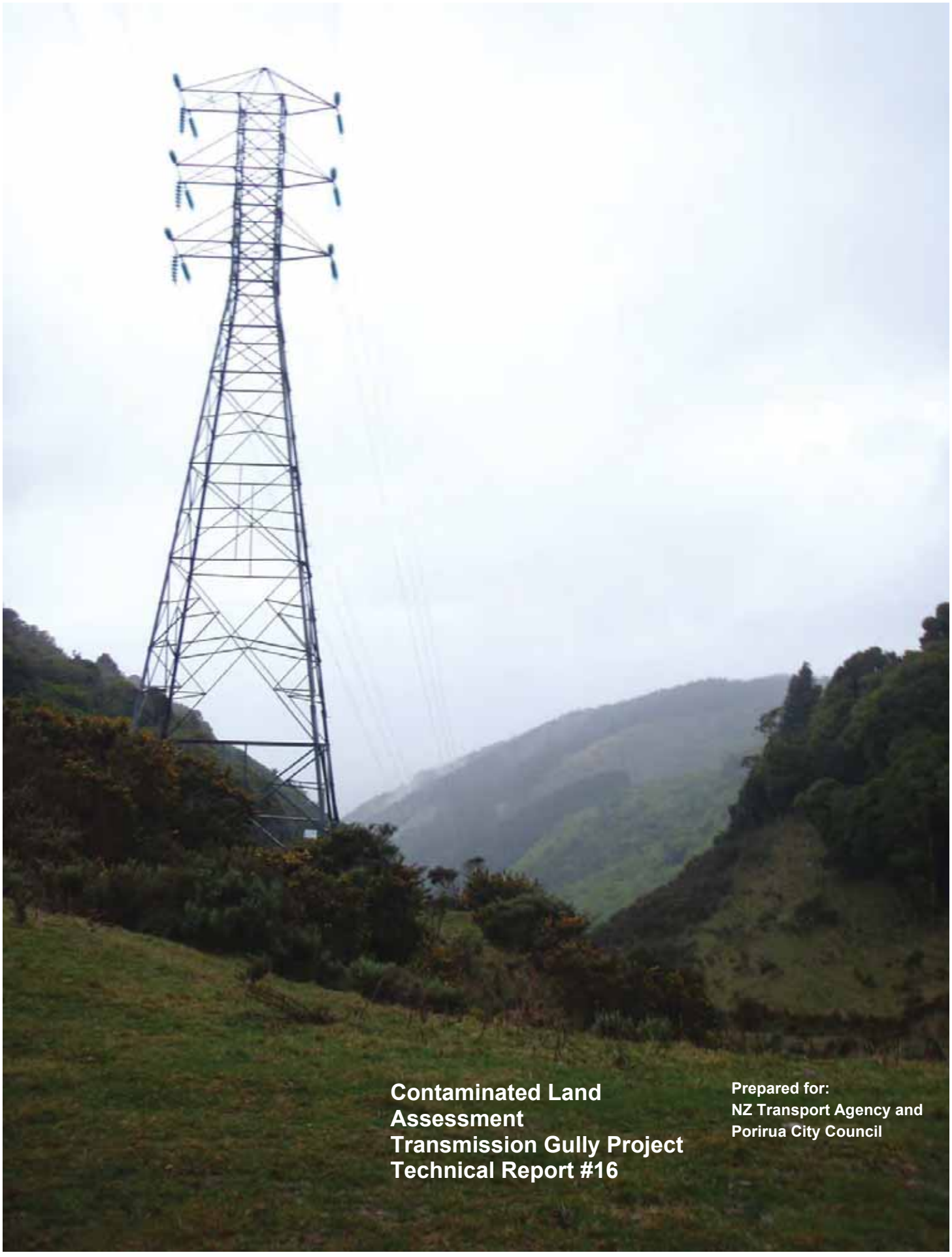

Contaminated Land Assessment
Transmission Gully Project
Technical Report #16

Prepared for:
NZ Transport Agency and
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Document control

aurecon

Document ID: Contaminated Land Assessment Report

Rev No	Date	Revision details	Typist	Author	Verifier	Approver
0	21 June 2010	DRAFT	TM/BG/AL/ RS	TM/BG/AL/ RS	NP	JK
1	28 June 2010	DRAFT FOR CLIENT REVIEW	TM/BG/AL/RS	TM/BG/AL/RS	NP	JK
2	23 August 2010	ISSUE COPY	TM/BG/AL/RS	TM/BG/AL/RS	NP	JK
3	23 February 2011	REVISED ISSUE COPY	TM	TM	NP	JK
4	15 May 2011	ISSUE COPY	TM	TM	NP	JK
5	01 June 2011	FINAL ISSUE COPY	TM	TM	NP	JK

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Contents

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Abbreviations

Abbreviation	Meaning
AEE	Assessment of effects on the environment
ANZECC	Australia New Zealand Environment and Conservation Council
AST	Aboveground storage tank
BEDL	Below effective detection limit
BHFFP	Battle Hill Farm Forest Park
BSN '#'	Bridge structure number
CLMG	Contaminated land management guidelines
CSMP	Contaminated soils management plan
CLS	Contaminated land specialist
CSM	Conceptual site model
DQO	Data quality objectives
EIR	Environmental impact report
EMI	Electromagnetic induction
EMP	Environmental management plan
EPA	Environmental Protection Authority
GATS	Greater Wellington Area Land Use and Transportation Strategic review
GPS	Government Policy Statement on Land Transport Funding 2009/10 – 2018/19
GPR	Ground penetrating radar
GRPA	Government Roading Powers Act 1989
GWRC	Greater Wellington Regional Council
HAIL	Hazardous activities and industries list
HDPE	High density polyethylene
HSNO	Hazardous Substances and New Organisms Act 2001
KCDC	Kapiti Coast District Council
km	Kilometre
km^2	Square kilometres
LTMA	Land Transport Management Act 2003
mg/m^3	Milligrams per cubic metre
MfE	Ministry for the Environment
m^3	Cubic metres
mm	Millimetre
NATO	North Atlantic Treaty Organisation

Abbreviation	Meaning
NES	National Environmental Standard
NIMT	North Island Main Trunk
NoR	Notice of requirement for designation
NZTTG	New Zealand Health and Environmental Guidelines for Selected Timber Treatment Chemicals
NZTA	NZ Transport Agency
ORC	Organochlorine
ORP	Organophosphate
ORN	Organonitrogen
OSH	Occupational safety and health
PAH	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PCC	Porirua City Council
PCP	Pentachlorophenol
QA/QC	Quality assurance/quality control
RoNS	Road of national significance
RPD	Relative percent difference
RMA	Resource Management Act 1991
RSS	Risk screening system
SAR	Scheme assessment report
SCV	Soil Contaminant Value
SH1	State Highway 1
SH58	State Highway 58
SLUR	Selected Land Use Register
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TDM	Travel demand management
TEQ	Toxicity equivalence
TEF	Toxicity equivalence factor
TPH	Total petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
UXO	Unexploded ordnance
WCP	Western Corridor Plan
WHO	World Health Organisation

Glossary of Terms

Term	Definition
Alignment	The horizontal or vertical geometric form of the centre line of the carriageway.
Alluvial deposits	Unconsolidated sedimentary deposits laid down by a stream or river.
Alluvial fan deposits	Sedimentary deposits that accumulate at the mouth of a stream, generally fan shaped in plan, resulting from a diminution, or cessation, of sediment transport by the stream.
Colluvium	Loose deposits of rock debris accumulated through the action of gravity found at the base of slopes.
Contaminant	Defined in section 2 of the RMA as: "any substance (including gases, odorous compounds, liquids, solids and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat - (a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or (b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged."
Contaminated land	Defined in section 2 of the RMA as: "land that has a hazardous substance in or on it that - (a) has significant adverse effects on the environment; or (b) is reasonably likely to have significant adverse effects on the environment."
Designation	Defined in section 166 of the RMA as: "a provision made in a district plan to give effect to a requirement made by a requiring authority under section 168 or section 168A or clause 4 of schedule 1."
Environmental management plan	A site or project specific plan developed to ensure that appropriate environmental management practices are followed during the operation of a project.
Environmental risk assessment	An evaluation of possible risk from a receptor contacting a source through a completed pathway. Risk may manifest in the form of acute (immediate) or chronic (long-term) adverse effects. Environmental risk is typically evaluated for human health and ecological receptors.
Exposure Pathway	A route by which contaminants can contact a receptor. Receptors can include people, flora and fauna, groundwater, surface water, or air. Examples of pathways for human receptors include routes such as ingestion, inhalation, dermal absorption, or injection. Environmental pathway examples include percolation of rainwater carrying contaminants to groundwater, stormwater runoff into surface water bodies and uptake of contaminants through plant root systems.
Guideline values	Risk-based values for individual contaminants that are based on various studies. Guideline values are used to evaluate laboratory analytical data

Term	Definition
	from soil and water samples to determine whether additional action is required. Guideline values are typically media-specific and provided for protection of human health and ecological receptors.
Hazardous activities and industries list	A list of activities and industries that are considered likely to cause land contamination resulting from hazardous substance use, storage or disposal.
Judgmental sampling strategy	A sampling strategy that involves sample collection at areas that, in the judgement of the environmental professional, may be contaminated. The goal of this strategy is to provide a "worst reasonable case" sampling result as samples are typically collected from areas which have detectable potential contamination (e.g., staining or odour).
Section 1 (MacKays Crossing)	That part of the Main Alignment between station values 00000 and 03500, referred to generally as MacKays Crossing.
Section 2 (Wainui Saddle)	That part of the Main Alignment between station values 03500 and 06500, referred to generally as Wainui Saddle.
Section 3 (Horokiri Stream)	That part of the Main Alignment between station values 06500 and 09500, referred to generally as Horokiri Stream.
Section 4 (Battle Hill)	That part of the Main Alignment between station values 09500 and 12500, referred to generally as Battle Hill.
Section 5 (Golf Course)	That part of the Main Alignment between station values 12500 and 15500, referred to generally as the Golf Course.
Section 6 (State Highway 58)	That part of the Main Alignment between station values 15500 and 18500, referred to generally as State Highway 58.
Section 7 (James Cook)	That part of the Main Alignment between station values 18500 and 21500, referred to generally as James Cook.
Section 8 (Cannons Creek)	That part of the Main Alignment between station values 21500 and 24900, referred to generally as Cannons Creek.
Section 9 (Linden)	That part of the Main Alignment between station values 24900 and 27700, referred to generally as Linden.
Systematic sampling strategy	A sampling strategy that involves laying out a grid over an area and collecting samples from each grid location. This sampling pattern is used where there is no "point source" of contamination, but instead there is potential for widespread contamination, such as from pesticide application.
Transmission Gully Main Alignment (*the Main Alignment*)	A proposed 27km expressway between Linden (Wellington City) and MacKays Crossing (Kapiti Coast).
Transmission Gully Project (*the Project*)	Refers collectively to the Transmission Gully Main Alignment, the Kenepuru Link Road and the Porirua Link Roads.
Unexploded ordnance survey	A geophysical survey using electromagnetic or ground penetrating radar techniques to identify underground anomalies that may be indicative of the presence of unexploded ordnance.

Executive Summary

The Transmission Gully Project (the Project) consists of three components:

- The Transmission Gully Main Alignment (the Main Alignment) involves the construction and operation of a State highway formed to expressway standard from Linden to MacKays Crossing. The NZ Transport Agency (NZTA) is responsible for the Main Alignment.
- The Kenepuru Link Road involves the construction and operation of a road connecting the Main Alignment to existing western Porirua road network. The NZTA is responsible for the Kenepuru Link Road.
- The Porirua Link Roads involves the construction and operation of two local roads connecting the Main Alignment to the existing eastern Porirua road network. Porirua City Council (PCC) is responsible for the Porirua Link Roads.

The Main Alignment will provide an inland State highway between Wellington (Linden) and the Kapiti Coast (MacKays Crossing). Once completed, the Main Alignment will become part of State Highway 1 (SH1). The existing section of SH1 between Linden and MacKays Crossing will likely become a local road.

The Main Alignment is part of the Wellington Northern Corridor (Wellington to Levin) road of national significance (RoNS). The Wellington Northern Corridor is one of the seven RoNS that were announced as part of the Government Policy Statement on Land Transport Funding (GPS) in May 2009. The focus of the RoNS is on improved route security, freight movement and tourism routes.

The Main Alignment will be approximately 27 kilometres in length and will involve land under the administrative jurisdiction of four separate territorial authorities: Wellington City Council, Porirua City Council, Upper Hutt City Council and Kapiti Coast District Council. The Main Alignment will be a motorway under Section 71 of the Government Roading Powers Act 1989 (GRPA).

In order to advance the Transmission Gully Project, NZTA awarded contracts for completion of various technical studies, including ecology, water quality, air quality, highway design and land contamination. This report presents the findings of the Stage 1 and 2 land contamination studies conducted in support of developing a consent application for the highway.

The Main Alignment

The Main Alignment will provide an inland State highway between Wellington (Linden) and the Kapiti Coast (MacKays Crossing). Once completed, the Main Alignment will become part of State Highway 1 (SH1). The existing section of SH1 between Linden and MacKays Crossing will likely become a local road.

The Main Alignment is part of the Wellington Northern Corridor (Wellington to Levin) road of national significance (RoNS). The Wellington Northern Corridor is one of the seven RoNS that were announced as part of the Government Policy Statement on Land Transport Funding (GPS) in May 2009. The focus of the RoNS is on improved route security, freight movement and tourism routes.

The Main Alignment will be approximately 27 kilometres in length and will involve land in four districts: Wellington City, Porirua City, Upper Hutt City, and Kapiti Coast District.

The key design features of the Main Alignment are:

- Four lanes (two lanes in each direction with continuous median barrier separation)
- Rigid access control

- Grade separated interchanges
- Minimum horizontal and vertical design speeds of 100 km/h and 110km/hr respectively
- Maximum gradient of 8%
- Crawler lanes in some steep gradient sections to account for the significant speed differences between heavy and light vehicles

The Kenepuru Link Road

The Kenepuru Link Road will connect the Main Alignment to western Porirua. The Kenepuru Link Road will provide access from Kenepuru Drive to the Kenepuru Interchange. This road will be a State highway designed to following standards:

- Two lanes (one in each direction)
- Design speeds of 50 km/h
- Maximum gradient of 10%
- Limited side access

Porirua Link Roads

The Porirua Link Roads will connect the Main Alignment to the eastern Porirua suburbs of Whitby (Whitby Link Road) and Waitangirua (Waitangirua Link Road). The Porirua Link Roads will be local roads designed to the following standards:

- Two lanes (one in each direction)
- Design speeds of 50 km/h
- Maximum gradient of 10%
- Some side access will be permitted

Consents and approvals

NZTA and PCC are now seeking consents and approvals under the Resource Management Act 1991 (RMA) to authorise the construction and operation of the Project.

NZTA and PCC issuing a notice of requirement for designation (NoR) to designate all components of the Project. These comprise:

- NoR by NZTA to designate land in the Wellington City District Plan for “motorway purposes” (Transmission Gully Main Alignment)
- NoR by NZTA to designate land in the Porirua City District Plan for “motorway purposes” (Transmission Gully Main Alignment)
- NoR by NZTA to designate land in the Upper Hutt City District Plan for “motorway purposes” (Transmission Gully Main Alignment)
- NoR by NZTA to designate land in the Kapiti Coast District Plan for “motorway purposes” (Transmission Gully Main Alignment)
- NoR by NZTA to designate land in the Porirua City District Plan for “State highway (limited access road) purposes” (Kenepuru Link Road)

- NoR by the PCC to designate land in the Porirua City District Plan for “local road purposes” (Porirua Link Roads)

NZTA and the PCC are also seeking all the necessary resource consents required under regional plans to construct and operate all components of the Project.

An Assessment of Environmental Effects (AEE) will be developed as part of the submittal. This report is a factual report that will be an appendix to the AEE.

Project progression

Assuming that the NOR are confirmed and the resource consents are approved for the Transmission Gully Project via the national consenting process, NZTA will pursue further phases of the project. These will include procuring professional services contracts for design and a contract or contracts for construction of the Project.

NZTA has not yet decided whether it will procure these services using a design/build contract, separate design and construction contracts, or some other mechanism such as an Alliance, for example. Enabling works, i.e. involving physical works on the ground, will not commence before such time as the design is suitably advanced and a contractor has been appointed. Enabling works may include, but not be limited to, services relocations, unexploded ordnance (UXO) investigation, building demolition, contaminated soil remediation (if required), establishment of construction offices and equipment and construction of stormwater treatment devices required for construction activities. Any “enabling works” will include those works necessary to be completed prior to physical works construction. Following completion of enabling works, highway construction will begin. After the Project opens, operation and maintenance works will be conducted as required.

Route description

The Transmission Gully Main Alignment has been divided into nine sections for reference.

Section number	Section name	Station value (m)	Length (km)
1	MacKays Crossing	00000 – 03500	3.5
2	Wainui Saddle	03500 – 06500	3.0
3	Horokiri Stream	06500 – 09500	3.0
4	Battle Hill	09500 – 12500	3.0
5	Golf Course	12500 – 15500	3.0
6	State Highway 58	15500 – 18500	3.0
7	James Cook	18500 – 21500	3.0
8	Cannons Creek	21500 – 24900	3.4
9	Linden	24900 – 27700	2.8

Land contamination study scope of work

The scope of work addressed in this report was to conduct a land contamination study, consisting of a Stage 1 assessment and Stage 2 investigation of the route within the designation in general accordance with Ministry for the Environment Contaminated Land Management Guidelines (MfE CLMG), other relevant MfE guidelines and NZTA Contaminated Land Acquisition Protocol (2010a).

The land contamination scope of work was conducted using a staged approach. A Stage 1 land contamination assessment was conducted as the first phase of work. The Stage 1 assessment is largely a desktop study with site reconnaissance. Sampling and analysis are not included in the Stage 1 assessment. Instead, a qualitative risk evaluation was developed which helped focus the Stage 2 land contamination investigation, which does include sampling and analysis. The results of the Stage 2 land contamination investigation are then utilised to re-evaluate potential risk and to guide recommendations for remedial action or risk mitigation. The information from the land

contamination studies will be used to support the consent application documentation being prepared for the Transmission Gully Project.

The work conducted as part of both the Stage 1 and 2 land contamination assessment and investigation is addressed in this report. This report comprises a factual report of findings from the land contamination study conducted for the Transmission Gully Highway Project and it will be included as an appendix in the AEE document. The AEE document describes consenting requirements in detail and also addresses linkages that need to be considered, such as possible contamination of stormwater, releases of contaminants to air and noise effects during remedial action activities.

To help mitigate potential risk to future construction workers, the public, the environment and the Project, a preliminary Contaminated Soil Management Plan (CSMP) was developed and is included in ***Volume 5*** of this submission. The CSMP addresses steps to be taken should accidental discovery of contamination take place during construction and also provides for management of soil identified as contaminated during the Stage 2 land contamination investigation.

Stage 1 land contamination assessment

The Stage 1 land contamination assessment was conducted in accordance with MfE CLMG and included review of:

- Historic title records
- Historic and recent aerial photos
- Available council records
- Relevant reports (such as the Draft Scheme Assessment Report [SAR] published by NZTA in 2009)
- Information regarding local and regional geology and hydrology.

In addition, interviews were conducted with available persons who had knowledge of the sites along the route and site visits were conducted, particularly to areas where there were activities that could have led to contamination.

The Stage 1 land contamination assessment also included development of site-specific conceptual site models (CSMs) and a preliminary qualitative risk assessment that used a matrix system to rank the risk of various sites along the route. The risk values were adopted in accordance with the overall Transmission Gully Highway Project risk matrix established by NZTA. Based on the CSM and level of risk assigned, additional investigation was recommended for those sites assigned a medium and high level of potential risk. These sites included:

- Sang Sue Market Garden – identified due to market gardening activities, such as application of fertilisers and pesticides, frost control utilising diesel fuel, equipment leakage, possible presence of storage tanks and hazardous materials
- Former Golden Coast Nurseries – identified due to greenhouse/plant nursery activities, such as application of fertilisers and pesticides, frost control utilising diesel fuel, equipment leakage, presence of storage tanks and hazardous materials and possible presence of asbestos in building materials
- Car Haulaways – identified due to the storage and fueling of vehicles and possible presence of asbestos in building materials
- Pauatahanui Inlet Garden Supplies – identified due to composting activities, which may have included application of pesticides and fertilisers, diesel fuel and hazardous materials storage, evidence of minor hydrocarbon releases, proximity to a stream and potential for site flooding
- Porirua Gun Club – identified due to the presence of ammunition and clay targets in shooting range areas, an ammunition burn pit, possible hazardous materials storage, a rubbish disposal area, a drainage ditch which collects site run off and a wastewater/leachfield area.

- Greater Wellington Regional Council (GWRC) former sheep dip site – identified due to the possible presence of pesticides and heavy metals at a sheep dip facility located uphill from the Transmission Gully Highway route
- A former stockyard site near Battle Hill Farm Forest Park – identified as it was reportedly a possible livestock dip site and/or holding pen for animals following dipping operations
- Mana Coach facility – identified due to visible leakage in the bus parking area and presence of vehicle fueling and maintenance facilities
- MacKays Crossing area – identified as it was previously used for military operations and UXO has been found in the vicinity of the planned construction at Queen Elizabeth II Park

While other areas, such as farms and grazing areas, also carry a risk of contamination (such as from livestock dips, offal pits, rubbish pits, tanks, hazardous materials storage, etc.), the risk is considered lower than at those sites where more intensive activities took place. At these lower risk sites (as determined by the risk evaluation and assignment of values through the risk matrix), it was determined that no additional investigation was warranted at this time because, even with intensive drilling or test pitting along the route, there is no guarantee of finding the areas where these contaminating activities were undertaken. In addition, much of the route is characterised by steep hills rising up from narrow valleys and similar challenging terrain. This type of terrain is typically used for grazing. Features that carry a contamination risk are usually located near buildings (e.g., sheep dips are usually near the wool shed) and much of the route is not suitable for such buildings. An extensive geotechnical investigation was conducted as part of the Draft SAR; no obvious signs of contamination were detected during drilling and test pitting. Surface water sampling along the route conducted as part of the current investigation (under a separate work stream) has not identified contamination along the farm and greenfields sites; the only elevated concentrations of contaminants of concern are those typically associated with urban runoff and are only present in urban areas. Based on these factors, together with a review of historic documentation and interviews with persons knowledgeable of the area and project risk criteria, it was determined that these sites would be managed under the CSMP which details the proper steps to be taken in the event of accidental discovery.

Other sites which may pose a risk of contamination include older buildings which may contain asbestos in building materials, polychlorinated biphenyls (PCBs) in light fixtures and cooling units and lead-based paint. In addition, hazardous materials could be stored in the buildings. Accessible buildings were visually evaluated as part of the Stage 1 assessment. However, a detailed assessment of the buildings was not conducted during the Stage 1 or Stage 2 land contamination study. A hazardous materials management plan and asbestos management plan should be developed and implemented prior to the demolition or disturbance of any of the buildings.

Two potential landfill sites were identified in the Stage 1 land contamination assessment. However, one facility, the Sievers Grove landfill, is outside the footprint and downgradient of the Highway. Aurecon was unable to find reliable information regarding the second reported landfill (Ribbonwood Tce Landfill); it was not apparent in historic aerial photos and persons knowledgeable of the area's history had no knowledge of this landfill. It is located in an area that is currently planted as a plantation forest, making a geophysical survey impractical. Therefore, no investigation was conducted at this time. Instead, the Ribbonwood Tce Landfill is addressed in the CSMP.

Stage 2 land contamination investigation

The Stage 1 land contamination assessment recommended development of a work plan to guide an intrusive investigation into the sites with a higher level of potential risk (as determined by the risk evaluation and assignment of values through the risk matrix); this work plan was completed in March 2010. Sites identified for soil sampling were the Porirua Gun Club, Car Haulaways, former Golden Coast Nurseries, Sang Sue Market Garden, Pauatahanui Inlet Garden Supplies, GWRC former sheep dip site and the former stockyard site. In addition, a non-intrusive geophysical survey was specified to evaluate the potential presence of UXO near MacKays Crossing.

For each site to be investigated through soil sampling, a sampling strategy was selected based on the CSM which considered the potential source of contamination and expected behaviour of the contaminants of concern at each site setting. For sites where general contamination across the site could be expected, such as through application of fertilisers and pesticides, a grid-based sampling system was selected in accordance with MfE CLMG. Where discrete sources of potential contamination were identified (e.g., Car Haulaways where vehicle leakage was a suspected source of contamination), a targeted sampling strategy was selected. At sites where both widespread and discrete sources of contamination were present, a stratified sampling regime was adopted, combining grid-based and targeted sampling.

At all sites where soil samples were collected, the co-located samples were collected from a minimum of two depths (near-surface and shallow subsurface). All of the near-surface samples were submitted for analysis and a percentage of the shallow subsurface samples were also analysed. Duplicate samples were collected at a rate of ten percent and rinseate samples were collected from equipment used for sampling to verify that equipment decontamination procedures were adequate.

Soil samples were analysed by RJ Hill Laboratories, an IANZ accredited laboratory. The analyses were based on site-specific contaminants of concern identified during the Stage 1 land contamination assessment. Samples from the Porirua Gun Club's ammunition burn pit were also analysed by AsureQuality's laboratory for dioxins and furans. A surface water sample was collected at the Pauatahanui Inlet Garden Supplies facility and analysed by RJ Hill Laboratories. Samples were collected in accordance with the work plan and MfE CLMG by trained personnel. All equipment was decontaminated and samples were maintained under chain of custody.

Stage 2 investigation data evaluation

Following receipt from the laboratory, data were evaluated against adopted risk based guideline values for the protection of human health and ecological receptors at commercial/industrial sites and ecological receptors at recreational/parkland sites.

Guideline values were selected based on the MfE CLMG No. 2, "*Hierarchy and Application in New Zealand of Environmental Guideline Values*", Report 491 (2007). The 2011 Cabinet Paper issued on the National Environmental Standard for Assessing and Managing Contaminants in Soil (NES) was used to evaluate contaminants in soil. The NES establishes soil contaminant values (SCV) for several metals, pesticides, and benzo(a)pyrene.

For those contaminants not included in the NES, the MfE's Environmental Guideline Value (EGV) Database (2003) was used to help identify possible guideline values. In addition, other relevant New Zealand guidance documents, such as, "*Identifying, Investigating and Managing Risks Associated with Former Sheep Dip Sites: A Guide for Local Authorities*", Report 775 (MfE, 2006) were utilised for the selection of guideline values. Neither the Greater Wellington Regional Council (GWRC) nor the local councils provide guideline values for assessing contamination. Instead, the GWRC defines "contamination" as the presence of contaminants above background or guideline values. Therefore, the MfE CLMG guidance is the most appropriate to use in this case. In addition to risk-based criteria, the *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS, 2003), provided by GWRC as a guidance document, was also utilised for comparison of data against regional background concentrations as applicable.

Human health risk evaluation

While it appears that anthropogenic activities have led to slightly elevated concentrations of several contaminants of concern at all but two of the sites investigated, all samples analysed were below human health guideline values for all analytes.

At the Porirua Gun Club, lead was found at concentrations up to ten times the current human health risk based guideline value of 700 mg/kg. Polycyclic aromatic hydrocarbons (PAH) were also found in concentrations above human health guideline values in areas where clay target fragments are present along the boundary of the alignment. Dioxins and furans are present at the ammunition burn pit, but are present in concentrations well below guideline values. Due to the high concentrations of metals at the site, remedial action is recommended prior to the commencement of construction. The contamination does not appear to be highly mobile. Samples were collected at two depths and selected samples from the deeper strata were analysed for comparison purposes. The deeper samples analysed were typically lower in concentration and below guideline values and downgradient surface water sampling conducted as part of the Transmission Gully Highway Project water quality investigation did not return results that would be indicative of contamination from the site.

The Porirua Gun Club is still in use; contaminating activities continue at the site. It is recommended that the site be re-evaluated after operations cease. This could take the form of an additional land contamination assessment update with some limited sampling to determine whether conditions have changed substantially, particularly in areas where contamination was below, but close to, guideline values. Based on this re-evaluation, a remedial action plan should be developed and implemented prior to the start of construction.

Hydrocarbons were present above laboratory detection limits at the Car Haulaways site; however, all are well below human health risk based guideline values. Metals detected within soil samples at the site are also below human health risk based guideline levels. Samples taken from building materials did not contain asbestos.

At the Pauatahanui Inlet Garden Supplies and both livestock sites, constituents of concern were present above laboratory detection limits, but were all below human health risk based guideline values.

At the former Golden Coast Nurseries site, arsenic was detected above the NES human health guideline value for commercial/industrial sites. One sample had an arsenic concentration of 100 mg/kg; the NES SCV is 70 mg/kg. The sample also had elevated concentrations of copper and zinc; however, these concentrations were below human health guideline values. The sample was located at a depth of 0.1 m and the co-located deeper sample had an arsenic concentration well below the human health guideline value. This area is within one of the nursery buildings and is likely the result of past spillage of garden chemicals and the contamination appears to be localised. Asbestos was detected in some of the building materials samples collected from the former Golden Coast Nurseries.

At the Pauatahanui Inlet Garden Supplies site, hazardous materials were stored and operations continued after completion of the intrusive investigation. Subsequent to completion of the Stage 2 investigation, NZTA was informed that the facility was storing treated timber for use or possibly for burning. A follow-up site inspection revealed the presence of an outhouse, a digger, an empty storage shed, debris, soil piles with debris, apparent waste asphalt, gold coloured gravel, wood chips, timber and charred wood fragments. While these features are not likely to pose a significant risk to human health, they should be removed from the site, properly disposed of and the site reinspected to evaluate the potential presence of contamination. This is addressed in the CSMP.

A geophysical survey was conducted in the MacKays Crossing area using EM61 geophysical equipment. The area directly adjacent to the existing SH1 appears to be free of UXO. However, numerous anomalies in the paddocks further away from the existing SH1 were detected. While some of the anomalies are quite large and are likely to be buried fence material and similar, other anomalies are indicative of the possible presence of UXO. Note that the survey conducted may lead to “false positive” data (i.e., anomalies identified as possible UXO may be innocuous materials). However, in the interest of being conservative and in the context of potential risk from UXO, false positive data is not considered problematic. Appropriate excavation of the anomalies by experienced UXO personnel is recommended before the start of construction, as part of the enabling works. Note

that a protocol has been developed for accidental discovery of UXO and is included as an attachment to the CSMP.

Ecological risk evaluation

Samples from all sites were analysed for heavy metals. With regard to chromium, most of the samples were within typical background ranges for chromium in the Wellington region; however, many were near or slightly above the higher end of the background ranges. However, consultation with the Transmission Gully Highway ecologists and landscape architect team, as well as with the stormwater management team, indicates that the effects should be no more than minor for the majority of the areas where chromium was present slightly above background values.

At the former Golden Coast Nurseries, Lindane and DDT congeners were detected in some of the samples as was Endosulfan. Endosulfan was present below ecological risk based guideline values; however, detected Lindane concentrations were above the ecological risk based guideline value of "below laboratory detection limits".

Zinc, arsenic, chromium, nickel and copper were also present in soil samples from the former Golden Coast Nurseries above ecological risk based guideline values in some of the samples; however, only one area had concentrations that were significantly above guideline values and well above the expected background values. Copper was significantly elevated at several sample locations and while it is well below human health guidelines, it is more than an order of magnitude above ecological risk based guideline values. It is likely that this elevated result is due to spills or releases at these particular locations; however, metals concentrations are generally elevated across the site. While there are elevated concentrations of metals present at this site, they should not pose a significant risk to future construction workers. Provided that soil is properly managed, the ecological risk is thought to be relatively low.

At the Porirua Gun Club, ecological risk based guideline values were exceeded for antimony, arsenic, copper, lead and zinc. This should be considered when the remedial action plan is designed.

At the Pauatahanui Inlet Garden Supplies facility, hydrocarbons were present in areas where localised spillage was visible. A surface water sample and samples collected from the stream bank did not indicate the presence of constituents of concern above screening-level laboratory reporting limits. Zinc was present above the recreational/parkland ecological risk based value of 200 mg/kg, with a concentration of 320 mg/kg in one soil sample. Copper was also present above the recreational/ parkland ecological risk based value in one sample. The remaining samples returned concentrations below ecological risk based guideline values for all constituents.

There are features present at the Pauatahanui Inlet Garden Supplies facility which could lead to environmental degradation. These features (such as charred timber, galvanised structures, waste asphalt and an outhouse) should be removed from the site and the site reinspected to evaluate whether additional sampling and analysis is warranted prior to construction.

Dieldren was present above ecological risk based guideline values in two primary and one duplicate shallow samples collected from the GWRC former sheep dip site. No other pesticides were detected above laboratory reporting limits. Metals are present slightly above typical background levels; however, all concentrations were below ecological risk based values.

At the former stockyard site, DDT congeners were also detected. Total DDT concentrations were above recreational/parkland guideline values in six samples; however, concentrations were below commercial/industrial ecological guideline values. Zinc was also present slightly above recreational/parkland ecological guideline values in one sample, with a concentration of 210 mg/kg as compared to a guideline value of 200 mg/kg.

Summary of Stage 2 investigation recommendations

Extensive remedial action is not required along the route, with the exception of the possible UXO at MacKays Crossing and impacted soil at the Porirua Gun Club. These are considered the two highest risk areas along the route and remedial actions include appropriate investigation for UXO at MacKays Crossing and proper soil treatment and disposal at the Porirua Gun Club. This does not mean that the remainder of the route is free of contamination; however, the risk is lower than at these two sites. Other potential risks along the route and associated recommendations include:

- Removal of debris, structures, equipment, etc. from the Pauatahanui Inlet Garden Supplies site. A follow-up inspection should be conducted following removal of these features to determine whether additional sampling and analysis are warranted. If material is removed down to native soil depth, additional sampling may not be required
- Potential asbestos, PCBs and lead-based paint at building structures slated for demolition should be thoroughly investigated, particularly at buildings constructed prior to 1990. An asbestos management plan and hazardous materials management plan should be developed as part of enabling works. Demolition should be carried out by personnel qualified to manage asbestos-containing material. Note that samples collected from some of the structures at the former Golden Coast Nurseries site tested positive for asbestos
- Discrete areas where contaminants are present above ecological risk based guideline values have been identified at all sites except the Mana Coach site. These elevated concentrations should be considered when managing and placing soil excavated from the site. While the majority of the concentrations are not high enough to cause significant adverse ecological effects, the soil in question should not be used to construct stormwater detention basins or placed in an ecologically sensitive environment. Instead, it would best be used as part of the road base where it would be beneath pavement, or within or beneath a structure. Due consideration should also be given to stormwater treatment with regard to runoff from this soil.
- At the former Golden Coast Nurseries, arsenic was detected in one sample above the NES SCV. Numerous constituents of concern at this facility were present significantly above ecological guideline values. Therefore, extra care should be taken at this site during construction to minimise dust and prevent stormwater runoff from leaving the site while the upper portion (~0.3 m) of soil is removed.

As no investigation can guarantee the absence of contamination, the CSMP should be implemented during future geophysical investigations and construction. This plan includes a protocol for stopping work if suspect contamination is discovered and details signs of contamination and potential contaminating activities (such as offal pits, sheep dips, rubbish disposal, etc.).

Other areas to be investigated

Subsequent to completion of the Stage 2 investigation, the highway route was adjusted slightly. Based on this adjustment, additional investigation requirements were identified as follows:

- Characterisation of the area along the existing SH1 where fuel spills, pesticide or herbicide use, or metals from vehicle components or leaded fuel could have impacted the soil
- The area north of the Maraeroa Marae and south and west of Mana Coach where imported fill of unknown quality could have been utilised
- The buildings at the proposed Kenepuru Interchange

These areas were investigated under a supplemental work plan and the work is addressed in separate letter reports.

Construction and maintenance operations

Requirements for carrying out construction and maintenance in a manner protective of human health and the environment are contained in both the AEE and the Project Construction Management Plan. The Construction Management Plan contains information regarding stormwater management, erosion control, noise and air quality management during construction and maintenance of the highway. The CSMP, provided in ***Volume 5***, addresses soil management and accidental discovery of contaminated sites. It also includes a protocol for the management of UXO.

1. Introduction

1.1 Project overview

The Transmission Gully Project (the Project) consists of three components:

- The Transmission Gully Main Alignment (the Main Alignment) involves the construction and operation of a State highway formed to expressway standard from Linden to MacKays Crossing. The NZ Transport Agency (NZTA) is responsible for the Main Alignment.
- The Kenepuru Link Road involves the construction and operation of a road connecting the Main Alignment to existing western Porirua road network. The NZTA is responsible for the Kenepuru Link Road.
- The Porirua Link Roads involves the construction and operation of two local roads connecting the Main Alignment to the existing eastern Porirua road network. Porirua City Council (PCC) is responsible for the Porirua Link Roads

In order to advance the Transmission Gully Project, the NZ Transport Agency (NZTA) awarded contracts for completion of various technical studies, including ecology, water quality, air quality, highway design and land contamination. This report presents the findings of the land contamination studies conducted in support of developing a consent application for the highway.

A phased approach was taken for the land contamination study. Limited information was available about potential contamination along the route. Therefore, a Stage 1 land contamination assessment was conducted to more fully determine where contamination might be present. Based on the findings of the Stage 1 assessment, a Stage 2 intrusive investigation was conducted that included the collection and analysis of samples and a geophysical investigation. The results of the Stage 1 and Stage 2 investigations are presented in this report.

1.2 Main Alignment

The Main Alignment will provide an inland State highway between Wellington (Linden) and the Kapiti Coast (MacKays Crossing). Once completed, the Main Alignment will become part of State Highway 1 (SH1). The existing section of SH1 between Linden and MacKays Crossing will likely become a local road.

The Main Alignment is part of the Wellington Northern Corridor (Wellington to Levin) road of national significance (RoNS). The Wellington Northern Corridor is one of the seven RoNS that were announced as part of the Government Policy Statement on Land Transport Funding (GPS) in May 2009. The focus of the RoNS is on improved route security, freight movement and tourism routes.

The Main Alignment will be approximately 27 kilometres in length and will involve land in four districts: Wellington City, Porirua City, Upper Hutt City, and Kapiti Coast District.

The key design features of the Main Alignment are:

- Four lanes (two lanes in each direction with continuous median barrier separation)
- Rigid access control
- Grade separated interchanges
- Minimum horizontal and vertical design speeds of 100 km/h and 110km/hr respectively
- Maximum gradient of 8%
- Crawler lanes in some steep gradient sections to account for the significant speed differences between heavy and light vehicles

1.3 The Kenepuru Link Road

The Kenepuru Link Road will connect the Main Alignment to western Porirua. The Kenepuru Link Road will provide access from Kenepuru Drive to the Kenepuru Interchange. This road will be a State highway designed to following standards:

- Two lanes (one in each direction)
- Design speeds of 50 km/h
- Maximum gradient of 10%
- Limited side access.

1.4 Porirua Link Roads

The Porirua Link Roads will connect the Main Alignment to the eastern Porirua suburbs of Whitby (Whitby Link Road) and Waitangirua (Waitangirua Link Road). The Porirua Link Roads will be local roads designed to the following standards:

- Two lanes (one in each direction)
- Design speeds of 50 km/h
- Maximum gradient of 1:10
- Some side access will be permitted

1.5 Purpose and scope of assessment

This report presents the findings of the land contamination study conducted as part of the environmental assessment of the Project. The purpose of this assessment was to evaluate potential contamination along the route within the designation.

This report is part of a suite of documents in support of the notices of requirement for designations and applications for resource consent for the Project

Background to the Transmission Gully Project

The concept of an inland, alternative route to bypass the existing SH1 coastal route and communities north of Wellington was first raised in the early 1940s and has been under consideration by various parties ever since.

The key events in the development of the Transmission Gully Project are:

- In the early 1940s, there was first talk of an alternative inland route for SH1 north of Wellington.
- In 1981, the National Roads Board embarked on an assessment of the Western Corridor (undertaken by the Ministry of Works and Development and the Ministry of Transport) looking at options for an inland route (now known as Transmission Gully) in comparison to an upgrade of the coastal route.
- In 1986, the findings of the National Roads Board's Western Corridor Report were released with the report rejecting an inland route and supporting major improvements along the existing coastal route.
- In 1987, the Greater Wellington Area Land Use and Transportation Strategic Review (GATS) was jointly funded by the National Roads Board, Wellington Regional Council and the Urban Transport Council. The Western Corridor section was separated out for early consideration. The

GATS considered a large number of options including routes through Porirua East/Whitby, Takapu Valley, Belmont deviation through Belmont Regional Park to SH2, as well as upgrades to the coastal route.

- In 1989, an environmental impact report (EIR) was produced to compare the impacts of options proposed in GATS including public transport and roading upgrades. The EIR considered both coastal and inland options. The EIR concluded that in addition to public transport upgrades, roading improvements were required to address the growing congestion on SH1. The EIR found the inland route was more environmentally and socially acceptable. The favoured route was an inland alignment from MacKays Crossing to Takapu, continuing through the Takapu Valley with an interchange on SH1 at Tawa.
- In 1990, the Parliamentary Commissioner for the Environment (PCE) conducted an audit of the EIR. The PCE agreed in principle with the findings of the EIR with some reservations and recommendations. The audit found that Takapu Valley was not necessarily the best alignment at the southern end and that further investigation of the links to the Hutt Valley and Porirua was required. The PCE's principal recommendations were to finalise and designate the inland route and to consult with the public to reduce uncertainty for both the coastal and inland route communities.
- In 1991, the Wellington Regional Council conducted further investigations into possible alignments at the southern end. A number of alignments were examined and the conclusion was for a connection to SH1 at Linden as well as connection to western Porirua via a Kenepuru link. Justification for this was clear benefits to the management of Porirua traffic and relief to SH58 around Pauatahanui Inlet. This would also reduce environmental and social impacts associated with the Takapu Valley option.
- In 1996, a preliminary design was produced for the Linden to MacKays Crossing alignment and the notices of requirement were lodged.
- In 1997, the hearing takes place for the notices of requirement for the Linden to MacKays Crossing alignment.
- In 2003, all the appeals on the notices were finally resolved and the designations for the Linden to MacKays Crossing alignment were included in the relevant district plans.
- In 2004, an existing local road designation was altered to provide local road access to the Linden to MacKays Crossing alignment from eastern Porirua.
- In 2004, the Western Corridor Transportation Study (jointly commissioned by Greater Wellington Regional Council and Transit New Zealand) commenced to provide the basis for an integrated transportation strategy to manage travel demands in the Western Corridor. The resulting Western Corridor Plan (WCP) included consideration of major public transport and roading options and travel demand management (TDM) initiatives. Consultation on the WCP indicated that affected communities did not support the coastal route and expressed a strong preference for the Transmission Gully Project.
- In 2006, the WCP was endorsed by the Transit NZ Board and adopted by the Greater Wellington Regional Council and included the Transmission Gully Project in the Regional Land Transport Strategy (2007 to 2016) for construction within 10 years as part of a balanced multi-modal approach to addressing transport needs within the Western Corridor.
- In 2008, a draft scheme assessment report (SAR) was undertaken which involved the assessment of numerous options for a Transmission Gully Project alignment both within and outside the confines of the existing designation. Together with a detailed consultation process, preferred alignment for Transmission Gully Project was produced.
- In 2009, detailed environmental and engineering investigation work commenced for the Project.
- In May 2009 the GPS is released which included the RoNS programme. The Wellington Northern Corridor is one of the RoNS.

- In December 2009, NZTA's Board announces that the Transmission Gully Project is the preferred route to improve access through the southern end of the Western Corridor. The NZTA press release stated; "our task was to choose the route which would deliver the best result for the region and New Zealand [as part of the Roads of National Significance], while also bearing in mind the potential impact on the environment and surrounding communities. In the end it was clear that Transmission Gully was the better choice. It is less expensive, it will provide a safer four-lane route, it's better for local communities and better for the environment, and it will reduce travel times between Kapiti and Wellington".
- In 2010, detailed environmental and engineering investigation work is progressed and the preferred alignment is optimised to accommodate road design, ecological, water quality and other considerations. In March, the NZTA signals its intention to lodge the statutory RMA documentation with the EPA using the new "national consenting process".

1.6 Project progression

Assuming that the Notices of Requirement are confirmed and the resource consents are approved for the Transmission Gully Project via the national consenting process, NZTA will pursue further phases of the project. These will include procuring professional services contracts for design and a contract or contracts for construction of the Project.

The procurement model has not been decided, but could be a design/build contract, separate design and construction contracts, or some other mechanism such as an Alliance. Enabling works, i.e. involving physical works on the ground, will not commence before such time as the design is suitably advanced and a contractor has been appointed. Enabling works may include, but not be limited to, services relocations, UXO investigation, building demolition, contaminated soil remediation (if required), establishment of construction offices and equipment and construction of stormwater treatment devices required for construction activities. Any "enabling works" will include those works necessary to complete prior to physical works construction. Following completion of enabling works, highway construction will begin. After the Project opens, operation and maintenance works will be conducted as required.

1.7 Transmission Gully Highway alignment

The Main Alignment is a proposed 27km expressway from Linden in Wellington City to MacKays Crossing on the Kapiti Coast. The Main Alignment consists of nine sections as shown in the plan set and in the table below:

Section number	Figure number	Section name	Station value (m)	Length (km)
1	16.2	MacKays Crossing	00000 – 03500	3.5
2	16.3	Wainui Saddle	03500 – 06500	3.0
3	16.4	Horokiri Stream	06500 – 09500	3.0
4	16.5	Battle Hill	09500 – 12500	3.0
5	16.6	Golf Course	12500 – 15500	3.0
6	16.7	State Highway 58	15500 – 18500	3.0
7	16.8	James Cook	18500 – 21500	3.0
8	16.9	Cannons Creek	21500 – 24900	3.4
9	16.10	Linden	24900 – 27700	2.8

1.8 Development of the current design

The SAR was undertaken between 2006 and 2008. The key objective for this phase was to identify the most advantageous route alignment which could then be further refined and used for assessment and consenting.

The SAR is referred to as Phase I and the investigations and assessments (the current phase) are referred to as Phase II. Phase III refers to the consenting of the Project.

Work undertaken on the route since 2006 provided the first real opportunity to conduct on-site, in-depth investigations into the impact of the proposed alignment from an engineering and environmental perspective.

The key aspects that were considered during the SAR phase were:

- Geotechnical constraints;
- Physical environmental impacts;
- Social impacts;
- Cost;
- Timeliness;
- Network flexibility; and
- Route performance and safety.

The associated findings from these investigations indicated that the proposed route provides several significant benefits over the existing designated alignment and the coastal route.

The key benefits include:

Improving route security

While both the existing coastal route and the Transmission Gully Project route traverse fault lines, the Transmission Gully Project's proposed design offers greatly improved route security for the existing State Highway 1 and the region's road network over the existing coastal route.

Where the route is vulnerable to damage from major seismic events, engineered earth embankments have been used rather than bridge structures, which will provide greater resilience and allow easier and quicker reinstatement in order to restore road access to the region.

Improving highway safety and function

The alignment will be constructed for open road speed limits (100km/h) and a median barrier will be provided along the entire route. Crawler lanes and an arrester bed as well as 'run-off areas' for out of control vehicles) on the steepest sections, along with grade separated interchanges to remove conflicts associated with vehicle turning movements provide additional safety improvements over the coastal route.

Managing environmental impacts

Generally, the proposed route provides greater opportunities to manage environmental impacts as compared to the previously designated alignment or the coastal route. The mitigation measures required by conditions on the existing designation (such as the planting of approximately 150,000 native trees and shrubs) will still be able to be utilised in the proposed alignment.

Improving connections to local roads

An eastern Porirua interchange known as the James Cook Interchange will connect to both James Cook Drive in Whitby and Warspite Avenue in Waitangirua, providing improved connections with the wider Porirua area.

The Kenepuru Link Road will also connect the Main Alignment to western Porirua.

1.9 Contaminated land study

Typically, land contamination studies are conducted in a step-wise process, with findings from the Stage 1 assessment guiding the scope for the Stage 2 investigation, if required.

The Stage 1 land contamination assessment is largely a desktop study with site reconnaissance. sampling and analysis are not included in the Stage 1 assessment. As part of the Stage 1 assessment, a CSM is developed and a qualitative risk evaluation is conducted which helps focus the Stage 2 investigation, to include sampling and analysis. The results of the Stage 2 investigation are then utilised to re-evaluate potential risk and to guide recommendations for remedial action or risk mitigation.

However, when the contaminated land study contract for the Transmission Gully Highway Project was initially awarded, NZTA requested that a scope of work be prepared and estimated, covering both a Stage 1 land contamination assessment and a Stage 2 land contamination investigation. This scope of work was prepared by Aurecon and a Scoping Documents was developed based on the limited information available, such as from the Draft SAR. Subsequently, through discussions with NZTA, the scope of work was amended to utilise a phased approach for the land contamination study, with the Stage 1 land contamination assessment scope of work awarded. Subsequent to the completion of the Stage 1 land contamination assessment, a Revised Scoping Document was prepared that detailed the Stage 2 investigation scope of work.

The information from the Stage 1 and Stage 2 land contamination study will be used to support the consent application documentation being prepared for Transmission Gully. The scope of work for each phase of work is described below.

Stage 1 assessment scope of work

The Stage 1 land contamination assessment included the following items:

- Evaluate historic title records
- Evaluate historic aerial photos
- Research and evaluate Council records related to land contamination
- Research and summarise other reports prepared for the Transmission Gully project
- Interview readily available personnel knowledgeable of the individual properties (sites)
- Conduct site visits, with an overview tour of the route and detailed inspections of properties where contamination is likely

Because of the size of the route, access constraints and time limitations, not every site along the route was inspected in detail. Instead, a tour of the preferred alignment which was hosted by NZTA in August 2009 was utilised to gain an initial understanding of possible contamination issues along the route. Detailed site visits were conducted in September 2009, December 2009 and February 2010. A second tour of the length of the route, focussing on areas of potential concern, was conducted in February 2010. A follow-up site inspection of the Pauatahanui Inlet Garden Supplies facility was also conducted in August 2010.

Sites of interest identified by the August 2009 general site tour and Draft SAR were:

- MacKays Crossing, where past military activities were conducted and the potential exists for UXO
- Sang Sue Market Garden, where fertilisers, pesticides, heavy metals and a diesel storage tank may be present

- The Car Haulaways Ltd site, an area used for the storage of imported cars prior to distribution around New Zealand and where an aboveground storage tank (AST) was present
- Former Golden Coast Nurseries, where pesticides and heavy metals may be present from nursery activities
- Pauatahanui Garden Supplies, where pesticides, herbicides, heavy metals and a fuel storage tank may be present
- Porirua Gun Club, where ammunition and clay targets could have contaminated the soil
- Areas where sheep dips may have been present, such as former stockyard sites south of Battle Hill Farm and the area west of the Takapu Road Transpower Substation
- Mana Coach where vehicle storage, maintenance and fueling could have led to contamination

Additional sites, such as the former Sievers Grove and Ribbonwood Tce Landfills, were identified through review of Council records and historic aerial photos. Additional information was also obtained from interviews with persons knowledgeable of the area and specific sites.

The Stage 1 land contamination assessment scope was limited to properties within the highway alignment as it was identified in December 2009; adjacent properties were generally evaluated only from a perspective of whether they might contribute to groundwater or soil contamination at properties on the route itself.

The Stage 1 scope of work also included making recommendations as appropriate for additional work, such as sampling and analysis of select sites. A draft Stage 1 land contamination assessment report was prepared; the information contained in the draft report was utilised to formulate the Revised Scoping Document. The draft Stage 1 report was not finalised; instead, this report includes the findings from both the Stage 1 land contamination assessment and Stage 2 land contamination investigation.

Stage 2 investigation scope of work

The Stage 2 land contamination investigation scope of work was initially submitted to NZTA in September 2009 in an overall scoping document. As described above, it was subsequently agreed that Aurecon would conduct the Stage 1 land contamination assessment and then amend the scoping document to more accurately reflect the findings from the Stage 1 assessment. The Revised Scoping Document was provided to NZTA in February 2010. Following acceptance of the Revised Scoping Document, a work plan was prepared to guide the Stage 2 land contamination investigation.

The Stage 2 land contamination investigation consisted of:

- A geophysical survey for UXO in the vicinity of MacKays Crossing
- Soil sampling at specified locations, which included the Sang Sue Market Garden, Car Haulaways, Golden Coast Nursery, Pauatahanui Inlet Garden Supplies, two potential sheep dip sites, the Porirua Gun Club and Mana Coach
- Limited surface water sampling at Pauatahanui Inlet Garden Supplies
- Analysis of samples by an IANZ accredited laboratory
- Evaluation of laboratory analytical data against risk based criteria and established Wellington region background concentrations for specific constituents of concern
- Evaluation of possible remedial or mitigation actions
- Development of this report

The findings of both the Stage 1 land contamination assessment and Stage 2 land contamination investigation are presented in this report.

Other areas to be investigated

Subsequent to the completion of the Stage 2 investigation, the highway route was adjusted slightly. Based on this adjustment, additional investigation requirements were identified as follows:

- Characterisation of the area along the existing SH1 where fuel spills, pesticide or herbicide use, metals from vehicle components or leaded fuel could have impacted the soil
- The Lewis's Fabric facility where works will be conducted for the proposed Kenepuru Interchange
- The area north of the Maraeroa Marae and to the south and west of Mana Coach where imported fill of unknown quality could have been utilised

These areas were investigated under a supplemental work plan and the work was addressed in separate letter reports.

In addition, the tenant at Pauatahanui Inlet Garden Supplies vacated the site. A site reconnaissance was conducted in August 2010 to visually evaluate the status of the site. A letter report was prepared that details the results of this site visit.

1.10 Limitations

Aurecon has prepared this report (the "Report") for the use of NZTA (the "Client") for its use for inclusion in consent application documentation for the Transmission Gully Project.

The Report must be read in light of:

- The limited readership and purposes for which it was intended
- Its reliance upon information provided to Aurecon by the Client and others which has not been verified by Aurecon and over which Aurecon has no control
- The limitations and assumptions referred to throughout the Report, such as limited site access and budgetary constraints
- The cost and time constraints imposed on the Report
- Other relevant issues which are not within the scope of the Report

Subject to the limitations referred to above, Aurecon has exercised all due care in the preparation of the Report and believes that the information, conclusions, interpretations and recommendations of the Report are both reasonable and reliable. Aurecon makes no warranty or representation to the Client or third parties (express or implied) in respect of the Report, particularly with regard to any commercial investment decision made on the basis of the Report. Use of the Report by the Client or third parties shall be at their own risk and extracts from the Report may only be published with permission of Aurecon.

Soil and rock formations are often variable, resulting in heterogeneous distribution of contaminants across a site. Contaminant concentrations may be estimated at chosen sample locations; however conditions, between sample sites can only be inferred on a basis of geological and hydrological conditions and the nature and the extent of identified contamination. Boundaries between zones of variable contamination are often indistinct and therefore interpretation is based on available information and the application of professional judgement.

The accuracy with which sub-surface conditions are characterised depends on the frequency and methods of sampling and the uniformity of sub-surface conditions and is therefore limited by the scope of the works undertaken. Without extensive sampling and analysis, contamination cannot be confirmed or refuted. Where additional sampling and analysis (or similar) is recommended in this

Report, it should not be inferred that the site is contaminated or presents a risk to human health or the environment. Analogously, when no additional action is recommended, it should not be inferred that the site is free of contamination.

This report has been prepared based on Stage 1 and 2 land contamination assessments. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that any party may suffer as a result of using or relying on any such information or recommendations contained in this report, except to the extent Aurecon expressly indicates in this report. Should further information become available regarding the conditions at the site, including previously unknown likely sources of contamination, Aurecon reserves the right to review the report in the context of the additional information.

This report does not address remedial action or mitigation in detail, nor does it detail requirements regarding protection of air, surface water, or groundwater quality. The AEE provides an assessment of all media (air, water, soil) and describes the linkages between the various requirements, such as protection of air quality while excavating contaminated soil. Instead, this report is a factual report of the findings of the land contamination study carried out along the route. Recommendations for further actions and/or consent conditions are included in the report; however, detailed future actions are not described herein.

This disclaimer must accompany every copy of the Report, which is an integral document and this report must be read in its entirety.

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2. Site Information

2.1 Legal descriptions

The route comprises 27 km from MacKays Crossing to Linden and over 100 parcels of land are affected. A list of legal descriptions is provided in ***Table 16.1*** in ***Appendix 16.B*** (provided on CD with this report), along with historic title information. The information in ***Table 16.1*** is listed generally from north to south along the route. Parcel sizes and street addresses (where available) are also provided. Sites of potential concern, as identified during the Stage 1 assessment, are indicated in bold type in ***Table 16.1***.

2.2 Highway description

As mentioned in Section 1, the route is divided into nine sections as shown the plan set. Each section is briefly described below. The preferred highway route and sites of potential concern are indicated on the figures. ***Table 16.2*** lists site use and adjacent property information for each of the sites of potential concern.

Section 1: MacKays Crossing (Station 0000 to 3500)

This section is approximately 3.5km long, and extends from the tie-in at the existing MacKays Crossing Interchange on SH1 to the lower part of the Te Puka Stream valley. The Main Alignment will connect to the existing SH1 at approximately 00700m. The first 700m is the existing State Highway 1 alignment which is a grade separated interchange providing access across the North Island Main Trunk rail line (NIMT). Any alteration to the MacKays Crossing Interchange will be minimal.

This section of the Main Alignment will provide for three lanes in the northbound carriageway from 00700m and from 02100m in the southbound carriageway. Southbound traffic will be able to exit the Main Alignment at approximately 01250m. This exit will pass under the Main Alignment at approximately 01800m and will connect to the existing SH1 heading south towards Paekakariki. Traffic heading northbound from Paekakariki will be able to join the Main Alignment from a connection at approximately 01200m.

A subway at 01990m will provide vehicular access across the state highway to three properties. This subway will also provide access across the Main Alignment for pedestrians, cyclists and stock. For the rest of this section heading south, the carriageway will be three lanes in both directions and rises up the Te Puka Stream valley. At approximately 02900m there will be an arrestor bed adjacent to the northbound carriageway for any out of control vehicles heading downhill. The section finishes at 03500m.

The sites of potential concern in this section include MacKays Crossing past military operations, Sang Sue Market Garden, former Golden Coast Nurseries and Car Haulaways. The MacKays Crossing area is open space and grazing land. The Sang Sue Market Garden is an operating market garden, growing vegetables for sale. The former Golden Coast Nurseries and Car Haulaways sites have been acquired by NZTA and are currently vacant. The former Golden Coast Nurseries site was an operating nursery until late 2009. The site has glass houses, a joinery business and a residence present. The Car Haulaways site was used for the storage of newly imported vehicles, pending distribution to car dealerships throughout New Zealand. An office and three small metal sheds are present at the site. Both the Car Haulaways and former Golden Coast Nurseries sites had underground storage tanks (USTs) present in the past; however, the USTs were removed prior to NZTA acquiring the property. Neither the former Golden Coast Nurseries or Car Haulaways businesses are operating.

Note that the area associated with the sites of potential concern will be a “fill” rather than “cut” area with regard to highway construction.

Section 2: Wainui Saddle (Station 3500 to 6500)

Section 2 starts at approximately 03500m and will continue climbing for about 2km to the top of the Wainui Saddle at approximately 262m above sea level (at about 05500m). This will be the highest point of the Main Alignment. Just south of the Wainui Saddle peak at about 05600m there will be a brake check area for both northbound and southbound carriageways. Slightly further south, at approximately 06000m, three lanes in each direction will be reduced to two lanes in each direction. Section 2 finishes at 06500m.

There are no sites of potential concern in this section. The majority of this section is located within a relatively narrow valley between steep hillsides. The area is predominantly used for grazing.

Section 3: Horokiri Stream (Station 6500 to 9500)

This section is approximately 3km long and extends from the southern end of the Wainui Saddle to the northern end of Battle Hill Farm Forest Park. For the entire length of this section, the Main Alignment will run generally parallel to the Horokiri Stream. From 06500m to approximately 08550m the Main Alignment will be to the west of the Horokiri Stream, while from 08550m to 09500m it will be to the east of the stream. As the Main Alignment runs parallel to the stream it will cross a number its minor tributaries which generally run perpendicular to the Horokiri Stream and the Main Alignment.

Over this section, the Main Alignment will cross the Horokiri Stream once with a bridge at 08540m. The section finishes towards to northern boundary of the Battle Hill Farm Forest Park (BHFFP) at approximately 09500m. There are no sites of potential concern for this section. The majority of this section is predominantly used for grazing.

Section 4: Battle Hill (Station 9500 to 12500)

This section is approximately 3km long and extends from the northern boundary of the BHFFP to the Pauatahanui Golf Course. Shortly after the Main Alignment enters the BHFFP from the north it crosses over the Horokiri Stream with a bridge at approximately 09720m. Over the remainder of this section heading south the Main Alignment will follow the Horokiri Valley floor which widens from north to south through the BHFFP.

Access across the Main Alignment for park users will be provided by a subway located at approximately 10500m. This will provide a connection between the eastern and western part of the park for pedestrians, cyclists and stock. The Main Alignment will continue south from the BHFFP boundary towards the Pauatahanui Golf Course. At about 11750m it will crosses an unnamed stream with a bridge. Access across the Main Alignment will be available underneath this bridge. The section finishes at 12500m where there will be a subway providing pedestrian and stock access across the Main Alignment.

The former stockyard site is located at the southern end of Section 3, in a broad valley with gently sloping hills on either side of the valley. The plan set shows the general area of Section 4 and the approximate location of the former stockyards. The area over the former stockyard site will be a fill area during highway construction.

Section 5: Golf Course (Station 12500 to 15500)

This section is approximately 3km long, and extends from north to south through rural land adjacent to the Pauatahanui Golf Course and Flighty’s Road. The Main Alignment will cross a number of small tributaries along this section but there will be no major stream crossings requiring bridges. There are no sites of potential concern within this section; however, it should be noted that

hazardous materials may be stored and used at the Golf Club. The hazardous materials storage area for the Club is well away from the highway footprint.

Section 6: State Highway 58 (Station 15500 to 18500)

This section is approximately 3km long and starts at 15500m. The SH58 / Pauatahanui Interchange will be located at approximately 17500m. At this interchange the Main Alignment will be elevated above a roundabout which will provide access to and from the Main Alignment for traffic travelling in both directions on existing SH58. Immediately south of this interchange, at approximately 17660m, there will be a bridge across the Pauatahanui Stream.

At approximately 18250m the Main Alignment will widen to provide three lanes in each direction. This section finishes at approximately 18500m.

The Pauatahanui Inlet Garden Supplies site is at the corner of SH58 and Bradeys Road in this section. The land is owned by NZTA and was leased to New Zealand Composting Ltd, which took third party materials (such as recycled green waste) to be blended and composted for use as landscaping material. The area is generally flat.

The location of the Pauatahanui Inlet Garden Supplies site is shown on this figure. The area will generally be a fill area, however, it is not anticipated that a large amount of fill will be utilized. It is currently planned that the area will be utilized as a highway construction yard while construction activities are ongoing.

Section 7: James Cook (Station 18500 to 21500)

This section starts just south of the State Highway 58 / Pauatahanui Interchange, at approximately 18500m. Three lanes will be provided for both the northbound and southbound carriageways. The James Cook Interchange will be located at approximately 19500m. This will be a dumbbell interchange with the Main Alignment being elevated above the local road connections. These roads will provide access to the Main Alignment in both directions to and from the Porirua Link Roads. In the vicinity of this interchange, the number of lanes in each direction will be reduced from three to two. This will occur at approximately 18900m in the northbound carriageway and at 19500m in the southbound carriageway. From the James Cook Interchange, the Main Alignment will continue southwards for a further 2km. This section finishes at approximately 21500m.

There are no sites of potential concern in this Section; however, the Mana Coach site near the end of the Waitangirua link road

Section 8: Cannons Creek (Station 21500 to 24900)

This section begins at 21500m and is approximately 3.4 km long. Throughout this section the Main Alignment will run along the eastern side of Duck Creek valley, and across an undulating, weathered greywacke plateau between Duck and Cannons Creeks.

There will be four bridges in this section:

- A 140m long bridge starting at 21555m, crossing a tributary of Duck Creek;
- A 150m long bridge starting at 21845m, crossing a tributary of Duck Creek;
- A 160m long bridge starting at 22780m, crossing a tributary of Duck Creek;
- A 260m long bridge starting at 23550m, crossing Cannons Creek.

These bridges will follow the horizontal alignment of the Main Alignment. This section finishes at 24900m.

The Takapu Road electricity substation is located to the south of Cannons Creek. The land is predominantly rural pasture land; a large portion is owned by GWRC and operated by Landcorp and is part of Belmont Regional Park. There is an historic sheep dip located to the west of the substation. The highway will be located downgradient of the former sheep dip site and is approximately 10m lower in elevation than the former sheep dip site. The highway construction will primarily involve fill activities.

Section 9: Linden (Station 24900 to 27900)

This southernmost section is approximately 2.8km long. From the start of the section at approximately 24900m, a third lane will be provided in the northbound carriageway heading uphill.

There will be two bridges:

- A 50m long bridge starting at 25790m, crossing an unnamed stream that flows into the Onepotu arm of the Porirua Harbour;
- A 90m long bridge starting at 26010m, crossing an unnamed stream that flows into the Onepotu arm of the Porirua Harbour.

The Kenepuru Interchange will be located at approximately 26700m. This interchange will involve the Main Alignment being elevated above a roundabout which will connect to the Kenepuru Link Road.

South of the Kenepuru Interchange, the Main Alignment will continue downhill to where it will tie into the existing SH1 along the Tawa straight. For traffic joining the Main Alignment in a northbound direction, the carriageway will be elevated and will pass over the existing southbound SH1 carriageway. Traffic continuing to Porirua will be able to do so by taking the left lane exit from the existing SH1.

The Porirua Gun Club is located near Station 25000 and is a site of potential concern. The highway construction in this area will involve substantial cuts along the northern side of the Gun Club.

There are no other sites of potential concern along the section; however, SH1 will be raised to accommodate the flyover bridge near the Kenepuru Link Road. Additional land contamination investigation work was conducted along SH1 and is discussed in a separate letter report.

The Kenepuru Link Road

The Kenepuru Link Road will provide a connection from the Main Alignment to western Porirua. This link road will provide a connection from the Kenepuru Interchange to the existing Kenepuru Drive and will be approximately 600m long. There will be a roundabout at the intersection with Kenepuru Drive. The Kenepuru Link Road will be a State highway designed to the following standards:

- Two lanes (one in each direction);
- Design speeds of 50 km/h;
- Maximum gradient of 10%; and
- Limited access only.

The Kenepuru Link Road will run under existing SH1 and will be bridged over the NIMT.

Previously, SH1 was to be lowered and the Kenepuru Link Road connected by a bridge over the Lewis's Fabric facility. This change to the highway design occurred in December 2010 and the findings of a full Stage 1 environmental assessment of the area will be addressed in a separate letter report.

The Porirua Link Roads

The Porirua Link Roads will connect the Main Alignment to the eastern Porirua suburbs of Whitby and Waitangirua. The Porirua Link Roads will be local roads designed to the following standards:

- Two lanes (one in each direction);
- Design speeds of 50 km/h;
- Maximum gradient of 10%; and
- Some side access will be permitted.

The Waitangirua Link Road will be approximately 2.5km long will run from the James Cook Interchange to the existing intersection of Niagara Street and Warspite Avenue. This will be a signalised intersection. The Waitangirua Link Road will cross five waterways. The most significant of these will be a crossing of Duck Creek requiring a culvert. The Waitangirua Link Road will link into the western side of the James Cook Interchange.

The Whitby Link Road will be 0.9km long and will run from the existing roundabout at the intersection of James Cook Drive and Navigation Drive to the Waitangirua Link Road. The new intersection of the proposed Waitangirua and Whitby link roads will be an unsignalised T-intersection with traffic from the Whitby Link Road giving way to Waitangirua Link Road traffic.

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3. Stage 1 land contamination assessment

3.1 Introduction and background

The Stage 1 land contamination assessment consisted of:

- Review of existing information regarding topography, geology, soils, hydrology, hydrogeology, groundwater usage, climate, services and zoning
- Review of current and historic title records
- Review of historic and current aerial photos
- Review of available Council records
- Site reconnaissance, including two site tours and individual site visits
- Interviews with persons knowledgeable of the sites

The results of these activities are presented below, along with a summary of findings. The findings were utilised to identify potential contaminants of concern, develop site conceptual models and undertake a qualitative risk evaluation which are presented in ***Section 4*** of this report.

3.1.1 Overview

The Transmission Gully highway route is approximately 27 km long. Three businesses, Sang Sue Market Garden, former Golden Coast Nurseries and Car Haulaways Ltd, are located just south of MacKays Crossing. MacKays Crossing was also used for military purposes in the 1940s and 1950s and there is a potential that UXO is present.

Pauatahanui Inlet Garden Supplies is located at the SH58 interchange. The Porirua Gun Club is located along the route to the east of Porirua. One confirmed and one suspected historic landfill are located east of Porirua. There is one confirmed sheep dip present upgradient of the route and there is a suspected former sheep dip present near Battle Hill Farm Forest Park.

There are commercial operations located at the end of the Waitangirua Link Road and the Kenepuru Link Road.

The remainder of the site is largely comprised of greenfields (i.e., grazing land), which varies from flat paddocks to narrow valleys with steep hills on either side.

3.2 Topography, geology and soils

The Transmission Gully route traverses a wide range of topography, which is briefly described below.

Greywacke bedrock underlies the entire length of the route. In some sections, varying thickness of old and recent alluvium, estuarine, dune, loess, fan and colluvium deposits overlie the bedrock (NZTA, 2009). Additional detail is provided in this section.

As described in Section 2, the route is divided into 9 sections as shown in the plan set. Each section has distinct terrain and geomorphological characteristics.

A general description is provided in this section. The Draft SAR prepared for the Transmission Gully project should be referred to for more detailed and definitive information regarding site topography, geology and soils. The information provided in this section has been compiled from the Draft SAR (NZTA, 2009), the Draft Annual Groundwater Monitoring Report Jan 09 to Jan 10 (Opus, 2010),

borehole logs from the geological investigation conducted during the SAR stage of the project and information gathered during site visits. Note that additional intrusive geotechnical investigations were not conducted during this phase of the Transmission Gully Highway project as investigations were conducted as part of the Draft SAR phase. For each of the sites of concern, borehole logs were retrieved for the nearest piezometer that was installed as part of the Draft SAR process. These borehole logs were reviewed as described in the following sections.

Section 1: MacKays Crossing (Station 00000 – 03500)

This section is generally characterised by low flat sand dunes and inter-dunal soft ground with outwash alluvial fan deposits at the northern entrance to Transmission Gully. The Ohariu faultline is located on the eastern side of the section while a landslide area exists on the hillside to the southeast of Car Haulaways (NZTA, 2009). The Sang Sue Market Garden, former Golden Coast Nurseries and Car Haulaways sites are located in this section. This is also the section that was subject to past military activities that may have resulted in the presence of UXO.

The borehole log prepared by Opus for the Draft SAR was retrieved for BH 79, located at Station 1650, near the Sang Sue Market Garden. The top 3 m of soil is described as fine to medium dune sand. This is underlain by alluvium, comprised of sandy fine to medium gravel and gravelly medium to coarse sand to 11 m below land surface. From 11 m to approximately 15 m below land surface, the soil is described as fine sand with some gravel and shell fragments, with the geology described as marine sands and gravels.

The borehole log prepared by Opus for the Draft SAR was retrieved for BH 06, located at Station 2150, near the Golden Coast Nursery. The upper 3 m (below land surface) is characterised as coarse gravels with minor sand. From 3 m to 11 m below land surface, the soil is described as silty gravel. The geology from ground surface to approximately 11 m below land surface is described as Holocene Alluvium. This is underlain by Pre-Holocene Alluvium to approximately 17 m below land surface. Pre-Holocene marine sands are present from approximately 17 m to 24 m and Wellington Greywacke is present below 24 m.

Section 2: Wainui Saddle (Station 03500 – 06500)

This section extends from the foot of the Te Puka Stream to the south side of the Wainui Saddle. The Te Puka Stream valley runs in a north-south direction, falling steeply to the north from Wainui Saddle. The valley is flanked by steep Greywacke slopes rising to altitudes in excess of 400 m. The Wainui Saddle has an altitude of approximately 275 m. The Ohariu faultline is sub-parallel to the route, following the floor of the valley over much of the section (NZTA, 2009).

Section 3: Horokiri Stream (Station 06500 – 09500)

The Horokiri Stream in this section runs in a north-south direction, descending to the south steeply at first from Wainui Saddle, then flattening to a more moderate grade near Battle Hill. The valley in this section is relatively narrow and flanked by steep Greywacke slopes. A splinter fault to the Ohariu faultline traverses the western side of the valley for a length of approximately 2 km from the Wainui Saddle southwards (NZTA, 2009).

Section 4: Battle Hill (Station 09500 – 12500)

The Horokiri Valley floor widens from north to south through the Battle Hill Farm Forest Park. The valley is flanked by Greywacke slopes. Trace remnants of older gravel deposits are present along the east side of the valley. The former stockyard site is located in this section. The borehole log for BH 57 prepared by Opus as part of the Draft SAR was reviewed. The top 0.5 m is characterised as topsoil. From 0.5 m to 3 m below ground surface, the soil is described as coarse sandy fine to medium gravel alluvium. This is underlain by sands and gravels, described as Holocene alluvium to a depth of approximately 12 m. From 12 m to 29 m below land surface, the geology is described as Pre- Holocene alluvium, with sands and gravels. The soil below 29 m is described as weathered sandstone, with the geology described as Wellington Greywacke.

Section 5: Golf Course

This section is generally characterised by gently rolling terrain with a number of older terrace gravel deposits overlying Greywacke bedrock.

Section 6: SH58 (Station 15500 – 18500)

This section extends through rolling rural and rural residential land north of SH58, crosses SH58 and a low-lying estuarine plain associated with the Pauatahanui Inlet, then climbs the moderately steep weathered Greywacke terrain to the south. The Pauatahanui Inlet Garden Supplies facility is located in this area and is situated adjacent to Pauatahanui Stream, off Bradey Road at SH58.The borehole log for BH 01, located at Station 17680, prepared by Opus for the Draft SAR was reviewed. In the first 2 metres, samples were not recovered. Sandy fine gravel with some silt, becoming more dense and silty with depth, is present from 2 m to 4 m below land surface. This is underlain by silty gravel to a depth of approximately 10 m, where clay is present. In general, the upper 10 m are characterized as Holocene alluvial deposits and from approximately 10 m to 24 m, the geology is characterized as alternating marine/alluvial deposits. The material below approximately 24 m is characterized as Wellington Greywacke.

Section 7: James Cook (Station 18500 – 21500)

The route in this area flanks a significant tributary of Pauatahanui Stream adjacent to Bradey Road, rising to a saddle with the Duck Creek Valley. The route then follows the east side of Duck Creek valley, crossing a number of steeply-incised tributary streams. The Moonshine faultline is located in Duck Creek Valley.

Section 8: Cannons Creek (Station 21500 – 24900)

This section runs along the eastern side of Duck Creek Valley and across an undulating, weathered Greywacke plateau between Duck and Cannons Creeks. The route crosses the deeply-incised Cannons Creek at the southern end of the section. The GWRC sheep dip site and Transpower Takapu Substation are located in this area. The borehole log for BH40, located at Station 23990, prepared by Opus for the Draft SAR, was reviewed. The top 1 m is described as topsoil comprised of brown silt with some clay and minor sand. From 1 m to 3 m, the soil is described as brown silty clay with the geology described as alluvium. The soils below 3 m are described as weathered sandstone and mudstone, with the geology characterised as Wellington Greywacke.

Section 9: Linden (Station 24900 – 27700)

The route in this area continues from Cannons Creek along the moderately steep northeast- then northwest-facing flanks of a broad ridgetop, crosses a number of steep gullies and ends in the gentle slopes of the Porirua Stream Valley at Linden. The Porirua Gun Club is located in this area. The borehole log for BH 28, located near the Porirua Gun Club at Station 25040, prepared by Opus for the Draft SAR was reviewed. The top 2 m is characterised as fill material consisting of clayey silt and silt. From 2 m depth, the soil is characterised as weathered siltstone and sandstone, with the geology described as Wellington Greywacke.

3.3 Hydrology, hydrogeology and groundwater usage

3.3.1 Hydrology

The Transmission Gully route traverses three watersheds:

- The Wainui watershed with a combined area of 670 ha that discharges to the Kapiti Coast through Queen Elizabeth II Regional Park. It includes the Wainui and Te Puka Streams
- The Pauatahanui watershed has an area of 10,640 ha and includes six sub-catchments – Kakaho Stream, Horokiri Stream West Branch, Horokiri Stream East Branch, Ration Stream,

Pauatahanui Stream and Duck Creek, all of which discharge into the Pauatahanui Inlet. The Transmission Gully route passes through the Horokiri East Branch, Ration and Pauatahanui Streams and Duck Creek catchments

- The Porirua watershed has an area of 5,325 ha and includes Kenepuru Stream and its smaller tributary Cannons Creek. These flow into Porirua Stream

Hydrologic studies have been undertaken as part of the Transmission Gully Highway Project Phase 2 Investigation; the report produced from these studies (SKM, 2010) provides additional detail regarding site hydrology. As part of the Project water quality study, surface water samples were collected directly upstream and downstream from the Pauatahanui Inlet Garden Supplies site.

With regard to the samples collected from downstream of the Pauatahanui Inlet Garden Supplies site, median total and dissolved metal concentrations were below guideline values, except for total copper. Total copper was consistently above the guideline value during all "wet" season samples from this site. in all instances, the dissolved metal concentration was below the respective guideline value (i.e., ANZECC Water Quality Guideline for protection of 95% of freshwater species). Total median phosphorus and dissolved reactive phosphorus concentrations were above guideline values for both upstream and downstream sampling sites (information from SKM, 2010).

The GWRC gathers State of the Environment water quality data at Elmwood Bridge, which is between the locations sampled as part of the Transmission Gully Highway Project. The GWRC data indicates good water quality with median values for most parameters within guideline values.

Information obtained to date (November 2010) does not indicate the presence of any substantial surface water contamination. The 2010 study has shown that copper and zinc are present above background concentrations in the more developed urban areas (such as Porirua); however, they are not traceable to a point source (e.g., such as the Porirua Gun Club) but appear to be indicative of typical urban runoff (SKM, 2010).

3.3.2 Hydrogeology

As part of the development of the Draft SAR, geotechnical investigations were undertaken between August 2007 and April 2008. Boreholes were advanced to obtain cores which were logged and piezometers were installed in the majority of the boreholes to enable groundwater levels to be monitored. In addition, 177 trial pits were excavated together with 15 hand auger holes which were all logged on site. Six fault trenches were excavated to better locate the Ohariu fault north of the Wainui saddle and to investigate a splinter fault south of the saddle.

According to the Draft SAR, within the slopes above the main valleys, groundwater levels are typically about 10 m to 20 m below ground level, but depths of 35 m or greater were evident in some areas. However, surface water is apparent along the route as expressed by the numerous streams.

GWRC staff were contacted to conduct a bore search within a 1 km radius of the sites of interest. Information provided in the bore search includes distance and direction of bores to the boundary of the sites of interest, bore depth, groundwater use and aquifer type where available. The results of the bore search are provided in ***Table 16.3, Appendix 16.B***.

Information provided by the GWRC bore search for the Section 1 area (McKays Crossing) revealed that gravel, silt and sand deposits typically host the Kapiti groundwater system. These deposits form a thick sequence of aquitards and aquifers underlying the sites of interest (Car Haulaways Ltd, Sang Sue Market Gardens, former Golden Coast Nurseries). Groundwater level varies in this area and depends on which aquifer is considered. However, groundwater is generally abstracted from between 8 m to 31 m depth below ground surface. Groundwater is used for potable supply as well as irrigation. Several bores have been installed at MacKays Crossing for the purposes of geological research.

The Kapiti Coast District Council currently abstracts groundwater from an 18 m to 23 m deep semi-confined aquifer, directly adjacent to the former Golden Coast Nurseries, for public water supply.

The bore search did not identify any bores within a 1 km radius of the following sites:

- Pauatahanui Inlet Garden Supplies
- Porirua Gun Club
- Transpower Substation site
- Former GWRC Livestock Dip site
- Pauatahanui Golf Club site

As part of the Transmission Gully Project, NZTA has undertaken monitoring of numerous piezometers adjacent to the route and a draft report has been developed (Opus, 2010) which provides additional detail regarding groundwater levels along the route. Intrusive geotechnical investigations have not been undertaken as part of the current phase of work for the Transmission Gully Highway Project. The information presented in the table below is from the Draft Annual Groundwater Monitoring Report Jan 09 – Jan 10 (Opus, 2010). Where two Piezometer Reference values are given in the table, nested piezometers are indicated.

Nearest Site of Potential Concern	Station Value	Piezometer Reference	Final Dipped Depth (m)
Sang Sue Market Garden, Former Golden Coast Nurseries, Car Haulaways	2150	6A	14.04
		6B	3.55
Former Stockyard Site	9890	57A	29.16
		57B	9.00
Former Stockyard Site	9880	60A	5.25
Pauatahanui Inlet Garden Supplies	17860	1A	29.1
		1B	6.07
GWRC Former Sheep Dip Site	23990	40A	36.52
Porirua Gun Club	25040	28A	34.19
		28B	17.28

3.4 Climate

Climate data was obtained from the NIWA climate database. Information was available from Porirua from 1951 through 2000. Total rainfall, mean air temperature and mean daily maximum and minimum air temperature, averaged over a 30 year period, were available and are summarised below.

- Total average rainfall ranged from 1971 mm/annum (averaged over the period from1951 – 1980) to 2015.4 mm/annum (1971 – 2000)
- Mean air temperature ranged from 11º (1951 – 1980) to 11.3ºC (1971 – 2000)
- Mean daily maximum air temperature ranged from 16.3ºC (1951 – 1980) to 16.6ºC (1971 – 2000)
- Mean daily minimum air temperature ranged from 5.8ºC (1951 – 1980) to 6ºC (1961 – 1990 and 1971 – 2000)

It should be noted that because of the length of the route and changes in topography, there are numerous microclimates along the preferred alignment, with temperatures being more moderate at sea level.

3.5 Buildings

Most of the parcels are unoccupied; however, a description of the buildings present is provided with descriptions of individual sites.

3.6 Storage tanks

Storage tanks are addressed on a property-by-property basis.

3.7 Services

Most of the property titles reviewed included easements for conveyance of electricity, water and/or sewage. Several also included easements for a natural gas pipeline.

As noted in the Draft SAR, trunk or transmission mains for electricity, water and gas are affected by the Transmission Gully route. Local distribution networks for electricity and water at MacKays Crossing, SH58 and Linden are also affected where the Transmission Gully route connects to the existing road network. The information below is from the Draft SAR and is supplemented by information gained during three site visits conducted to date.

Electricity

There is a high voltage (110kV) transmission line running along most of the length of the Transmission Gully corridor from MacKays Crossing in the north to the Takapu substation in the south. This 110kV line is duplicated northwards from a small substation located to the west of Car Haulaways. From this substation southwards, the 110kV line is carried on towers that are generally located in the floors of the Te Puka and Horokiri Stream valleys, as far as Battle Hill. South of Battle Hill, the line runs across rural land and the Pauatahanui golf course, turning southwest near SH48 to link into the Pauatahanui substation. South of SH58, the line runs along the ridge between the Transmission Gully route in the Duck Creek Valley and Porirua East. The line then crosses the Transmission Gully route at Cannons Creek and to the Takapu substation.

Several other high voltage lines converge on Takapu substation in this area, notably, a 220kV line that connects to the substation from the east. This is the only 220kV transmission line noted by the Draft SAR in the Transmission Gully corridor.

Water

The Te Marua to Porirua water supply pipeline crosses the Transmission Gully route in three locations:

- At the proposed James Cook Interchange where the supply is carried in two (more or less) side-by-side pipes. The pipes run from the east across the Transmission Gully route toward Waitangarua, with a branch-main supplying water to the Whitby area
- Approximately 1,300 m south of the James Cook Interchange where the pipe crosses from the east and then swings south to follow the floor of the Duck Creek Valley as far as Cannons Creek
- At Cannons Creek where the pipe following the floor of the Duck Creek Valley crosses the route down Transmission Gully

Gas

The Kapuni and Maui gas supply pipelines feature along much of the Transmission Gully route. At the north end, gas pipes follow the existing SH1 from MacKays Crossing to the west of Te Puka

stream and then turn south, climbing the ridge to the west of the Transmission Gully route. The pipes remain on the west side of the corridor through Battle Hill before crossing to the east side and back to the west near the Pauatahanui golf course, to the east and back to the west again approximately 1.5 km north of SH58.

A gas pipeline follows SH58 from west to east across the Transmission Gully route before turning south to climb toward the site of the James Cook Interchange, generally along the line of the route. South of the James Cook interchange, the pipe divides, with one pipe running to the east of the route and the other to the west.

A gas pipeline crosses the alignment in two further locations, once at approximately 1.8 km north of Cannons Creek bridge and then at Cannons Creek itself.

Other services

Other services in the area include fibre-optic cables, underground power cables and street lighting. These are present primarily at areas where the Transmission Gully route intersects with the local road network.

3.8 Property title records

Historic land ownership from title records has been reviewed to obtain evidence of previous land uses on the various parcels of land as the occupation of land owners is often included. While an occupation does not necessarily denote land use for a property, it can give an indication of potential land use. Site ownership information was gathered from title records and is summarised in ***Table 16.1*** in ***Appendix 16.B***. ***Table 16.1*** also provides comments which indicate which sites were identified as sites of concern during the Stage 1 environmental assessment and addresses are provided where available.

Most of the properties are owned by individuals or Councils. Some parcels have been purchased by the government, with the owner listed as the Crown. The majority of the parcels owned by the Crown are listed as “for use as a road” (or similar). Copies of title records are provided in ***Appendix 16.C***, on a CD accompanying this document.

3.9 Historic aerial photographs

Historic aerial photographs were obtained from NZ Aerial Mapping Limited and Opus International Ltd (Opus). The latest satellite imagery was also obtained from Google Earth and was included in the review.

Historic photographs were available dating from circa 1941, 1942, 1956, 1966 and 1988. Google Earth and Opus photos were dated 2009 and 2006, respectively.

The findings of the historic aerial review are presented in ***Table 16.4*** in ***Appendix 16.B*****.** Copies of the historic aerial photos are provided in ***Appendix 16.D***.

For the most part, the land was open space or grazing land in the 1956 photos. Development is shown in some photos in 1996 and the 1998 photos are similar to today’s configuration for the sites of potential concern. The exception is the MacKays Crossing area, where military operations are apparent in the 1940s, but the land has reverted to open space and grazing land by the 1960s.

3.10 Surrounding land use

For the majority of the route, the land use surrounding the highway is rural pasture land. There is some commercial development along the route, including the Sang Sue Market Garden, Car Haulaways and Golden Coast Nursery sites, Pauatahanui Inlet Garden Supplies site, former stockyard site near Battle Hill, GWRC sheep dip site and Porirua Gun Club site. Only the Sang Sue Market Garden and Porirua Gun Club are still in operation. The former stockyard site near Battle Hill

had cattle holding pens which are no longer present. A deer pen is still in place and may still be utilised. The Car Haulaways, Golden Coast Nursery and Pauatahanui Inlet Garden Supplies sites are owned by the Crown and the businesses are no longer operating. The GWRC sheep dip site has not been operational for a number of years and is part of Belmont Regional Park.

The northernmost Porirua Link Road traverses open space and terminates at Navigation Road, which is also an open space area. The southernmost Porirua Link Road traverses open space and terminates at Warspite Avenue. A Marae, Plunkett facility, electrical transformer, vacant lot and Mana Coach parking lot are present on either side of the planned link road at the western end.

The Kenepuru Link Road traverses open space and plantation forest and will "fly over" SH1 and the Lewis's Fabric facility, connecting with Kenepuru Road at the north-eastern end.

Table 16.2 in ***Appendix 16.B*** provides information regarding titles, parcel sizes, an overview of current and historic land use and a description of adjacent land use for each of the sites of concern.

3.11 Zoning

The zoning information presented below is from the Draft SAR. Note that zoning designations may change over time; therefore, this information should be considered a "snapshot" of site zoning.

Section 1: MacKays Crossing

The land within the vicinity of MacKays Crossing is zoned Rural in the Kapiti Coast District Plan. To the west of the North Island Main Trunk Railway, the land is zoned Open Space while Queen Elizabeth II Park is zoned as conservation. The market gardens and Car Haulaways are zoned for commercial use.

The District Plan lists future land use as low-density rural, with potential for higher density residential near the MacKays Crossing roundabout.

Section 2: Wainui Saddle

This section is within the jurisdictions of Kapiti Coast District, Porirua City and Upper Hutt City Councils. It is zoned Rural by all three authorities.

Section 3: Horokiri Stream

This section is zoned Rural within the Porirua District Plan.

Section 4: Battle Hill

All of the land within this section is zoned Rural within the Porirua District Plan, although a number of small-scale rural residential subdivisions are present.

Section 5: Golf Course

All the land in this section is zoned Rural within the Porirua District Plan, but there have been a large number of subdivisions granted within the area.

Section 6: SH58

Zoning in this section is a mixture of Rural and Suburban, with the suburb of Whitby forming the outer extent of the Suburban zone. However, the Wellington Regional Strategy has identified this area as likely to come under pressure for development, so additional Suburban and/or urban zoning may be forthcoming in the future.

Section 7: James Cook

The majority of this section is zoned Rural in the Porirua City Plan, although a small area of Suburban zoning encroaches above James Cook Drive.

Section 8: Cannons Creek

The land in this area is generally zoned Rural. However, Warspite Avenue is zoned Residential. Belmont Regional Park is also in the area.

Section 9: Linden

The whole of the section is zoned Rural in the Porirua City and Wellington City Plans. Where the Transmission Gully Highway joins the existing SH1, the land use is predominantly open space and residential and along Kenepuru Drive the land use is large commercial and light industrial.

3.12 Council records review

In line with the scope of work for this assessment, a review of Council records has been undertaken. The following Councils were contacted:

- Wellington City Council
- Porirua City Council
- Kapiti Coast District Council
- Upper Hutt District Council
- Lower Hutt District Council
- GWRC

A list of the parcels along the preferred alignment was provided to the Councils (as applicable) and a request for any relevant records was made. As part of this request, the Selected Land Use Register (SLUR), held by the GWRC, was checked to assess whether any property within the preferred alignment was listed as a potentially contaminated site.

A summary of information from the Council records request is provided below. ***Table 16.5*** in ***Appendix 16.B*** provides an overview of findings from Council records. Copies of the records obtained are provided in ***Appendix 16.C***, which is provided on a CD accompanying this document.

3.12.1 Queen Elizabeth II Park and MacKays Crossing area

Council records indicate that “significant finds of stray ammunition” have been found in the park. A detailed study was conducted by MWH and reported in April 2001; the report is included in ***Appendix 16.C*** on a CD accompanying this report. There appears to be potential for UXO in the area of MacKays Crossing; in addition, metal contamination (lead, iron, copper) was detected in water samples from the area.

The MWH report also identified landfills within the area; however, they appear to be north and west of the Transmission Gully preferred alignment.

A second MWH report dated September 2001 (see ***Appendix 16.C*** on attached CD), makes recommendations for further investigation. However, no records of additional investigation were provided by the Council.

The site is listed on the GWRC SLUR.

3.12.2 Former Golden Coast Nurseries

Information obtained for the former Golden Coast Nurseries site comprised an inventory of sprays and chemicals stored on-site and a brief report on the removal of an underground storage tank (UST), including laboratory results.

The 9,000 litre diesel UST was removed in December 2009 by Mansfield Installation Ltd. Soil samples were taken by Mansfield Installation Ltd. on behalf of the land owner. The results indicated that there was no contamination present above commercial/industrial risk based guidelines. Numerous photographs were supplied and a conversation with GWRC indicates that they are satisfied with the laboratory results, which were provided by an IANZ accredited laboratory.

Sprays and chemicals stored on-site included insecticides, fungicides, miticides, herbicides and other miscellaneous chemicals (Thrive, silver nitrate, etc.).

3.12.3 Car Haulaways Ltd Site

The Car Haulaways Ltd site is listed on the SLUR as a "service station – public/private transport operation." The Council information indicates that a UST was removed in 2003 and residual contamination is below commercial/industrial risk based guideline concentrations. It also reports that an AST is present and had not been investigated.

The UST removal was conducted by MWH under the direction and supervision of Shell Oil Company. MWH did not note the presence of fill material and their report indicates that it is not likely that fill material was imported onto the site. The report indicates that samples were collected under MWH protocols and analysed by an IANZ accredited laboratory. While some residual hydrocarbons were detected (see report in ***Appendix 16.C***), concentrations were below commercial/industrial risk based guideline values.

A letter from Occupational Safety and Health (OSH) Service was also provided. The OSH letter gives permission for filling a "2,000 above ground 3(a) tank from a farm delivery tank wagon." This letter indicates that Kapiti Coast District Council is to provide licensing and approval for the facility.

Photos of the area from where the UST was removed and the current AST were also provided. Note that a subsequent letter report was provided by Council indicating that the AST had been properly removed.

3.12.4 Mana Coach Services

Council records included an application for the renewal of a dangerous good license and information related to the removal of a UST. The dangerous goods license renewal application is not dated, but requests permission for the storage of fuel oil and compressed gases, such as acetylene.

The UST was removed in April 2004, with oversight provided by URS Corporation. The URS letter report was provided by Council, along with a letter indicating that PCC was satisfied that there was no contamination present above commercial/industrial risk based guidelines. The UST was located within the workshop, approximately 90 m away from the proposed highway footprint. According to the URS report, no soil above guideline values was left on site. Another UST is shown on drawings accompanying the report. This diesel fuel UST is located south and east of the workshop where the removed UST was located, approximately 85 m from the highway footprint. No additional information on this UST is provided in the report; an additional check of Council records also provided no additional information. Therefore, it is assumed that the tank is still in use. It should be noted that the UST is downgradient of the highway footprint.

3.12.5 Pauatahanui Inlet Garden Supplies

Council records provided included the Planning Report (2001) and hazardous substances inventory list. No additional information was provided.

3.12.6 Transpower Substation, 35 Paremata Haywards Rd, Pauatahanui, Porirua

This Pauatahanui substation site is listed on the SLUR as a Power Generation/Distribution – Substation. Council records state that Transpower has no record of contamination or remediation at this site.

3.12.7 Transpower Substation, 530 Takapu Road

The site at 530 Takapu Road is a Transpower substation and is listed on the GWRC's SLUR as a Power Generation/Distribution – Substation. Council records state that Transpower has no record of contamination or remediation at this site.

3.12.8 Ribbonwood Tce landfill

Council records indicate that an historic landfill was located at Lot 6 DP 78422 with an address of 0 Ribbonwood Tce. However, title records indicate that the address for Lot 6 DP 78422 is 30 Ribbonwood Tce and that the property is owned by Her Majesty the Queen.

The Council record indicates that the property is on the SLUR as a Landfill – General Landfill Sites.

The letter states: "Porirua East landfill is a small landfill. No other information about the type of waste taken or years of operation is held by GWRC".

Porirua City Council was contacted regarding this landfill. There is limited information available; a drawing showing the approximate location was provided and is included in ***Appendix 16.C*** (Council Records) of this report. It is theorized that this landfill was a small private landfill as there are no Council records available for the site.

3.12.9 Sievers Grove Landfill

The Sievers Grove landfill, Cannons Creek, Porirua, is listed as an historic landfill on the GWRC SLUR. The legal description provided is PT Lot 1 DP 28193 Lot 1 DP 33453-Porirua Park. The letter states:

"It was opened in 1954 and closed in 1976 taking mainly industrial waste. Monitoring of surface water quality was undertaken from early October 1996 until August 1997 by Greater Wellington. Leachate of iron was noted - but thought to be attributed to naturally high iron levels in the area. In 2000 Porirua City Council was intending to monitor the landfill.

A query of the records indicated that these results are not held by GWRC. The site is currently used as a sports playing field and plant nursery. Porirua City Council provided a map of the location of the former landfill. It is outside the footprint of the Transmission Gully Highway footprint and significantly downgradient of the highway.

3.12.10 Takapu Road former sheep dip sites

A Council letter and portions of a URS report indicate that there are two possible former sheep dip sites located on Takapu Road. One is located at 523 Takapu Road, the other 282 Takapu Road. The URS report indicates that there are visible remnants of the former sheep dips at both sites. The sheep dip site at 282 Takapu Road reportedly served the Takapu Valley. This site is not within the Transmission Gully footprint. It is located south and east of the highway in a valley and is not upgradient of the highway. Based on its location and large distance from the highway, additional consideration and investigation of the site is not warranted.

However, the former sheep dip site at 523 Takapu Road is directly upgradient of the highway footprint and therefore requires additional investigation. Throughout the remainder of this document, the 523 Takapu Road sheep dip site is referred to as the GWRC former sheep dip site.

3.13 Site visits and interviews

Site visits were conducted in August, September and December 2009, and February 2010. The site visits undertaken included tours of the entire route and reconnaissance visits to individual properties. In addition, interviews were conducted with persons with knowledge of the site. These are described below.

3.13.1 Initial site visit

On 23 August 2009, Aurecon attended a tour of the site of the Transmission Gully project. Consultants for all work streams met at NZTA offices. After a brief introduction, consultants left the offices to view the proposed Transmission Gully route in a Unimog off-road vehicle. Due to property owner and land entry issues as well as inclement weather which made driving some sections of the proposed route impractical, not all sections of the proposed route were viewed. ***Appendix 16.E*** contains a photo summary from the initial site tour.

The first section viewed was the northernmost section, which begins at MacKays Crossing. Access was gained through the Perkins farm property. Steep, hilly, heavily vegetated terrain and some landslide areas are located adjacent to the proposed route (Photos 1 and 2). The next viewing point was near Wainui Saddle which is the highest point of the proposed route. The area consists of rolling hills that are open and grassy (Photos 3 and 4).

Due to land entry and weather issues, a portion of the route was not included on the tour and the next viewing point was Battle Hill. Battle Hill Forest Park is a GWRC park that is used for small farming activities as well as recreational opportunities such as walking, horseback riding and mountain biking. A talk with one of the rangers at the park conveyed that only pesticides readily available from retail stores (e.g., Round-Up) are currently used; he knew of no use of DDT or poisons in the past. Pest control at the site is conducted by trapping rather than through poisoning. Battle Hill Park is grassy and hilly; however, the area to the east of the proposed Transmission Gully route is heavily wooded (Photos 5 and 6).

The next viewing point was near Pauatahanui. The area is hilly and has numerous gorse shrubs as well as long and short grasses (Photo 7). Nearby is a commercial business which makes compost material from waste wood and other waste products (Photo 8). At the time of the site visit, Aurecon was informed by NZTA that there was a potential for contamination due to chemicals at the site.

Near the Whitby/Waitangirua Interchange is a residential area with vegetated (gorse, forest, tall grasses) green spaces between houses (Photos 9 and 10). Further south is higher density residential neighbourhoods as well as commercial businesses.

3.13.2 September 2009 site visit

On 9 September 2009, a preliminary site visit was conducted of several sites along the route, including several that were identified as having potential interest from a contaminated land perspective: MacKays Crossing area, Pauatahanui Inlet Garden Supplies, Jalal site and Ballinger Industries Ltd. The MacKays Crossing area was known to contain potential UXO. The Pauatahanui Inlet Garden Supplies site was believed to have on-site fuel storage. With regard to the Jalal and Ballinger Industries sites, the type of operation conducted was unknown and needed to be verified.

At the time of the site visit, site access was not available to these areas. Therefore, pictures were taken of the site from accessible areas (i.e., the road or car park) to give a rough indication of the land use and to help evaluate the potential for contamination at the site. Photos are included in ***Appendix 16.E***.

East of existing SH1

Section 5 SO 404046, Lot 2 DP 10816 and Pt Section 1 SO Plan 36580

This area is located east of the existing SH1 and appears to be pasture land. The area is covered with stands of trees, grass and gorse bushes and appears to be used for sheep grazing (Photos 11-13). Some structures are present near the road and are assumed to be associated with sheep grazing.

Lot 1- 2 and 4 DP 71816 (Van Cruchten)

This area is used for sheep grazing (Photos 14 to 16). Animal pens, animal sheds and residential houses are located on the site. In addition, piles of lumber and rusty materials (i.e., drums or metal frames) appear to be deposited on site.

Lot 1 DP57703 (Baxter)

This site appears to be used for sheep grazing with grassy paddocks and a residential house located towards the northeast portion of the property (Photo 17).

Lot 1 DP 53032 (Car Haulaways)

This site is fenced with a wire chain link fence with wire at the top. It appears to be used to store vehicles. The ground is either paved or gravelled although there were patches of grass observed (Photos 18 to 20).

Lot 1 DP 47726 (Liss)

Multiple greenhouses could be seen at this property (Photo 20). Two business signs were near the entrance to the site: Golden Coast Nurseries and Acacia Joinery (Photo 21).

Lot 2 DP 87790 (Walker)

Forest is present at the portion of the site nearest the existing SH1.

Pt Lot 2 DP 4269 (Perkins)

Residential houses, farm buildings and grassy paddocks were located on this site (Photos 22 – 24). The farm buildings appear to be stables and associated sheds as horses were observed around the area. However, there were two buildings located further southwest of the stables that appeared to be used for businesses. For these buildings, a digger, an AST on a trailer, drums, reservoirs and tools could be seen around the building. A sign at one of the buildings read “Continuous Spouting”.

West of existing SH1

Section 101 Blk 11 Paekakariki SD and Lot 1 DP 52615

To the west of the existing SH1 is predominantly a grassy, open area, with some stands of trees. The railway line is located to the northwest (Photo 25). In Lot 1 DP 52615, there is a small family cemetery (six headstones) located near the road (Photo 26).

Pt Lot 4 DP 714 (Riepen)

From observations made from the road, this site appears to be primarily pastoral land for raising and grazing horses.

Pt Lot 4 DP 4269 (Sang Sue Ltd)

A vegetable market is located at this site (Photos 27 to 29). The majority of the site is used for growing crops (market garden). The car park for the market is paved and there are mounds of soil and gravel located near the southwest boundary. Behind the buildings, which are beyond the designation, the area was overgrown and wooden boxes, tyres, machinery, drums (which appeared to be petrol or oil) and a steel reservoir tank could be seen (Photo 28).

Pt Lot 5 DP 4269

This site is predominantly used to graze sheep. A drain or stream bisects the site with some slightly raised mounds of soil beside the drain banks (Photo 30). A fenced area for a Vector high pressure natural gas compound was located adjacent to the existing SH1 (Photo 31).

Section 4 SO 38167 (Pauatahanui Garden Supplies)

This site is located west of the intersection of SH58 and Bradey Road (Photos 32 to 34). On the site, there is one main building and two sheds associated with the business. There are storage areas for various sizes of gravel on the site. In front of the building appeared to be bags of fertiliser. The ground appears to be gravelled with various mounds of fill material located on site. To the north of the building area, the area is grassed but there was still evidence of mounds of fill material. In the back of the building area, there appeared to be an AST and a square reservoir.

Lot 1 DP 82381 (Jalal)

This area appears to be a residential site with a cleared rectangular area of bare dirt located west of the house. Horses could be seen grazing in the paddocks around the house (Photo 35).

Pt Lot 2 DP 48357 (Ballinger Industries Ltd)

This site houses a bowling alley. A paved parking lot surrounds the site with storage trailers located on the edge of the car park (Photo 36). The railway is located immediately east of the site.

3.13.3 December 2009 site visits and interviews

On the 7 and 8 December 2009, a site walkover was conducted of several areas of potential concern that were identified from the preliminary inspections and historic information. Site interviews were also conducted at this time. However, the sensitivity of the project and access constraints limited the amount of information able to be collected from site owners.

Walkover visits were conducted of:

- Sang Sue Market Gardens
- Pauatahanui Golf Course
- Pauatahanui Inlet Garden Supplies
- Porirua Gun Club

Several other sites were inspected from public rights of way. These included:

- Former Golden Coast Nurseries
- Kapiti Coast District Council water treatment facility
- Porirua City Council water reservoir site and leased property site
- Vector Limited substation site
- Mana Coach Services

Details of these site inspections are provided in the following sections. Photos are provided in ***Appendix 16.E***. It should be noted that during the December 2009 site visits, the exact Transmission Gully Highway alignment had not been established, nor was the amount of land expected to be included within the designation and potentially disturbed by construction. Therefore, whenever possible, the entire site was evaluated. Subsequent to the site visits and prior to implementation of the Stage 2 land contamination investigation, the highway alignment was established and the area of concern was adjusted to better match the actual alignment.

Sang Sue Market Gardens (Pt Lot 4 DP 4269)

The Sang Sue property covers an area of 22 hectares. The majority of the Sang Sue Market Garden site is covered with vegetable crops. The site also comprises a shop, located approximately 50 m from SH1 on the south western corner of the property. The majority of the non-horticulture operations appear to occur immediately behind the shop within a large shed, presumably used for packing and vegetable storage, in addition to a number of smaller lean-to type structures. A cool store is also in this location. The remainder of the site comprised primarily of vegetable plots, separated by drainage channels and wind breaks. Only the vegetable plots are within the Transmission Gully Highway designation.

The owner was not available for an in-depth interview at the time this report was developed; only a brief conversation was conducted and the items in the interview questionnaire were not addressed during the site visit.

The Sang Sue site is shown on ***Figure 16.1,*** in ***Appendix 16.A***.

Pauatahanui Golf Course (Lot 4 DP 337497)

A preliminary inspection of this site was undertaken on the 7 December 2009. Full access was not available at the time of the visit.

Preliminary observations indicate that the golf course site is kept in a tidy condition. Grass appeared to be very green and lush and well established vegetation (trees) lined the fairways. The golf course gently slopes to the west until it reaches a low point immediately below the Clubhouse and car park area. This is situated near the western boundary of the site.

A stream traverses the property, bisecting it from north to south, along the western third of the property.

Near the stream, but to the north of the Clubhouse is a large shed, presumably used for storing maintenance equipment and potentially fertiliser. No other sheds could be seen during the preliminary inspection. It is possible that pesticides may also be utilised at this facility; however, this could not be confirmed during the inspection.

Porirua Gun Club

The Gun Club site is less than 1 hectare in area. The majority of the site is grassed or covered in shrub, with areas of weathered bedrock exposed in parts. The site walkover revealed the following main features:

- The site has historically been excavated in two main areas to allow for a suitable area for a pistol range and a rifle range to be established. These excavations essentially split the Gun Club into two levels – an upper level (rifle range area) and lower level (pistol range and Clubhouse area)
- Six main structures currently exist on the site including:
  - Upper Level: a rifle range structure and bullet catch.
  - Lower Level: a clubhouse and toilet facility, clay target machine shed and two storage sheds.
- A 0.05 m piezometer was identified behind the rifle range. Its use is not known

- A large steel storage container (locked) was identified in between the rifle range and pistol range. The contents of the storage container are not known as it was not accessible during the site visit

Strips of concrete are located on the ground outside the Clubhouse on the lower level and are used as shooting stations for clay pigeon shooters. The concrete strips 'fan out' from the machine that releases the clay targets. This area of the site does not appear to have been in use for some time.

Numerous spent bullet casings, shotgun cartridges and broken clay targets litter the ground on the upper and lower level. Although spent bullet cases were prevalent over the entire site in question, the majority were found immediately in front of the rifle range and in a small steel enclosure near the pistol range. This steel enclosure appeared to be the location where spent shotgun cartridges were dumped and burned. In the vicinity of this steel enclosure are numerous wooden structures, spare targets and general rubbish.

An open drainage channel is evident at the base of an embankment, which drains runoff towards the gully.

The bank opposite the pistol range (within a 45 degrees range) is used for pistol shooting practice. This area is likely to contain significant amount of spent ammunition. A circular area of grass on this bank is discoloured and likely to be due to the pistol shooting.

The area (approximately 2 m^2) immediately outside the clay target dispensing shed is covered with broken clay targets, likely to have accumulated due to machine misfiring.

The area below the Clubhouse is dominated by rubbish comprising wire netting, old rubber tyres, metal frames, wooden frames etc. This area appears to have been excavated to form a flat site, potentially to allow for the discharge of wastewater from the nearby toilet facility. However, septic tank vents could not be found during the site visit. No other hazardous materials were observed. There was no sign of USTs or ASTs, significantly stressed vegetation, sumps, pits, or lagoons.

The only stains observed were at the location of the bullet disposal enclosure and minor vehicle leaks on the gravel parking area.

The features described above are shown on ***Figure 16.4, Appendix 16.A***.

Pauatahanui Inlet Garden Supplies

The site contains a single-storey aluminium building (approximately 8 m x 6 m), which has a concrete floor and is located approximately 60 m from SH 58 and 90 m from Bradey Road. Pauatahanui Stream is adjacent to the property along SH58.

The building is mainly used for sales, office space and storage for the business. At the time of the site visit a small number of 10 kg bags of gypsum soil conditioner were stored in the building along with items associated with the business such as signage, tools, hoses, minor amounts of paint, a fridge/freezer and furniture. An air compressor and two 20 L containers of engine oil were also present. Some dark coloured stains were noted on the concrete floor.

The building contains a canopy which provides cover for bagged (40 L) mulch, bark, topsoil, compost and wood. Whilst the building has a concrete floor, the ground surface under the canopy is primarily gravel.

Behind the building is a shed and attached caravan used as a temporary residential dwelling, an outhouse, a storage container and an elevated 1000 L water reservoir used for potable supply. An additional aluminium shed is located beside the building that is used for storage purposes. The general area behind the building has significant amounts of wood refuse, dog kennels, corrugated iron, old car seats and tyres and plastic bins and pipes. A large, well established Totara tree is located immediately behind the building and appeared healthy.

Adjacent to the building and storage shed was the footprint of an old AST. According to the lessee of the site, the AST was installed new and used for approximately 5 years before being removed in 2007. The AST stored 2000 L of diesel fuel and was housed in a steel bund to prevent accidental releases from occurring. The AST had a regular bowser to dispense fuel as required. Evidence of minor spillage of diesel, adjacent to the AST footprint, was noted during the site walkover. No major leakages of diesel were known to the lessee or observed during the site visit.

Approximately eleven "bins" are located on the site. The bins have been created by concrete blocks and it appears they can be moved as required. Each bin has a floor area of approximately 8 m^2. The bins contain river stone, rock and gravel of various sizes, soil and, lime chip. There is at least 30 m between the bins and the current waterway (Pauatahanui Stream). Piles of bark mulch, twig mulch, bark nuggets and compost are located in an open area closer to SH58. All material is placed directly onto the ground.

Runoff from the processing area is directed to an open drain bounding the northern side of the processing area. Runoff is then directed northwards through overgrown grasses, approximately parallel to SH58, where it ponds. It is likely that the drainage water eventually travels to the Pauatahanui Stream. According to the lessee, the ponded area remains saturated for about 9 months of the year but dries out during January, February and March. The drainage water in this area was relatively clear during the time of the site visit.

The area to the north of the building is used as a drying and storage area for firewood. At the time of the site visit, wood processing machinery was situated in this area. It is understood that the machinery was undergoing maintenance while business was slow. During the site walkover, empty diesel containers, old engines, one car battery, tyres and spare parts were noted lying on the ground. Minor dark staining of the ground was also noted.

The remainder of the site is predominately covered in various grass species as well as reeds in boggy areas. A prominent grass covered bund has been developed adjacent to the wood storage area running in a north-south orientation. It is approximately 80 m long, 5 m wide and 2 m high. It is understood that the lessee constructed the bund from fill material collected on site. Other smaller mounds of soil have been formed from fill material on site.

The features noted above are shown on ***Figure 16.7, Appendix 16.A***.

Kapiti Coast District Council (Lot 1 DP 87790 & Lot 3 DP 70122)

Lot 1 DP 87790 was evaluated from the road as access was restricted. The site comprised a water treatment plant within a concrete building and associated pipes, a high power transmission line tower and a diesel generator contained within a fenced compound. Signage on the water treatment plant indicated chlorine (2XE) was stored within the building. The site was in a tidy condition with no obvious signs of leakage. Lot 3 DP 70122 was not accessible during the time of the site visit. Subsequent to the site reconnaissance, it was discovered that this facility is not within the highway alignment.

Porirua City Council sites, Pt Lot 1 DP 3138, Lot 2 DP 30550

Two Porirua City Council owned sites were visited. The first was Pt Lot 1 DP 3138, which is a grassed area with a water reservoir and telemetry shed present. The reservoir comprises a cylindrical concrete structure located at the northern end of the property on a flat section of land. The telemetry shed is located approximately four metres to the north-east of the reservoir. The site is in a tidy condition; however it appeared that the telemetry shed has been subject to some minor vandalism. Grass surrounds the reservoir and telemetry shed and is in a healthy condition. Gorse dominates the remainder of the site. The majority of the land slopes to the north and west, with the exception of the area of land under the reservoir and shed which is flat.

The second is Lot 2 DP 30550, which hosts a Plunket facility and a Marae. From observations made from the road, the sites appeared in a tidy condition and vegetation (grass, shrubs and trees) surrounding the sites was healthy.

Vector Substation site, Lot 5 DP 3055

The Vector substation site on Lot 5 DP 3055 hosts a substation building on a grassed section surrounded by a chain link fence. Although access into the building could not be obtained, a concrete floor was exposed around the perimeter of the building. There was no evidence of spillage or leakage surrounding the building. In addition the surrounding grassed area was in a tidy, clean condition and vegetation appeared healthy.

Mana Coach Services

The Mana Coach Services site could not be inspected due to access constraints. However, partial inspection was undertaken from the adjacent reserve, located outside the site boundary. The following items were noted during the site visit:

- The site is occupied by:
  - an office building located at the northern end of the property
  - a storage container located in the centre of the property
  - a large building thought to be a bus repair workshop also located in the centre of the property, closest to Commerce Crescent
  - a bus parking area south of the buildings
- There are two entrances to the site, one at the north and one at the south end of the property
- The majority of the site is used as a parking area for buses and coaches
- The site is primarily covered with asphalt
- The site is elevated from Commerce Crescent with a retaining wall supporting the front of the property
- The site is surrounded by a high barbed wire fence
- Minor staining was observed in the bus parking area, most likely from vehicle leakage from parked vehicles
- Some scrap metal and old tyres were observed between the large building and the storage container, located adjacent to the fence beside Commerce Crescent

It should be noted that with the exception of the bus parking area at the south end of the property, the features mentioned above are well away from the Porirua Link Road and the area is downgradient of the road. The features mentioned above are shown on ***Figure 16.8, Appendix 16.A.***

3.13.4 8 February 2010 detailed site visits

Former Golden Coast Nurseries

The former Golden Coast Nurseries property houses glass houses, screened structures, a residence and Acacia Joinery. The site is fenced; there is a locked sliding gate just off SH 1, which is at the western boundary of the site. Features described below are noted on ***Figure 16.2, Appendix 16.A***. Site visit photographs are provided in ***Appendix 16.E***.

There are two glass houses present on the northern portion of the site immediately adjacent to the entrance. Beyond these two glass houses, there is a large glass house and office complex. Another glass house is present across a small dirt road within the property boundary (near the eastern

boundary of the site on the northern end of the site). Between this easternmost glass house and the large glass house and office building, there is a covered area with picnic tables present along the northern site boundary. East of the easternmost glass house is a small area with a concrete block wall on three sides. There was a chair and makeshift table present in the area.

A residential house and garage are present to the south of the easternmost glass house and Acacia Joinery is directly south of the residence. The area directly to the west of the residence is a small yard with grass, flowers and trees. The area directly west of Acacia Joinery is comprised of a gravel road with screened structures present. A glass and corrugated metal building is also present near the south-western corner of the site. There are shelves and tables present within each of the nursery buildings.

Inside the glass houses, there are concrete paths between the nursery benches; the area directly beneath the benches appears to be soil (likely for drainage). There is vegetation present in the soil beneath some of the benches.

The largest structure houses nursery benches, an office and a chemical storage area. The chemical storage area is empty, but signs warning employees of potential hazards are present. This building also has wooden doors with peeling paint.

In the easternmost mesh structures, the floors are covered with geotextile material, which has been placed on the underlying soil. The westernmost mesh structure has a gravel floor.

The open areas of the site are paved with gravel and shingle. Disused tyres were present on the west side of the easternmost glass house. Heaters and evaporative coolers were present in the majority of the glass houses. Plastic pots were also stored in boxes in several of the structures.

Access to the interiors of the residence and Acacia Joinery was not available during the site visit.

In the area between the residence and Acacia Joinery, there is debris and a plastic drum present. Because of the debris, access to the drum was not possible; it is not known whether it is empty and no labels were visible. There are also several bags of unknown material stored in this area. Disused lumber, concrete blocks, pipes and metal grating are present on the west side of Acacia Joinery. Directly to the south of the Acacia Joinery building, there is an area that has been covered with geotextile material, which is weighted down with concrete blocks.

At the south-westernmost glass house, two disused empty drums are present between the glass house and the fence. A small amount of debris and a bathtub are also present in this area. There was no visual evidence of staining around the drums. However, there was a bright green liquid in the poly drum; it appeared to be similar in colour to anti-freeze.

A conversation with a representative from Opus (who was managing the sale of the site to NZTA) has indicated the following:

- An existing 9,000 L underground storage tank located on the property was removed from the site on 11 December 2009
- The UST was 30 years old, but was in use for only 8 years and was used to store diesel fuel
- During the tank removal, five soil samples were collected and sent to a laboratory for analysis. According to Opus, the soil surrounding the tank was visually clean

Council records indicate that the 9,000 litre diesel UST was removed in December 2009 by Mansfield Installation Ltd. Soil samples were taken by Mansfield Installation Limited on behalf of the land owner. The results indicated that there was no contamination present above commercial/industrial risk based guidelines.

As noted above, sprays and chemicals stored on-site include insecticides, fungicides, miticides, herbicides and other miscellaneous chemicals (such as Thrive and silver nitrate).

Car Haulaways

The former Car Haulaways site was visited on 08 February 2010. The site is surrounded by an alarmed fence with an automatic gate. When the gate is closed, the alarm system is armed. The alarm system is activated if motion is detected within 1 metre of the fence. Features described below are noted on ***Figure 16.3, Appendix 16.A***. Site visit photographs are provided in ***Appendix 16.E***.

There is a one storey office building just inside the entrance, to the north of the gate. The office structure's age is not known, however, it appears to be in good repair. It is constructed with siding and brick on the exterior, with aluminium windows.

East of the office, there is a small storage shed with an adjacent concrete pad. The shed is constructed of wood and corrugated metal with a concrete floor. The shed is empty except for shelving and a cone-shaped galvanised ventilation stack that exhausts through the roof of the shed. There are supports next to the shed to the north and an area that appears to have been a bermed storage area. There is a concrete pad to the south of the shed. There is a fire extinguisher mounted on the northern exterior wall. What appears to be a vent pipe is present just north of the shed near the eastern corner.

On the eastern boundary (near the centre of the site), a storage shed is present. It is constructed of corrugated metal and is separated into two spaces, each with a door and a wall in between. There is wooden shelving present in each of the sheds. The floor is concrete. There is staining evident on the shelves in both areas.

There is a disused small drum of oil adjacent to the northernmost shed and there is evidence of staining on the shelves and floors of both sheds. There is a flexible tube connected to the drum which leads through a hole in the wall in the shed. There is minor staining present inside and outside of the shed. There is also a small amount of debris present on the north side of the shed and a fire extinguisher is mounted on the northern exterior wall.

There is a bermed area north of the sheds that was reportedly used for an aboveground diesel fuel storage tank. There was a small amount of what appeared to be hydrocarbon staining present within the bermed area.

The area to the west of the sheds is paved with concrete and asphalt. Railroad tracks are present in the concrete pad portion, as is a drainage structure. The drainage structure appears to be filled with dirt.

The remainder of the site is covered with shingle and gravel.

Minor surface staining was noted in a few areas of the site; this appears to be the result of small leaks from stored vehicles and transport vehicles. There is a small area of apparent erosion in the approximate centre of the site; it is not known if this is from past vehicle washing or stormwater runoff. Erosion is also apparent leading toward the gate; this appears to be from stormwater runoff.

There is vegetation present in a small area along the centre of the site and around the boundary (fence line). There is a lawn and roses present in front of the office structure, near SH1. No other vegetation was present.

SH1 is present to the west of the site, former Golden Coast Nurseries (described below) is south of the site. Sang Sue Market Garden is farther to the west, across SH1. A 2-lane road is present to the north of the site with paddocks present across the road. Undeveloped land is present east of the site.

3.13.5 February 2010 route visit

On 9 February 2010, NZTA arranged for a site visit of most of the Transmission Gully Highway route. The site visit was conducted using off-road vehicles, so much of the site was accessible. Photos from this site visit are provided in ***Appendix 16.E***.

Features observed during this route visit that were not readily accessible during previous site and route visits included the Perkins farm property, Transpower Substation sites, a former stockyard site, the former Toomey property, portions of Belmont Regional Park and the GWRC property operated by Landcorp. Note that these sites were observed as part of a "windshield tour"; detailed site visits were not conducted as this was a group visit of the entire route.

As a general observation, much of the route is comprised of a valley between steep slopes. Because of the topography and limited access, the land is largely used for grazing. The land does not appear suitable for intensive cropping. Sheep and cattle were present along most of the undeveloped portions of the route. Feral goats were also observed along the route.

The Transpower Substation sites were observed from the vehicle and appeared to be well maintained with secondary containment present around many of the structures within the substations. No staining was apparent.

The Perkins farm property has a residence present, as well as various outbuildings typical of agricultural operations (barns, sheds and animal pens).

The former Toomey property was inspected as it was one of the stops on the route visit. The property has a house, tennis court and swimming pool. The house appears to be relatively new and the property appears to be well maintained. Pool maintenance chemicals were not observed, but chlorine is reportedly used to maintain the pool.

The GWRC/Landcorp site has structures in the form of concrete walls present. These structures are reportedly associated with former sheep dip operations and are noted on ***Figure 16.9, Appendix 16.A***.

The former stockyard deer pen in the valley behind Battle Hill was observed; there was a reported sheep dip present in the general area, but it was not visible from the vehicle. The former stockyard pens are shown on ***Figure 16.10, Appendix 16.A***.

3.13.6 Interviews

3.13.6.1 Transpower interview

A representative of Transpower, Brendan Olsen, was interviewed on 12 February 2010 regarding use of PCBs and any hazardous materials releases from the site. Mr. Olsen stated that to the best of his knowledge, there had been no reported spills or releases at the Transpower Substation sites. He also indicated that PCBs were not utilised in the majority of the equipment at the sites and that all hazardous materials are stored with appropriate secondary containment.

3.13.6.2 Fred Carroll interview

Mr. Fred Carroll, a retired Assistant Engineer with Porirua City Council, was interviewed on 16 February 2010. He was suggested by the Porirua City Council as a person who may have knowledge of the former Ribbonwood Tce Landfill. Mr. Carroll was familiar with the former Sievers Grove landfill, but did not have knowledge of the former Ribbonwood Tce Landfill. He said that based on the location, it may have been used by Tawa rather than Porirua.

3.13.6.3 Norm Cobb interview

When Aurecon staff reported to take samples at the former stockyard site on 26 April, the key was not available. They travelled to the Battle Hill Park office to retrieve the key and met Mr. Norm Cobb and discussed the potential sheep dip site with him. Aurecon had previously been told that the sheep dip site was on the Kennings property; however, the location specified was on another property. Animal pens were present in the location which had been previously referred to as the "Kennings sheep dip and former stockyard" site.

Mr Cobb, an employee of Landcorp Farm for the last 25 years, indicated he did not believe that there was a sheep dip located at the cattle pens and deer pens/stockyard as these yards were primarily used as satellite yards for the main stockyard. Mr Cobb also stated that the sheep dip for the farm was located 1.5 km north of the Battle Hill Park office, at a farm settlement next to Paekakariki Hill Road, but was removed approximately two years ago. The sheep dip site referred to by Mr Cobb is at the Kennings property; it can be seen on past aerial photos.

3.13.6.4 Andrew Noble interviews

Andrew Noble, Opus, provided assistance with property information on several occasions. Mr Noble is assisting NZTA with property issues and has a great deal of knowledge of the Wellington region. On 26 April 2010, Mr Noble provided information regarding the former sheep dip site and indicated that based on his knowledge of the area and typical farming operations, it would be highly unusual to have two sheep dips in close proximity (i.e., at the Kennings and former stockyard site properties). He had some knowledge of the animal pens at the former stockyard site property and indicated that the newer pen was largely used for deer and sheep and the older pen was mostly used for cattle.

3.14 Summary of Stage 1 findings

A summary of the Stage 1 land contamination assessment findings is provided in ***Table 16.6*** In ***Appendix 16.B***. The summary of Stage 1 findings is based on the review of current and historic records, site visits and interviews with persons knowledgeable of the sites, as well as an understanding of the type of construction work anticipated at each of the sites of concern. ***Table 16.6, Appendix 16.B***, lists the type of construction work (cut or fill) anticipated for each of the sites of concern.

This information formed the basis for the development of a site conceptual model for each of the areas of concern as well as the general route and a qualitative risk evaluation. The site conceptual models, combined with the qualitative risk evaluation, then formed the basis for development of a Stage 2 land contamination investigation work plan and the Stage 2 investigation itself and are described in more detail in ***Section 4***.

4. Characterisation of potential site contamination

4.1 Potential areas of contamination

Based on the findings of the Stage 1 land contamination assessment, which included evaluation of historic documentation, interviews with persons knowledgeable of the sites and site visits, potential areas of contamination for the sites identified along the proposed route were identified. These include:

- MacKays Crossing
- Sang Sue Market Garden
- Car Haulaways
- Former Golden Coast Nurseries
- Pauatahanui Inlet Garden Supplies
- Porirua Gun Club
- Mana Coach
- GWRC sheep dip site
- Former Stockyard site
- Former Ribbonwood Tce Landfill
- Buildings to be demolished or adjacent to route
- Farms

Note that following the adjustment of the alignment, additional potential areas where contamination should be evaluated were identified; these are addressed in separate letter reports and include the area along SH1 near the Kenepuru Link Roads, the Lewis's Fabric facility and the vacant area adjacent to the Mana Coach bus parking area.

4.2 Potential types and sources of contamination

4.2.1 Approach

The next step in the process was to evaluate the types of potential contamination which may be present at each site (i.e., hazardous materials present) and the possible source (e.g., spillage, pesticide application).

The types of potential contaminants listed are based on current information available about each site. Where detailed investigation has not been possible at this time (due to site access limitations), and where activities listed on the MfE's Hazardous Activities and Industries List (HAIL) are known to be present, contaminants were presumed based on the HAIL and/or professional judgement from past experience at similar sites.

4.2.2 Greenfields, farms, buildings

Greenfields sites are considered to include areas that have historically been forest, native bush, or grazing areas. Based on Aurecon's past experience at greenfields sites and the topography and nature of the route, the risk of contamination is considered to be low as described in more detail in ***Section 4.4.1***. The types of potential contamination present would typically include minor releases of hydrocarbons from off-road vehicles, or minor hazardous materials releases from timber cutting operations.

In some instances, buildings are located within the footprint of the preferred alignment and may be demolished. It is possible that lead-based paint was utilised on structures and that asbestos-containing materials may be present. In addition, hazardous materials may be (or have been) stored. These may include anti-freeze, paint, soldering fluxes, pesticides, herbicides, compressed gases and petroleum products. Fluorescent light ballasts and cooling systems may also contain PCBs. Buildings may also have septic tank and leachfield systems (active or decommissioned). In addition to biological waste, it is possible that hazardous materials were disposed of “down the drain” into the septic system or directly onto the land.

For farm sites, there is potential risk that features such as sheep dips, pesticide use, or chemical spills could have occurred. In addition, farm sites often contain offal pits, rubbish and effluent disposal areas and burn pits. Potential contaminants of concern include total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), pesticides, herbicides, volatile and semivolatile organic compounds and biological hazards.

4.2.3 MacKays Crossing

The area around MacKays Crossing was historically utilised for military practice exercises involving ordnance. During previous construction activities in the area, UXO was discovered. There is a potential for UXO to be present in areas not yet investigated or remediated.

4.2.4 Sang Sue Market Garden

Sang Sue Market Garden has historic market garden (largely vegetable growing) activities since the 1970s could have resulted in hot spots of pesticide, herbicide and heavy metal contamination across the site. It is not known if burning diesel fuel was utilised for frost protection. If so, TPH and PAH could also be constituents of concern

Note that only the horticultural activities are located within the highway footprint. The remainder of the areas are outside of and downgradient of the highway footprint.

4.2.5 Former Golden Coast Nurseries

Horticultural activities have occurred at this location since the 1970s.

These activities could have resulted in hot spots of contamination across the site. Chemicals used on site included insecticides, fungicides, miticides, herbicides and other miscellaneous chemicals (such as Thrive and silver nitrate).

Potential contaminants of concern include pesticides, fungicides, herbicides TPH, PAH and heavy metals.

4.2.6 Car Haulaways

The Car Haulaways site is essentially a transfer station where new vehicles were loaded onto transport trucks for delivery to dealerships around New Zealand. Areas of potential concern include:

- AST – There is minor surface staining present in the bunded area that housed the former AST. The potential contaminants of concern are TPH and PAH. Because the AST was not present for a long period of time, leaded fuel was not likely to have been utilised

- Car storage area - The ground surface where vehicles were parked is gravel, shingle and concrete. Historic aerial photos indicate that the gravel surface covering was also in place in 1988. There is potential for soil to be impacted from leakages or spills from vehicles. The contaminants of concern are metals, PAH and TPH

- Storage sheds – There is staining present in all of the storage sheds and debris adjacent to the sheds. The areas near the sheds were also reportedly used for vehicle washing. There is a drain

in the concrete pad in front of the eastern storage sheds that may have been utilised for wash-down water drainage. Potential contaminants of concern are TPH, PAH and metals

There was a UST present on site. However, it was removed by MWH under Shell Oil Company oversight. Residual contamination remaining on site was below commercial/industrial guidelines. This area will be subject to fill, rather than cut. Based on the information report by MWH and the future construction planned, additional investigation is not warranted.

4.2.7 Pauatahanui Inlet Garden Supplies

Pauatahanui Inlet Garden Supplies provides materials such as compost, lime, mulch and other biodegradable materials, which are bulk stored in bins on site. Areas where contamination could be present include:

- Storage / Processing Area – These bins do not have a sealed base and as such have the potential to create leachate in wet weather. Potential contaminants of concern include pesticides and heavy metals

- Storage Shed – Fertilisers and small quantities of other hazardous materials (pesticides, paints) have been stored on site. All of these substances have generally been stored in the building that has a concrete floor. However, there is the potential for spillage around the building and historic pesticide application. Potential contaminants of concern include pesticides and heavy metals

- Former AST – An AST was located on the site, reportedly for approximately 5 years. There is evidence of minor staining in front of the AST footprint. According to the site lessee, no environmental testing was undertaken when this tank was removed from site. The potential contaminants include TPH and PAH

- Wood Processing Area – Machinery is sometimes serviced on-site in the vicinity of the wood storage area. Some minor staining of the ground was noted during the site walkover. The potential contaminants of concern include TPH and PAH from equipment leakage and semivolatile organic compounds and metals from treated timber

- Composting – the facility receives “recycled green waste” from the local tip for use in composting. Pesticides and herbicides are contaminants of potential concern

4.2.8 Porirua Gun Club

The Porirua Gun Club provides facilities for pistol and rifle shooting as well as clay target shooting. Waste ammunition is present as are waste clay targets. The clay targets are present both around the target release equipment and in a wide area where they typically fall when shot from the sky. In addition, it appears that waste ammunition is burned in one area.

The potential contaminants of concern are metals from spent ammunition (primarily lead and copper), dioxins and furans from burning ammunition and PAH from clay targets.

4.2.9 Mana Coach

The Mana Coach facility is located in Porirua, along the proposed Waitangirua Link Road route. The facility supplies coaches for tours and local passenger transport services for the local Porirua and Kapiti communities. Vehicle repairs and fuelling have taken place at the workshop areas; Council records indicate that a UST was removed with no residual contamination present. Hazardous materials have been stored at the facility and a diesel fuel UST is likely still present at the site.

The primary contaminants of concern are TPH, PAH and heavy metals. It is not known if solvents were utilised; if so, volatile and semivolatile organic compounds may also be of concern. However, it should be noted that the workshop and UST areas are outside and downgradient of the highway footprint.

4.2.10 Pauatahanui Golf Club

The Pauatahanui Golf Club has been present for more than 30 years. Hazardous materials most likely present would be associated with lawn and club maintenance, such as pesticides and herbicides (weed killers).

Historic maintenance activities could have resulted in soil contamination across the site in the form of pesticides, herbicides and heavy metals.

Fertilisers, pesticides, herbicides and other maintenance chemicals stored on site are likely to be located in the storage shed near the Clubhouse. The location of this shed is down gradient and some distance from the proposed route. Potential for contaminated soil (pesticides) to impact upon the construction works are considered to be minor given the locality of the shed from the proposed route.

4.2.11 Ribbonwood Tce landfill site

A review of Council records indicates that a landfill was present at Ribbonwood Tce. The Council records indicated that dates of operation and type of refuse received were not known. It should be noted that the Council records give an address of 0 Ribbonwood Tce; however, the legal description corresponds to a property now designated as 30 Ribbonwood Tce. Porirua City Council provided a map of the approximate location of the former landfill.

Because it is not known what type of waste the landfill received, or for how long, it is difficult to narrow the list of potential contaminants. Most likely contaminants include pesticides, herbicides, TPH, PAH and heavy metals. In addition, volatile and semivolatile organic compounds could also be present, along with a host of other compounds.

4.2.12 GWRC former sheep dip site

The property is owned by GWRC and operated by lessee Landcorp Farm and is located on Takapu Road. There is a former sheep dip site west of the Transpower substation. Remnants are visible today and the sheep dip is visible on historic aerial photos. The sheep dip site is also documented in Council records.

Contaminants of concern include pesticides and heavy metals.

4.2.13 Former stockyard site

During an interview with NZTA, it was indicated that one or more sheep dip facilities may have been present at the former stockyard site. Potential contaminants of concern include pesticides and heavy metals. (Note that this information was shown to be inaccurate following completion of the Stage 1 assessment.)

4.3 Conceptual site models

Based on the Stage 1 findings and identification of the potential contaminants of concern, a CSM was constructed. Environmental considerations taken into account in constructing the CSMs are shown below.

Item	Description
Surface water	Surface water and run off from rain and dust settlement activities may mobilise contaminants (dissolved and particulate) and therefore may contribute to migration of contamination.
Groundwater	Groundwater may contribute to migration of contamination of soluble and mobile contaminants.

Item	Description
Subsurface geology	Subsurface geology may influence migration pathways. For example, contaminants generally travel more quickly through gravels than through clay materials.
Areas of uncontrolled filling	There was potential fill material noted at the Porirua Gun Club and topsoil material was noted at several properties. There is also potential for fill material next to the Mana Coach facility and along the existing SH1. The majority of the fill material in the Wellington Region is from quarries; however, the exact sources of fill material are not known.
Off site sources of contamination	The surrounding areas are primarily greenfields. No offsite sources in the vicinity of the sites, other than existing SH1, were identified by the Stage 1 environmental assessment and site inspections.
Flora and fauna	The sites of concern are in areas which are disturbed through industrial, commercial, or farming activities. Therefore, they are not considered areas of high ecological significance. However, they may be adjacent to or upgradient of areas with high ecological values; therefore, ecological protection was considered in the context of future land use.
Infrastructure and services	Contaminants may cause damage to infrastructure, such as speeding corrosion of metal underground piping.

Potential exposure pathways were evaluated in light of expected future construction and future land use. Current exposure pathways, if any, were not evaluated; only pathways that would be complete during the construction process or during highway operation and maintenance (after construction) were considered.

In all cases, there are potential dermal exposure, inhalation and ingestion pathways for highway construction and maintenance workers who may be exposed to contaminants.

Contaminants, particularly in disturbed areas, may also migrate via surface water runoff and impact surface water or local ecology. Contaminants may travel through the vadose zone, impacting groundwater and local ecology.

Each of these exposure pathways will potentially be complete at each of the sites listed during construction, assuming that the highway route traverses contaminated sites. Following construction, the pathways will potentially be complete if contamination is left in place.

Table 16.7, Appendix 16.B, provides the CSM developed for each site. For each site, human exposure was evaluated for current and future site workers and users and adjacent site users. In addition, groundwater, surface water, flora and fauna and services/infrastructure were evaluated. The CSM was utilised to develop the recommendations for the Stage 2 investigation presented in ***Section 5*** and to inform the preliminary qualitative risk evaluation.

4.4 Risk evaluation

A preliminary qualitative risk evaluation has been undertaken for each of the land use activities identified on each site of potential concern. The risk evaluation is based upon the potential for contamination sources located on each site based on the site history and information obtained in the desk study.

The risk evaluation was conducted using a risk matrix that allows for the classification of risk based on the likelihood of a given consequence.

4.4.1 Preliminary qualitative risk evaluation

Risk can be evaluated by quantifying the degree of risk present at a given site, based on the likelihood of a consequence occurring. A risk matrix has been developed by NZTA for the overall Transmission Gully Highway Project. The Project risk matrix lists likelihood and consequence criteria and associated numerical values. This Project risk matrix formed the basis for the preliminary qualitative risk evaluation.

For purposes of this risk assessment, likelihood was determined to range from almost certain to rare. Definitions for likelihood categories are provided in ***Table 16.8, Appendix 16.B***. Consequences were evaluated ranging from low to critical in the areas of safety, health, environmental, production, damage to reputation and equipment damage. Definitions for consequence categories are provided in ***Table 16.9, Appendix 16.B***.

As shown in ***Table 16.10, Appendix 16.B***, a risk assessment matrix was developed based on the likelihood of the consequence and degree of consequences. A score is associated with each likelihood and each type of consequence (low to critical). The risk assessment matrix was then utilised in formulating the degree of potential risk present at the site. The risk matrix is a standard matrix utilised throughout the environmental industry and referenced in MfE CLMG documentation. Scoring, likelihood and consequence definitions follow those established by NZTA for the overall project.

Based on the investigation findings, a preliminary environmental risk evaluation was conducted for the sites with potential contaminating activities and is summarised in ***Table 16.11, Appendix 16.B.*** Risk rankings were assigned on the basis of a subjective evaluation of the risk categories. An allocation of each factor to a likelihood and consequence category was conducted, with points assigned in accordance with the matrix shown in ***Table 16.10, Appendix 16.B***. This risk matrix, combined with the CSM, formed the basis for recommendations from the Stage 1 assessment.

4.4.2 Assumptions for risk evaluation

Because the risk evaluation is qualitative, it is subjective in nature. The preliminary risk evaluation was used to determine whether sites warranted additional investigation.

Tables WS 14-8 and ***16.9, Appendix 16.B*** provide definitions for likelihood and consequence. These definitions formed the basis of the assumptions for the risk evaluation. However, there is a subjective element involved. For example, professional judgement is required in determining where an incident “could” or “should” occur. Because of the subjectivity involved, Aurecon used highly experienced personnel (with more than 20 years of environmental management and risk evaluation experience) to evaluate the likelihood and consequence of various possible incidences of contamination. Similarly experienced personnel conducted technical and peer reviews of the risk evaluation.

Note that risk must be considered within the context of the overall Transmission Gully Highway Project. For example, there is a degree of risk that an offal pit or rubbish pit (or similar) is encountered during construction. The CSMP addresses steps to be taken if this occurs; namely, cordon off the area, segregate affected materials, use experienced personnel to evaluate the area and properly dispose of the affected material. This could result in cessation of work on a portion of the highway for a period of time.

However, because of the large project size, work can carry on in other areas and the overall project (expected to last for several years) will not suffer substantial adverse effects from having a small area unavailable for a few days or even a few weeks. On this basis, the consequences associated with accidental discovery of contamination are considered to be quite low. Note also that costs of up to $2 million can be incurred for remedial action before a consequence is considered “major” as opposed to “moderate”. The classification of the level of risk was established for the entire Project and the risk categorisations assigned in this report are based on the overall Project risk.

As part of works, Aurecon contaminated land staff participated in an NZTA-sponsored risk evaluation workshop. Participants were asked to provide a list of potential risks prior to the workshops. The two highest risk areas identified in this study were associated with remediation of the Porirua Gun Club and the UXO at MacKays Crossing. In the context of the overall project, both risks were considered “minor” to “low” in the context of the project.

Note that the preliminary risk judgement was made in the absence of any soil analytical data. Because no data were available, the maximum realistic consequences were assumed. In the judgement of Aurecon staff, this risk met the definition for “moderate” consequences, defined as: “Moderate onsite environmental harm or potential for off-site harm, potential for adverse public perception” with associated costs ranging from $500,000 to $2,000,000.

Following completion of the intrusive investigation and evaluation of laboratory results, the risk evaluation was revisited and revised based on the available data.

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5. Recommendations from Stage 1 findings

5.1 Introduction

The recommendations from the findings of the Stage 1 land contamination assessment are presented below. As described above, these recommendations follow from the information gathered during the Stage 1 assessment and subsequent development of the CSMs and preliminary risk evaluation.

5.2 Greenfields sites and farms

5.2.1 Possible contamination issues

As previously described, the risk of contamination at greenfields sites and farms is relatively low. While contamination is possible, particularly at farms, the likelihood of features such as hydrocarbon or other hazardous materials releases, offal pits, rubbish and effluent disposal areas and burn pits, being located in the footprint of the preferred alignment is relatively low. Hazardous materials stored at farm buildings are addressed in ***Section 5.3, Buildings***.

5.2.2 Approach

While risk is present, it can be managed through two steps:

1. Interview property owners regarding potential contamination.

2. Develop and implement a CSMP.

Each is described in more detail below.

5.2.3 Interviews

Property owners, particularly farmers, should be interviewed regarding potential contamination. An interview questionnaire should be utilised. The interview should focus on locations of disposal and burn pits, above and underground storage tanks, septic tank systems, leachfields, effluent disposal areas, lagoons and hazardous materials releases. If timber milling took place, it should be determined if any timber treatment chemicals were utilised on the site.

5.2.4 Contaminated soil management plan

A preliminary CSMP has been developed and will form part of the overall Environmental Management Plan (EMP). The CSMP describes potentially contaminated site features, including site features (pits, tanks, sumps, septic systems, etc). Potential contaminants of concern will also be identified. Once construction details are more clearly understood, the CSMP should be updated and further developed to provide more detail. The CSMP should be implemented and utilised as the basis for worker training.

The CSMP includes procedures for action in the case of discovery of contamination. The procedures will include work stoppage until the situation has been evaluated by a qualified environmental professional. It also includes health and safety procedures and provides steps workers can take to protect themselves if contamination is discovered.

The CSMP will be provided to workers conducting Phase 3 geotechnical investigations so that they are aware of the potential for encountering contamination. If contamination is discovered during the Phase 3 geotechnical investigation, a qualified environmental professional should be called in to evaluate the area. The CSMP should also form the basis for the more detailed plan to be developed for construction and maintenance activities.

5.3 Buildings

Buildings constructed before 1990 may have utilised asbestos-containing materials and may have been painted with lead-based paint. Past experience has shown that lead-based paint may lead to soil contamination around the structure. In addition, building demolition materials may have special disposal considerations. Asbestos-containing building materials were utilised for many years in a wide variety of structures. Asbestos may be present in insulation, siding, wallboard, plaster, mastics, floor tiles and roofing materials.

In addition, hazardous materials (paints, solvents, solders, compressed gases, etc) are often stored indoors, particularly in outbuildings. In rural areas, septic tank systems are typically utilised to manage wastewater.

For buildings slated for demolition, the following is recommended:

1. Review building records to determine date of construction and evaluate construction material utilised. The building records should also assist with determining the use of the structure (residence, barn, storage shed, etc)

2. Interview property owners regarding past site activities and uses, hazardous materials storage, septic systems, above and underground storage tanks and use of lead-based paint

3. Based on the information gathered, develop a sampling and analysis programme to evaluate the presence of asbestos, lead-based paint (on structure and in soil) and hazardous materials releases

4. Develop a detailed plan for the management of site hazards, including disposition of septic systems, asbestos-containing materials, lead and other hazardous materials, as appropriate

A detailed asbestos management plan should be put in place prior to disturbing or demolishing structures.

5.4 MacKays Crossing

MacKays Crossing was the site of historic military training exercises which utilised live ordnance. This area was historically used as a range for practice firings by the military and shots were apparently fired from MacKays crossing in a southerly direction. During construction of nearby facilities, UXO was discovered.

GPR Geophysical Services, the consultant who conducted the UXO survey for the nearby area (Queen Elizabeth II Park) was interviewed during the preparation of the scoping document. He has extensive knowledge of past activities at the site and recommended a geophysical survey to evaluate the area for UXO.

For MacKays crossing a geophysical survey should be utilised to investigate, detect and plot the location of any anomalies that are considered possible UXO. The New Zealand military was contacted for coordination of UXO work.

Aurecon proposed to utilise GPR Geophysical Services to conduct a geophysical survey of the designated area in and around MacKays Crossing using time domain electromagnetic induction (EMI) as well as ground penetrating radar (GPR) where it will provide useful additional information on the target UXO.

The methodology will include the use of the following:

- A Geonics EM61 Time Domain metal detector capable of detecting ferrous and non-ferrous metal targets to a depth of 2 to 3 metres

- A GSSI SIR20 Digital ground penetrating radar system together with an appropriate frequency antenna

- Differential global positioning system post-corrected will also be used to accurately plot (+/-20 cm.) the location of all detected anomalies

On completion of the survey, a formal report will be provided covering objective, methodology, results and conclusions as well as a map showing the locations of possible UXO.

5.5 Sang Sue Market Garden

Past horticulture activities were identified as requiring further evaluation at the Sang Sue Market Garden. Note that the horticulture area is upgradient of the buildings and storage areas.

Horticulture activities, such as market gardens, typically involve the use of pesticides. Selective herbicides and products containing heavy metals may also be utilised. It is not uncommon to find "hot spots" of localised contamination around a market garden site. In addition, diesel fuel is sometimes burned with the smoke providing frost control.

It is recommended that grid-based sampling be conducted across the market garden area. The grid should have a maximum hot spot radius of 30 m (see MfE CLMG for guidance on establishing a grid with a 95% confidence within a 30 m radius). The 30 m radius was selected based on knowledge of site operations, the size of the area to be disturbed by highway construction and the overall size of the horticulture area. This will provide an initial screening of potential contamination at the site.

Soil samples should be collected at the approximate centre of each grid location from the near surface (0.01 – 0.1 m) and shallow subsurface (0.1 – 0.3 m). All of the surface soil samples and a minimum of twenty percent of the deeper samples should be analysed for pesticides and heavy metals. A minimum of twenty percent of the total number of samples collected should also be analysed for PAH.

The samples not analysed were placed on "cold hold" by the laboratory, pending receipt and evaluation of laboratory results. Should laboratory results indicate the presence of contamination above risk based guidelines, additional analyses could be conducted to further delineate the magnitude and extent of contamination present. Additional soil sampling across a finer grid and/or at greater depths may also be appropriate. This should be determined in light of evaluation of the laboratory analytical results.

5.6 Former Golden Coast Nurseries

According to the MfE, glass houses and nursery operations typically have pesticides and heavy metals present. Contamination is most commonly present around entrances to glass houses and storage sheds.

Council records indicate that an underground storage tank was recently removed. The report indicates that contamination above commercial/industrial guideline values was not present.

Soil samples should be collected from near the entrances of the nursery structures (with the exception of the residence). Samples should also be collected from across the site on a grid-based system, with a maximum hot spot radius of 30 m. In addition, samples should be collected from beneath benches in the glass houses on a grid-based system. Samples should be collected from the surface (0.01 m – 0.1 m) and shallow subsurface (0.1 m – 0.3 m).

All surface samples should be analysed for a broad range of pesticides and heavy metals. At least twenty percent of the samples should also be analysed for PAH and herbicides. A minimum of twenty percent of the deeper (shallow subsurface) samples should also be analysed.

As with Sang Sue Market Garden, the samples not analysed should be placed on “cold hold” by the laboratory, pending receipt and evaluation of laboratory results.

Should laboratory results indicate the presence of contamination above risk based guidelines, additional analyses should be conducted to further delineate the magnitude and extent of contamination present. Additional soil sampling across a finer grid and/or at greater depths may also be appropriate. This should be determined in light of evaluation of the laboratory analytical results.

5.7 Car Haulaways

The primary concern with regard to contamination at Car Haulaways is associated with hydrocarbon releases from fuel storage, maintenance activities, or minor vehicle leakage. A judgmental sampling programme is recommended to evaluate visibly stained areas, particularly around the storage sheds and in vehicle wash-down areas.

Near-surface (0.01m – 0.1 m) and shallow subsurface (0.1 m – 0.3 m) soil samples should be collected and analysed for TPH. Twenty percent of the samples should also be analysed for PAH.

5.8 Porirua Gun Club

5.8.1 Porirua Gun Club overview

The Porirua Gun Club has several distinct areas which were identified as requiring additional assessment. Sampling and analysis was identified as being required at the following areas:

- Upper level with rifle range structure and bullet catch, lower level with clay target machine shed and firing ranges including the bank opposite the ranges
- Ammunition disposal (burn) area
- Storage container
- Drainage channel
- Wastewater discharge and rubbish areas

There is also the potential that a septic tank is present.

5.8.2 Ammunition and target areas

During characterisation of spent ammunition and clay target areas, samples from this area should be collected carefully, with target fragments and bullets sieved out of the sample before analysis.

Based on past experience at similar firing ranges, it is reasonable to assume that the highly impacted areas (i.e., where there are numerous clay targets and/or spent ammunition present) are more or less equally contaminated. This assumption helps limit the number of samples and analyses required and forms the basis for this sampling strategy which focuses on delineating the magnitude and extent of contamination present.

It is recommended that up to five sample locations be identified and samples collected from the upper area and lower area (near the clubhouse), eight sampling locations from the range area between the clubhouse and the bank and ten sampling locations from the bank. Samples from each location should be collected on a judgmental basis from representative areas where bullets and targets are present. Samples should be collected from the near surface and shallow subsurface.

In addition, samples should be collected from up to eight locations at the outer edges of the spent ammunition and clay target area on the bank. These samples will be utilised to assist with identifying the extent of contamination.

Samples collected from areas where only ammunition is present should be analysed for heavy metals. Samples collected from areas where ammunition and clay targets are present should be analysed for heavy metals and PAH.

Five shallow (0.01 m – 0.1 m) samples should also be collected from nearby areas and analysed to help establish background concentrations of heavy metals and PAH.

Antimony should also be considered as it can be contained in ammunition. However, it is typically less than ten percent of the total metals contained in ammunition; a greater percentage causes ammunition to become brittle.

5.8.3 Ammunition disposal area

The potential contaminants of concern at the ammunition disposal area are heavy metals, PAH and dioxins/furans.

Up to six samples should be collected from this area; four from the outer edges (based on observation of staining) and two from the area with heaviest staining. Surface and shallow subsurface samples should be collected and analysed for heavy metals, PAH and dioxins and furans.

5.8.4 Storage container

At this time, it is not known what types of materials are stored in the locked container. Gun club staff should be interviewed and the contents of the container inspected. If hazardous materials are stored within the container, up to three samples should be collected from near the entrance of the container and analysed according to the materials present.

5.8.5 Drainage channel

Contaminants may be transported to the drainage channel by stormwater runoff. Preferential runoff pathways should be identified and up to five near-surface samples (0.01 m – 0.1 m) collected and analysed for heavy metals and PAH.

5.8.6 Wastewater disposal and rubbish area

Through interviews with site employees, it should be determined whether the wastewater disposal area is a leachfield for a septic tank. The sampling strategy assumes that this is the case.

Up to five samples should be collected from the shallow subsurface (0.1 m – 0.3 m) and analysed for faecal coliforms, E. Coli and heavy metals.

Samples should also be collected from areas where rubbish is stored and analysed for pesticides, TPH, PAH and heavy metals.

5.9 Pauatahanui Inlet Garden Supplies

The primary concerns at Pauatahanui Inlet Garden Supplies are potential releases from the former AST and various hazardous materials containers, surface discharges into the adjacent drainage channel and Pauatahanui Stream and storage of treated timber.

A judgmental sampling programme is recommended for container and AST releases with stained areas sampled and analysed. At the former AST, which reportedly stored diesel fuel, samples should be collected from the surface and shallow subsurface and analysed for TPH and PAH. This strategy should also be used for areas where other fuel releases may have occurred.

For releases from other hazardous materials, surface and shallow subsurface samples should be collected and analysed according to the material released.

Along the drainage channel and Pauatahanui Stream bank, up to eight sample locations should be selected and soil samples collected from the bank, with locations judgmentally selected from areas where there is staining or obvious channelling. Samples should be collected from just below the surface (0.01 m – 0.1 m) and analysed for TPH, pesticides and heavy metals. If surface water appears to be impacted, it should also be sampled and analysed.

Surface and shallow subsurface soil samples should be collected from the area around the entrance to the storage shed. Samples should be analysed for pesticides, heavy metals and TPH.

Up to five shallow (0.01 m – 0.1 m) samples should be collected from random areas around the site. These samples should be selected from areas that do not appear to have been affected by contamination. An additional three samples should be collected from unaffected areas outside of the property boundary (access permitting). These samples should be analysed for pesticides and heavy metals and utilised to establish background concentrations.

5.10 Mana Coach

At the time this report was developed, it had not been determined whether the Mana Coach property will be within the footprint of connector road development. The investigation strategy presented below assumes that it is within the construction area.

A detailed site visit should be undertaken, along with interviews with site personnel. The Council records indicate that a UST was previously present on site; it is not clear whether fuel is still stored on site. If other potentially contaminating materials have been stored on site, a sampling and investigation plan should be developed as appropriate.

5.11 Pauatahanui Golf Club

The risk of contamination associated with the Pauatahanui Golf Club is relatively low. An interview should be conducted with the Golf Club manager and/or groundskeeper to evaluate the types of chemicals and lawn maintenance products utilised. The CSMP discusses potential contamination sources at the Golf Club. No sampling and analysis is recommended at this time.

5.12 Historic landfill sites

A review of Council records revealed two historic landfill sites. The property containing one historic landfill (former Sievers Grove Landfill) is owned by Porirua City Council and has been developed as a park and nursery. The Ribbonwood Tce Landfill is owned by the Crown and is developed as a plantation forest.

The historic landfill property owned by Porirua City Council (former Sievers Grove Landfill) appears to have been investigated in the past; however, limited information was available from Council. The landfill was reportedly used for disposal of industrial waste. Based on a map provided by Porirua City Council, the landfill lies beyond the footprint of the highway. It is also substantially downgradient of the highway and is currently developed as a sports field and plant nursery.

Very limited information is available with regard to the former Ribbonwood Tce Landfill. The lack of information in Council records suggests that perhaps it was a small private landfill. Porirua City Council has provided a map of the approximate location of the former landfill (see ***Appendix 16.C*** on CD accompanying this report). The possible landfill area shown in the Council map is quite large; if this was a small private landfill, it is not likely that it encompassed this entire area.

For the Ribbonwood Tce landfill, a two-step approach is recommended once the vegetation is removed from the site. First, a geophysical survey using EM techniques is recommended to narrow the investigation area. This could then be followed by an intrusive investigation utilising test pits or trenches to investigate areas identified by the geophysical survey as potential landfill areas.

Because the former Sievers Grove Landfill is substantially downgradient of the highway alignment, no additional investigation is recommended at this time. No landfill gas has been noted by Council.

5.13 Transpower sites

The Transpower substation sites are not currently within the footprint of the highway, but they may be upgradient. The Transpower sites were viewed during the route visit and appeared to be in good condition.

According to a Transpower representative, there is no record of spills or releases from the substation sites and all hazardous materials have appropriate secondary containment. The sites should be addressed in the management plan; however, no sampling and analysis appears to be necessary at this time.

5.14 GWRC former sheep dip site

An historic sheep dip has been documented at the Belmont Regional Park near the farm area managed by Landcare. The sheep dip site is to be upgradient of the Transmission Gully alignment.

In this instance, as the former sheep dip site is upgradient of the Main Alignment, soil from the area a the upgradient edge of the Main Alignment will be investigated. Samples will be analysed for heavy metals, ORC/ORP/ORN pesticides and synthetic pyrethroids. Samples will be collected using either a hand auger (if feasible) or excavator and soil samples will be collected at three depths (0.0 m -0.1 m, 0.5 m and 0.9 m) to determine the vertical extent of contamination. The shallow samples will be analysed first and the deeper samples will be kept on cold hold and only analysed if contaminants are found in the other samples.

While the actual former sheep dip site may not be directly in the footprint of highway construction, contaminants may have travelled downgradient. It is recommended that up to three test pits or trenches be excavated downgradient of the former sheep dip site, along the upgradient edge of the highway construction area.

Soil samples should be collected from the test pit and analysed for heavy metals and pesticides. Soil samples should be collected at 0.5 m intervals or where changes in the soil horizon are apparent. If perched water is encountered, grab samples should be collected and analysed for heavy metals and pesticides.

5.15 Former stockyard site

The former stockyard site reportedly had one or more sheep dips present and was believed to be located in the valley on the southeast side of Battle Hill Park. If the sheep dips were present within the construction footprint or directly upgradient of the construction footprint, the MfE sheep dip investigation procedure should be followed for this area, starting with verification of the location of the sheep dip.

5.16 Perkins farm properties

The Perkins farm properties were viewed during the initial site visit and from the road during the December 2009 and February 2010 site visits. Full site access was not available so a detailed site inspection was not conducted. There appears to be hazardous materials and fuel storage present. The property is used for sheep grazing; it is not known if a sheep dip site is present. However, it appeared that fuel and hazardous materials storage was likely taking place at the property. Some of the structures appeared to be relatively old and lead-based paint may have been used in the past.

When it is determined which area of the site will be affected, a detailed site visit should be conducted and property owners interviewed to better evaluate the site. Following the site visit and interviews, a sampling and analysis programme should be formulated as appropriate. It is likely that a judgmental sampling programme, targeting areas of hazardous materials (pesticides, metals,

hydrocarbons) use and possible areas of lead-based paint contamination will be utilised. If structures are to be demolished, an asbestos management plan should be put in place prior to demolition.

5.17 Data quality objectives

In order to guide further work, generalised data quality objectives (DQOs) were developed and are presented in ***Table 16.12, Appendix 16.B***.

The DQOs were utilised to provide a framework for the reliable collection and reporting of data upon which the site contamination assessment will be based. The MfE CLMG were used for data evaluation and making decisions. Measures to be implemented to ensure that decision errors will be minimised included the following:

- The evaluation of data spatially and temporally within each subarea so that an evaluation of the heterogeneous nature of site geology has been accounted for
- The collection of an adequate number of samples to allow for statistical evaluation of data
- Redundancy in laboratory-specific procedures and analytical methods
- Redundancy in field analytical methods
- Use of QC samples to check the precision and accuracy of the data obtained

Utilising the DQOs and recommendations from the Stage 1 assessment, a work plan was developed for the Stage 2 investigation as described in ***Section 6***.

6. Ground investigation methodology and activities

6.1 Introduction

Based on the findings of the Stage 1 land contamination assessment, a work plan was developed to guide the Stage 2 investigation. The work plan followed the recommendations presented in ***Section 5*** and considered Stage 1 assessment findings, the CSMs, the preliminary qualitative risk evaluation, DQOs and the MfE CLMG requirements.

Subsequent to the completion of the Stage 1 assessment and development of the work plan, additional information was provided through interviews with persons knowledgeable of the areas and the highway route changed slightly in some locations. This resulted in the amendment of the work plan, consistent with the DQOs, which call for optimisation of data collection. These amendments are addressed as deviations from the work plan.

6.2 MacKays Crossing

A geophysical survey was conducted at the MacKays Crossing area in accordance with the work plan. A detailed report is provided in ***Appendix 16.F***. The scope of work was to identifying anomalies which could be indicative of UXO in the context of constructing Transmission Gully Highway. Research into the types of weapons that may have been used was conducted, by talking to the NZ Army, reading Council records, reviewing historic aerial photos and conducting an internet search of historic military operations at the area. Based on available information, the most likely type of munitions utilised in this area are mortar and cannon shells.

The UXO survey was undertaken using a Geonics EM61 MKI instrument (2 channels) with direct computer control. Full functional testing of the EM61 and GPS system was undertaken each day. This instrument is widely used for UXO surveys to the present day throughout the world and is fully able to meet the requirements of the survey. It is widely available for rental from both USA and pacific based geophysical equipment suppliers. A ground penetrating radar system and magnetometer were also available if required but the large number of anomalies seen in the surveyed area indicated that further surveying using other techniques would not be useful.

The EM61 together with differential post-corrected global positioning system was set up as a mobile trailer unit behind a modified quad bike for the purposes of this UXO survey (refer ***Figure 1*** in ***Appendix 16.F***). Due to the concentrated data collection window, essentially under the coils, the search lines were spaced at 1 metre intervals. This ensured that each area was thoroughly surveyed, with the result that each search area generated a great deal of data.

The EM61 was mounted on a 2m non-metallic trailer bar and was towed in low gear at constant RPM. The geophysicists who operate the equipment have a wide range of experience using vehicle towed EM systems and deliberately chose the short trailer mount (over the longer trailer systems available) because of the difficult terrain that was to be covered and the fact that no electrical noise was noticed on the EM61 signal (above the useful signal threshold) during detailed pre-survey testing. It has been found during the extensive surveys undertaken by the geophysicists that the electrical interference from quad bikes can be greatly reduced by the correct use of electrical suppressors/spark plugs and modern ignition systems on quad bikes.

The EM61 data was processed using standard processing methodology as was the post-processed GPS data. The EM61 data was processed using the DAT61 processing package and had time drift, filtering, editing of spikes and the data combined with the differentially corrected GPS positions. The GPS data was post-processed using the Trimble pathfinder office package and used a local base station for the differential corrections.

There were a total of eight areas covered during this survey. These were all the accessible areas in the designated search area and have simply been referred to as Area1, Area 2, etc. The layout of the areas covered can be seen in the marked up aerial photographs provided in ***Appendix 16.F.***

6.3 Field investigation activities

Field investigation activities were conducted in accordance with the work plan, MfE CLMG and the DQOs established prior to fieldwork initiation. The field activities conducted at each site of interest where intrusive sampling was undertaken is described below.

6.3.1 General sampling activities

Experienced Aurecon field staff conducted the site investigation activities. Each field team had at least one geoenvironmental engineer, trained in both geotechnical and environmental investigations. Soils were logged at each sample location.

Upon arrival at each site, a site reconnaissance was conducted to compare conditions with those encountered during the Stage 1 environmental assessment. Changes were noted in field logs. Photographs were taken of the overall site.

Sample equipment was decontaminated prior to each use using an initial tap water rinse and scrubbing with a brush to remove particles. The equipment was then washed in a solution of tap water and Decon 90 detergent. It was then rinsed with tap water, followed by a final rinse with deionised water provided by the laboratory. Rinseate samples were collected and analysed to evaluate the effectiveness of the decontamination procedures.

Nitrile gloves were worn during sample collection activities, with gloves changed between each sample. Samples were labelled and the collection time noted on the chain of custody form.

Photographs were taken of the sample jars and each sample location. A portable GPS unit was used to provide sample location information and sample locations were also noted on an aerial photo kept with the work plan in the field.

Samples were then placed on ice in a chilly bin pending shipment to RJ Hill Laboratories, an IANZ accredited laboratory, or AsureQuality, also an IANZ accredited laboratory. Samples were maintained under chain of custody throughout the process.

6.3.2 Sang Sue Market Garden

Soil samples were collected from the Sang Sue Market Garden on 19, 22 and 23 April 2010 by a team of Environmental Engineers from Aurecon. The market garden vegetable store was open to the public at the time the fieldwork was undertaken.

The weather during the fieldwork was generally fine and mild on all days. The preceding days were fine.

Field observations

Upon arrival on-site on 19 April, contact was made with the land owner. Aurecon field staff were informed at this time that the site would not be accessible on 20 and 21 April due to spraying activities scheduled to take place over the market garden. It is understood from the site owner that Glyphosate, a broad spectrum systemic herbicide used to kill weeds, was used during the spraying activities.

The market garden site comprises two main areas: crop fields (horticulture area), and market garden store and ancillary sheds.

Irrigation channels dissect the fields, generally in an east – west direction. The main channel turns toward the north near the eastern boundary of the site. No obvious signs of contamination were noted within the ploughed crop fields.

The ground conditions generally indicated beach and marginal marine deposits across the Sang Sue Market Garden site. The soil samples located along the northern section of the site typically encountered brown sands. These grade to silts to the south, which in turn grade to gravelly silt heading westward. Gravels were encountered in the southwest corner of the Sang Sue site. Imported sand was noted in sample location SS36 adjacent to the main site buildings. Each soil location was logged in accordance with NZ Geotechnical Society guidelines. Representative hand auger logs are included in ***Appendix 16.G***.

Sampling strategy

Only the eastern portion of the Sang Sue market garden will be impacted by construction and that only this portion of land will be purchased by NZTA. Sampling was therefore undertaken in this area, which comprises horticultural activities.

Soil sampling was conducted using a grid based pattern with a maximum hot spot radius of 20 m, as detailed in the Stage 2 Work Plan. The maximum recommended hot spot radius was 30 m; however, a smaller radius was chosen to provide a denser grid and higher level of certainty with regard to sampling across the site. Details of the sampling locations are presented in ***Figure 16.1*** in ***Appendix 16.A***.

A minimum of two soil samples were collected from each of twenty test locations, at two depths in accordance with the Stage 2 work plan. Forty primary samples were collected in total (two at each location). Soil samples were collected from the near surface (0.01 m – 0.1 m) and shallow subsurface (0.1 m – 0.3 m). Care was taken to ensure that the material collected as a single sample did not cross obvious strata boundaries, based on visual observation.

Sampling methodology

The soil samples were collected using a stainless steel trowel. Samples were generally collected from furrows between rows of plants so as not to disturb the plants. Near-surface samples were collected from apparent topsoil and shallow subsurface samples from apparent native soil beneath. Prior to sample collection and between each sample location, the trowel was decontaminated following the procedures as outlined in the MfE CLMG No. 5 (2004a). All samples were placed in appropriately labelled clean, unpreserved, 250 ml plastic containers or clean, unpreserved, 300 ml glass containers supplied by RJ Hill Laboratories. The samples were stored on ice and maintained under chain of custody until arrival at the laboratory.

Four duplicate soil samples were collected at randomly selected locations for quality control purposes. Five of the duplicate soil samples were taken from depths of 0.01 m – 0.1 m depth with the remaining five duplicate samples being taken from 0.1 m – 0.3 m depth. The primary sample names and their associated duplicate samples are shown below.

Primary sample name	Duplicate sample name
SS14-0.1	SS43-0.1
SS14-0.3	SS43-0.3
SS28-0.1	SS45-0.1
SS28-0.3	SS45-0.3

All of the samples collected from surface depth of 0.01 m – 0.1 m were analysed for ORC/ORP/ORN pesticides and heavy metals. Twenty percent of deeper samples (0.1 m – 0.3 m) were initially

analysed for ORC/ORP/ORN pesticides and heavy metals with the remainder placed on cold hold at the laboratory pending evaluation of the initial findings. In addition, twenty percent of the total number of samples were also analysed for PAH.

At the end of the each day's sampling, a rinseate sample (total of five samples) was collected from the equipment used for collecting the samples and stored in an appropriate container. Where two trowels were used for sampling on one day (i.e. when two sample teams were on-site), a rinseate sample was collected from each trowel. The samples were analysed for heavy metals, PAH and ORC/ORP/ORN pesticides.

6.3.3 Former Golden Coast Nurseries

The fieldwork for the intrusive investigation at the former Golden Coast Nurseries site was carried out on 20 and 21 April 2010. The site was closed to the public and vacant at the time the fieldwork was undertaken.

The weather on 20 and 21 April was partly cloudy and mild, while the preceding days were fine. Upon arrival onto the site on 20 April, a weed spray odour was detected. As spraying was taking place on the adjacent Sang Sue Market Garden property during both days, it was assumed that the spray had drifted across the road.

Field observations

The following were noted at arrival on-site:

- The majority of the site outside the glass houses was covered with asphalt
- A small overgrown garden and lawn was associated with the residential dwelling
- The majority of the glass houses comprised rows of benches
- The ground under the benches within the glass houses comprised mainly soil covered with pea gravel or mesh fabric
- Concrete pathways covered the ground in between the benches inside the glass houses
- The main glass house had an office, toilets and general storage area which were also surfaced with concrete

The ground conditions generally indicated beach and marginal marine deposits across the former Golden Coast Nurseries site. Gravels were typically encountered in most of the soil sample locations. Silts were encountered in the garden area (middle section) of the site and in some areas inside the glasshouses. Sand was located in three soil sample locations along the south-western boundary of the site. Each soil sample was logged in accordance with NZ Geotechnical Society guidelines. Representative hand auger logs are provided in ***Appendix 16.G***.

Sampling strategy

Soil sampling was conducted using a grid based pattern with a maximum hot spot radius of 20 m, as detailed in the Stage 2 Work Plan. The maximum recommended hot spot radius was 30 m; however, a smaller radius was chosen to provide a higher level of confidence through sampling a finer grid. The actual sample locations required minor adjustment in the field. This was undertaken to avoid asphalt and concrete covered surfaces.

Details of the sampling locations are presented in ***Figure 16.2*** in ***Appendix 16.A***.

A minimum of two soil samples were collected from forty test locations, at two depths in accordance with the Stage 2 Work Plan. Eighty samples were collected in total. Soil samples were collected from the near surface (0.01 m – 0.1 m) and a shallow subsurface (0.1 m – 0.3 m). Care was taken to

ensure that the material collected as a single sample did not cross obvious strata boundaries, based on visual observation.

In addition, four bulk building material samples (inclusive of a duplicate sample) were collected from structures on the site suspected of containing asbestos. Two samples were collected from the largest structure, which houses nursery benches, an office and a chemical storage area. An additional sample and a duplicate sample were collected from exterior cladding on the structure built onto the south side of the main nursery shed. These samples were collected using a judgmental sampling strategy.

Sampling methodology

The soil samples were collected with a stainless steel trowel. All samples were placed in appropriately labelled clean, unpreserved, 250 ml plastic containers or clean, unpreserved, 300 ml glass containers supplied by RJ Hill Laboratories. The samples were stored on ice and maintained under chain of custody until arrival at the laboratory. Prior to sample collection and between each sample location, the trowel was decontaminated following the procedures as outlined in the MfE CLMG No. 5 (2004a).

A total of eight (8) duplicate soil samples were taken at randomly selected locations for quality control purposes. Four of the duplicate soil samples were taken from 0.01 m – 0.1 m depth below ground with the remaining four duplicate samples being taken from 0.1 m – 0.3 m depth. One duplicate bulk building material sample was also collected.

All of the samples collected from surface depth of 0.01 m – 0.1 m were analysed for ORC/ORP/ORN pesticides and heavy metals. Twenty percent of the surface samples (equating to eight samples) were also analysed for herbicides and PAH.

Twenty percent of the deeper samples taken from 0.1m – 0.3 m below ground surface (eight samples), were initially analysed for ORC/ORP/ORN pesticides, herbicides, PAH and heavy metals with the remainder placed on cold hold at the laboratory pending evaluation of the initial findings. In addition, the three building samples were analysed for asbestos. A listing of primary sample names and their associated duplicate samples is provided in the following table.

At the end of each day's sampling, a rinseate sample (total of three) was collected from the equipment and stored in an appropriate container. Where two trowels were used for sampling on one day (i.e. when two sample teams were on-site), a rinseate sample was collected from each trowel. The samples were analysed for heavy metals, PAH, herbicides and ORC/ORP/ORN pesticides.

Primary sample name	Duplicate sample name
GCN6-0.1	GCN41-0.1
GCN6-0.3	GCN41-0.3
GCN13-0.1	GCN43-0.1
GCN13-0.3	GCN43-0.3
GCN27-0.1	GCN45-0.1
GCN27-0.3	GCN45-0.3
GN40-0.1	GN42-0.1
GN40-0.3	GN42-0.3
GCN-BLDG1	GCN-BLDG4

6.3.4 Car Haulaways

The Car Haulaways site is located adjacent to the existing SH1, approximately 1 km west of the Paekakariki Township. The site was operated as a storage yard for new cars from the 1970s until 2009. The potential sources of contamination at this site would be from hydrocarbon releases from fuel storage, vehicle maintenance activities and leakage from vehicles.

Field observations

Sampling was undertaken over two days on 19 and 20 April 2010 and on the morning of 21 April 2010. Weather on all three days was mostly sunny with partial cloud.

The site slopes from the south downward toward SH1 to the north at a moderate gradient. A drainage channel next to the gate collects runoff from the site which is dispersed through a partially concrete lined channel to the west of the gate on the north boundary of the site.

All stored vehicles had been removed from the site, which was mostly covered with gravel. Portions of the site are surfaced with concrete and asphalt. Surface and subsurface soils consisted mostly of gravel with silty sand. The gravels were coarse and well compacted. Some sample locations had to be moved slightly from the intended location marked on the sampling plan as concrete cover prevented samples from being collected at particular locations.

The location of former underground storage tanks was evident on site by imported sandy fill material that was markedly different from other soils across the site. The location of the former underground storage tanks was to the south of the office building and east of the small wooden storage shed and is shown in ***Figure 16.3, Appendix 16.A***.

A dark brown stain was observed on the ground at the location of sample CH18, along the southern boundary of the property and to the east of the storage sheds on the southern boundary of the property. No other stains were observed.

Pesticide spraying occurred at Sang Sue Market Gardens on the opposite side of SH1 to the Car Haulaways site on 20 April 2010. The pesticide spray odour was detectable during sampling activities at the Car Haulaways site.

The ground conditions generally indicated beach and marginal marine deposits across the Car Haulaways site. Light brown silts were typically encountered at most of the soil sample locations across the site. However light brown gravels were encountered along the northern and central areas of the site and gravelly sand was located in two soil sample locations along the southern edge of the site. Each soil sample was logged in accordance with NZ Geotechnical Society guidelines. Representative hand auger logs are included in ***Appendix 16.G***. The material appeared consistent with deposits common to the area. While there is a top layer of gravel across much of the site, the material beneath this loose gravel appears to be consistent with native soil based on observations, knowledge of site geology and information gained from the MWH UST report which indicated that fill was not present on the site.

Imported sandy silt was noted in sample locations CH10 and CH11 adjacent to former UST area located on the eastern boundary of the site.

Sampling strategy

A judgmental sampling plan was developed to evaluate the presence of contamination across the site, focussing on sampling stained areas, vehicle wash down areas, areas receiving drainage from where the cars were stored and around storage sheds. In addition, the office structure cladding material was evaluated for the presence of asbestos.

Twenty-one surface samples (0 m – 0.1 m depth) and twenty one shallow subsurface samples (0.1 m – 0.3 m depth) and three samples of building materials were collected as follows:

- Three surface and sub-surface samples were collected at the western area of the site where drainage water might collect
- Five surface and sub-surface samples were collected within the vehicle storage areas
- Seven near-surface and shallow subsurface samples were collected around the wash down and former AST area
- Six near-surface and shallow subsurface samples were collected adjacent to or downstream of the storage sheds
- Two duplicates of near-surface and shallow subsurface samples were taken
- Three building material samples were collected randomly from sections of the building with possible Fibrolite exterior wall cladding. One duplicate sample of the building material was also collected

All near-surface soil samples were tested for TPH, while twenty percent of near-surface samples (a total of four) were tested for PAH and heavy metals. Additionally, twenty percent of shallow subsurface samples (a total of four) were analysed for TPH, PAH and heavy metals. One sample from each of the representative areas (vehicle storage area, drainage collection at bottom of site, former AST and shed storage area) was selected to be analysed for all potential soil contaminants of concern (i.e., TPH, PAH, and heavy metals). Building material samples were tested for asbestos only.

Sampling methodology

Soil samples were collected with a decontaminated stainless steel trowel at surface level (0 m to 0.1 m) and at a shallow subsurface level (0.1 m to 0.3 m) on 19, 20 and 21 April. A peg bar was used to assist in getting to the required depth on 20 and 21 April, as the ground consisted of very densely packed gravels, which is the nature of the native soil in this area. Once the soil was loosened with the peg bar, the uppermost soil in the hole was scraped away and the sample collected with a decontaminated trowel.

Samples were placed in clean, unpreserved, clear glass 250 mL containers. Samples to be analysed for metals were placed in unpreserved, opaque 250 mL plastic containers. All containers were supplied by Hill laboratories. Once collected, the samples were stored immediately on ice and maintained under chain of custody.

Sampling locations are presented in ***Figure 16.3*** in ***Appendix 16.A***. A total of five duplicate samples were collected at randomly selected locations for quality control purposes. Two duplicate soil samples were collected from the surface layer (0 m – 0.1 m depth) and two duplicate soil samples were collected from the sub-surface layer (0.1 m – 0.3 m depth). A duplicate of the office building's cladding material was also collected. A list of primary and duplicate sample names is provided below.

All samples were placed on ice and sent to RJ Hill Laboratories, an IANZ accredited laboratory, under chain of custody. Samples were collected and handled in accordance with MfE CLMG requirements.

Primary sample name	Duplicate sample name
CH2(0.1)	CH3(0.1)
CH2(0.3)	CH3(0.3)
CH10(0.1)	CH11(0.1)
CH10(0.3)	CH11(0.3)
CH BLDG2	CH BLDG4

6.3.5 Porirua Gun Club

Soil samples were collected from the Porirua Gun Club on 12, 13, 14 and 15 April 2010 by a team of Environmental Engineers from Aurecon. The gun club was closed to the general public. Club members had to inform Aurecon when arriving on site to make sure the engineers would not be in the same area as the club members firing their weapons.

The weather during the fieldwork was generally fine and mild on all days. The preceding days were fine.

Field observations

Prior to arrival on-site on 12 April 2010, keys were obtained, so that access to the site could be gained. Prior to undertaking the soil sampling, a site walkover was conducted to confirm the specific sample locations. Numerous disused shell cases (rifle, shotgun and pistol), clay pigeon fragments and general rubbish were evident across most of the site, particularly in the areas around the clubhouse and lower ammunition/target area.

The ground conditions generally indicated surficial alluvial soils overlying in situ Greywacke rock across the Porirua Gun Club site. Silt was typically encountered in most of the soil sample locations across the site. Sand was also encountered in soil sample locations towards the eastern half of the Lower Level Firing Range and in one soil sample located at the top of the Lower Level Target Range.

Extremely weathered Greywacke rock (excavated as silt) was encountered in the soil sample where the existing hillside had been excavated for the Upper Level Rifle Range (southern section of the site). Each soil sample was logged in accordance with NZ Geotechnical Society guidelines. Representative hand auger logs are provided in ***Appendix 16.G***.

Sampling strategy

Sampling was conducted utilising a stratified sampling programme (i.e., both grid-based and judgmental pattern) based on knowledge of contaminant distribution established from the site history and professional judgement. As detailed in the Stage 2 Work Plan, the sampling locations were selected in seven main areas. These include:

- Ammunition/target areas (lower and upper level) – generalised grid-based sampling strategy with judgmental sampling in specific areas
- Ammunition burn pit – judgmental sampling strategy
- Storage shed – judgmental sampling strategy
- Drainage channel - judgmental sampling strategy
- Wastewater (leachfield) area - judgmental sampling strategy
- Rubbish disposal area - judgmental sampling strategy
- Background areas - judgmental sampling strategy, targeting areas which appeared outside of the impacted areas

Each sample area is discussed below and ***Figure 16.4*** in ***Appendix 16.A*** provides an overview of the location of the various areas. The sampling locations are presented in ***Figures 16.5*** and ***16.5*** in ***Appendix 16.A.***

Ammunition/target areas

The ammunition/target areas refer to four separate areas. The upper level rifle range building structure is located on a cut/fill platform excavated approximately 3 m to 6 m into the side of a ridgeline.

The lower level firing range (including clay target machine shed) located adjacent to the clubhouse and toilet block is also located on a cut/fill platform that has been excavated approximately 3 m to 4 m into the side of a ridge knoll, with the lower level target range area located on the bank opposite the lower range. The test areas are as follows;

Upper level rifle range building structure

Six soil samples and two duplicate soil samples (surface and shallow subsurface) were collected from three locations in a gravel area located immediately in front of the rifle range firing area (south side of building structure), where a great deal of spent ammunition casings and a few clay target fragments were present. The duplicate samples were collected from the westernmost test location.

Lower level firing range

Twenty-six soil samples and four duplicate soil samples (surface and shallow subsurface) were collected from thirteen locations across the lower level firing range (west of the clubhouse buildings) where a lot of spent ammunition casings and a few clay target fragments were present.

Two additional soil samples were collected from an additional sample location where a great deal of spent ammunition casings, a few clay target fragments and a shooting cage were present. This location was not in the original work plan, but was identified in the field as an area of interest due to the presence of ammunition casings and clay target debris. The test locations were as follows:

- Seven sample locations across the central section of the firing range competition range-markers
- Four sample locations along the western edge of the firing range and crest of the slope/embankment. The northern most test location was immediately in front of the locked doorway of the inbuilt storage bunker
- Two sample locations approximately a quarter of the way down the slope/embankment
- An additional sample location halfway down the slope/embankment in front of the storage bunker
- Duplicate samples were collected from the eastern side of the range-marker and in front of the storage bunker

Lower level target range area

Sixteen soil samples and two duplicate soil samples (surface and shallow subsurface) were collected from eight locations across the lower level target range area located on the bank opposite the lower range. There was a great deal of spent ammunition (bullets) and clay target fragments present in this area. The bank is covered in grass with areas of heavily vegetated gorse bushes. The duplicate samples were collected from the southern end of the clearing approximately halfway up the bank.

Ammunition burn pit

Ten soil samples and two duplicate soil samples (surface and shallow subsurface) were collected from five locations around the perimeter and inside the triangular ammunition burn pit cage. The ammunition burn pit is located towards the south of the clubhouse building, adjacent to the drainage channel and at the base of the 3 m to 4 m high cut bank. The sample locations are as follows:

- Four sample locations around the outside perimeter of the ammunition burn pit cage
- One sample location just inside the western opening of the burn pit cage

- Duplicate samples (for all constituents except dioxins/furans) were collected just inside the opening of the burn pit cage

Storage shed

Three near-surface soil samples and one duplicate soil sample were collected from three locations around the metal storage shed. The locations are as follows:

- Two sample locations were at the north western side of the storage shed, one located slightly up slope and adjacent to the shed door and the other located adjacent to the western corner of the storage shed
- One test location was situated at the rear of the shed adjacent to the base of a 3 m to 4 m high bank
- Duplicate samples were collected at the rear of the shed adjacent to the toe of the bank

Drainage channel

Five near-surface soil samples and one duplicate soil sample were collected from five locations in the drainage channel around the southern edge of the lower shooting range at the base of a 3 m to 4 m high cut bank. The test locations are as follows:

- Four test locations were equally spaced between the ammunition burn pits and the eastern edge/crest of the lower shooting range
- One test location was also situated in the drainage channel between the metal storage shed and the ammunition burn pit
- Duplicate samples were taken approximately halfway between the ammunition burn pits and the eastern edge/crest of the lower shooting range

Wastewater area

Five near-surface soil samples and one duplicate soil sample were collected from five locations in the grassed section of the wastewater (leachfield) area at the rear (northern side) of the timber clubhouse building. A large amount of corrugated iron and old building materials had been stockpiled behind the toilet block, preventing collection of soil samples over a portion of the area. The sample locations are as follows:

- Two sample locations close to the northern boundary/stock fence
- Two sample locations along the rear of the timber clubhouse building and toilet block
- One sample location in the middle of the wastewater (leachfield) area halfway between the buildings and stock fence
- Duplicate samples were collected adjacent to the toilet block

Rubbish disposal area

Six soil samples and two duplicate soil samples (surface and shallow subsurface) were collected from three locations across the rubbish disposal area. The rubbish disposal area is located west of the clubhouse building, on a cut platform 1 m to 2 m below the lower shooting range. The cut platform is located between the timber access stair from the clubhouse to the rubbish disposal area (eastern side) and a storage bunker (built into the north western corner of the lower shooting range). The sample locations are as follows:

- Two sample locations along the base of the 1 m to 2 m high bank cut bank, one located adjacent to the access stairs and the other close to the storage bunker
- One sample location close to the northern boundary/stock fence
- Duplicate samples were collected at the base of the cut bank, adjacent to the access stairs to the rubbish disposal area

Background areas

Ten soil samples and two duplicate soil samples (surface and shallow subsurface) were collected for analysis of background metals and PAH from five test locations along the western and north western extent of the Porirua Gun Club. It was considered that these areas would be unaffected by the current site activities and the samples analysed would establish background concentrations. The sample locations are as follows:

- One sample location from either side of the main (northern) access road between 10 m and 15 m away respectively from the main car parking area
- Three sample locations along the ridgeline above the upper target range. One was situated between the upper shooting range building and car parking area, one was located adjacent to the upper shooting range building and the third was located halfway between the upper shooting range building and targeting area
- Duplicate samples were taken from the eastern side of the main access road

Sampling methodology

Soil samples were collected with either a decontaminated stainless steel trowel or hand auger. All samples were placed in appropriately labelled clean, unpreserved, 250 ml plastic containers or clean, unpreserved, 300 ml glass containers supplied by RJ Hill Laboratories. The samples were stored on ice and maintained under chain of custody until arrival at the laboratory. Prior to sample collection and between each sample location, the trowel or hand auger was decontaminated following the procedures as outlined in the MfE CLMG No. 5 (2004a).

A total of 17 duplicate soil samples were taken from the seven areas of the Porirua Gun Club and were collected at randomly selected for quality control purposes. Ten of the duplicate soil samples were taken from 0.01 m – 0.1 m depth below ground with the remaining seven duplicate samples being taken from 0.1 m – 0.3 m depth. The primary sample locations, names and associated duplicate sample names are shown below.

Sample location	Primary sample name	Duplicate sample name
Storage shed	GC S03	GC S04
Drainage channel	GC S07	GC S08
Lower level firing range	GC S11 GC S13 GC S31 GC S32	GC S12 GC S14 GC S33 GC S34
Lower level target range area	GC S49 GC S51	GC S50 GC S52
Wastewater	GC S59	GC S60
Rubbish disposal area	GC S67 GC S69	GC S68 GC S70
Upper level rifle range	GC S81 GC S83	GC S82 GC S84
Background areas	GC S95 GC S97	GC S96 GC S98
Ammunition burn pit	GC S101 GC S103	GC S102 GC S104

The samples collected were analysed as follows:

Sample location	Sample name	Analyses
Ammunition/target areas (upper and lower)	GC S11 - GC S58, GC S65, GC S66 and GC S75 – GC S88	PAH and heavy metals
Ammunition burn pit	GC S101 - GC S112	PAH, heavy metals, dioxins and furans
Storage shed	GC S01 - GC S04	TPH, ORC/ORP/ORN pesticides and heavy metals
Drainage channel	GC S05 - GC S10	PAH and heavy metals
Wastewater area	GC S59 - GC S64	Heavy metals, faecal coliforms and E. Coli
Rubbish disposal area	GC S67 - GC S74	TPH, ORC/ORP/ORN pesticides and heavy metals
Background areas	GC S89 - GC S100	PAH and heavy metals

Where near-surface samples returned results above human health guideline values, representative samples were selected for analysis of the specific analytes in the corresponding shallow subsurface sample as shown below. Note that the NES SCV for lead was not in effect at the time the investigation was conducted; therefore, the guideline values of 300 mg/kg for lead and 210,000 mg/kg for copper were utilised.

Sample location	Near-surface sample name	Shallow subsurface sample name	Analysis
Lower level firing range	GC S15	GC S16	Lead
	GC S17	GC S18	Lead
	GC S19	GC S20	Copper and lead
	GC S21	GC S22	Lead
	GC S23	GC S24	Lead
	GC S25	GC S26	Copper and lead
	GC S27	GC S28	Lead
	GC S29	GC S30	Lead
Lower level target range area	GC S53	GC S54	Copper and lead
	GC S55	GC S56	Copper
Upper level rifle range	GC S85	GC S86	Copper and lead
	GC S87	GC S88	Copper and lead

In the ammunition/target areas all shallow samples were analysed and twenty percent of the deeper samples were analysed. The remaining deep samples were held on cold store at Hills Laboratory. Where initial results indicated concentrations above guideline values, the deeper samples were also analysed. At the other locations, all samples collected were analysed.

Following the evaluation of the initial laboratory samples, additional analyses were requested for thirteen deeper samples at the ammunition/target areas (upper and lower).

Due to a field oversight, no rinseate samples were conduct for the first three days, however at the end of the last day on site, a rinseate sample was collected from the equipment and stored in an appropriate container. The rinseate sample was analysed for heavy metals and PAH.

6.3.6 Pauatahanui Inlet Garden Supplies

The fieldwork for the intrusive investigation at the Pauatahanui Inlet Garden Supplies site was carried out on 27 and 28 April 2010. The site was closed to public and not in operation at the time the fieldwork was undertaken.

Field observations

At arrival on site and prior to undertaking the soil sampling, a site walkover was conducted to confirm the specific sample locations. This was undertaken as some site features that were noted during the previous site walkover had changed or moved. The following changes were noted:

- A mobile AST had been placed on the site of the old AST
- Black staining was noted underneath the new AST
- A port-a-loo had been installed adjacent to the AST
- The majority of chopped wood and machinery had been removed from the wood storage area
- Other disused items were noted in the wood storage area including a rusty trailer, wood splitter, old tractor engine, attachment for an excavator arm and a backhoe excavator boom
- One working excavator was parked in the wood storage area
- The Pauatahanui Stream appeared to have flooded the stream banks as indicated by muddy grasses on the true right of the stream. Flood waters appear to have been restricted to the immediate flood plain, no greater than 5 m from the stream bank and did not appear to have overtopped the elevated flood bank and onto the site itself

The weather on 27 April was overcast and mild, while the preceding days were fine. Significant rain fell in the late afternoon of 27 April and overnight. Upon arrival at the site on 28 April, ponding was noted over portions of the site, particularly the wood storage area and the drainage channel to the east of the site.

The ground conditions generally indicated beach and marginal marine deposits across the Pauatahanui Garden Inlet Supplies site. Sands and silts were typically encountered in most of the soil sample location across the site. Gravels were encountered in some soil sample located close to the existing Paremata/Haywards Road and two isolated areas in the centre of the site were gravel has been used as fill. Each soil sample was logged in accordance with NZ Geotechnical Society guidelines. Representative hand auger logs are provided in ***Appendix 16.G***.

Sampling strategy

Sampling was conducted utilising a judgmental strategy based on the findings from the Stage 1 land contamination assessment and professional judgement exercised in the field. The sampling locations were selected in four main areas. These included:

- the AST and leakage/spill areas - judgmental sampling strategy
- general site area – pseudo-random sampling strategy
- the stream bank and drainage area – judgmental sampling strategy
- surface water – opportunistic grab sample
- off-site background locations – judgmental sampling strategy

Twenty four shallow soil samples were collected from various areas of the site from a depth of approximately 0.01 m – 0.1 m below ground surface. Eight shallow subsurface were also collected from a depth of approximately 0.1 m – 0.3 m below ground surface. In addition, one surface water grab sample was collected from the Pauatahanui Stream to provide general qualitative information regarding surface water information from the stream directly adjacent to a runoff area.

Samples were collected from across the site as a larger area may be disturbed by construction or upgradient contamination could impact stormwater runoff. In addition, the site is prone to flooding, which could result in contaminant transport across the site. A generalised grid-based sampling pattern was used across the general area.

Each sample area is discussed below and details of the sampling locations are presented in ***Figure 16.7*** in ***Appendix 16.A***.

AST and leakage/spill areas

Soil samples were collected from four locations around the AST. A surface and subsurface soil sample was taken from each location. In addition, two duplicate soil samples (surface and shallow subsurface) were collected from the eastern side of the AST.

Four other test locations were also identified where soil staining was present. Two of these sample locations were situated within the wood storage area, while the other two sample locations were situated in the main yard, adjacent to the existing storage shed. Surface and sub surface samples were collected from these locations.

Stream bank and drainage area

Five surface soil samples were collected from the bank of the Pauatahanui Stream. Sample locations were restricted by vegetation and unstable ground present near the edge of the stream bank. Samples were collected from the crest of the bank. One duplicate surface soil sample was collected from this area.

Three surface soil samples were collected from the drainage channel near the eastern boundary of the site, adjacent to SH58. The samples locations were positioned in areas where obvious channelling had occurred and were evenly spaced to ensure representative samples were obtained.

Surface water

One surface water sample was collected from the Pauatahanui Stream. The sample location was positioned approximately 70 m down gradient of the existing sheds and yards.

General site and background locations

Six surface soil samples were collected from random locations around the site that did not appear to be affected by contamination. Two of these sample locations were situated directly adjacent to Bradey Road, while the remaining four samples were collected from the grazed paddocks to the north of the existing shed and yards.

Two additional sample locations were situated outside the property boundary on the western side of the Pauatahanui Stream and directly adjacent to Bradey Road. It was considered that this area was unaffected by the current site activities and the samples analysed would help establish background concentrations.

Sampling methodology

The soil samples were collected from a stainless steel trowel. All samples were placed in appropriately labelled clean, unpreserved, 250 ml plastic containers or clean, unpreserved, 300 ml glass containers supplied by Hill Laboratory. The samples were stored on ice and maintained under chain of custody until arrival at the laboratory. Prior to sample collection and between each sample location, the trowel was decontaminated following the procedures as outlined in the MfE CLMG No. 5 (2004a).

A total of six duplicate soil samples were taken at randomly selected locations for quality control purposes. Four of the duplicate soil samples were taken from 0.01 m – 0.1 m depth below ground with the remaining two duplicate samples being taken from 0.1 m – 0.3 m depth. The details are as follows:

Sample location	Primary sample name	Duplicate sample name
AST	PIG1-0.1	PIG5-0.1
AST	PIG1-0.3	PIG5-0.3
Spill area	PIG9-0.1	PIG10-0.1
Spill area	PIG9-0.3	PIG10-0.3
Stream bank	PIG15-0.1	PIG16-0.1
General area and background locations	PIG22-0.1	PIG23-0.1

The samples collected were analysed as follows:

Sample location	Sample Name	Analyses
AST and spill areas	PIG1 – PIG5 and PIG6 – PIG10	TPH, PAH, heavy metals
Stream bank and drainage areas	PIG14 – PIG19 and PIG11 – PIG13	TPH, ORC/ORP/ORN pesticides, heavy metals
Surface water	PIG29	TPH, ORC/ORP/ORN pesticides, heavy metals
General area and background locations	PIG20 – PIG24 and PIG25 – PIG28	ORC/ORP/ORN pesticides, heavy metals

The laboratory analytical reports are provided in ***Appendix 16.H***.

At the end of the each day's sampling, a rinseate sample (total of three) was collected from the equipment used for sampling and stored in an appropriate container. Where two trowels were used for sampling on one day (i.e. when two sample teams were on-site), a rinseate sample was collected from each trowel. The samples were analysed for heavy metals, TPH, PAH and ORC/ORP/ORN pesticides.

August 2010 site visit

On 21 August 2010, a site visit was conducted as the tenant had vacated the site. The AST and most of the equipment had been removed. The outhouse was still present, as was a small empty storage shed and an excavator. Debris was present on the site, both within large piles of soil and scattered about the site. Material that appeared to be waste asphalt was present across approximately one third of the site. The material was black in colour and consistent with gravel; however, there were large chunks of the material present as well. In other areas, a gold coloured gravel was present. Wood chips were apparent across the site and there were pieces of charred wood scattered around the site. A wood pile, with evidence of burning, was present on the site. Photos are provided in ***Appendix 16.E***.

6.3.7 Mana Coach

Soil samples were collected from the perimeter of Mana Coach bus parking area on 16 April 2010 by a team of Environmental Engineers from Aurecon. The bus parking area was in operation at the time the fieldwork was undertaken, however buses did not enter the car park during sampling.

The weather during the fieldwork was mild and the preceding days had been fine.

Field Observations

Upon arrival on site on 16 April, Aurecon Environmental Engineers presented themselves to the Mana Coach reception to meet the Yard Manager. He was offsite, but they had been informed we would be onsite field testing and requested we sign into the reception log book.

Mana Coach is currently an active bus depot comprising:

- An administration block and parking
- Vehicle maintenance buildings
- Refuelling area with a UST
- Bus parking area

The ground conditions generally indicated fan gravels deposits overlying in situ Greywacke rock across the Mana Coach site. Silt was typically encountered in most of the soil sample location across the site. Gravel was also encountered in northern most soil sample location.

Before departing offsite, Aurecon staff signed out of the reception log book.

Each soil sample was logged in accordance with NZ Geotechnical Society guidelines. A representative hand auger log is included in ***Appendix 16.G***.

Sampling strategy

Initially, based on the highway route, the southernmost bus parking area was within the highway construction area and the remaining depot facilities including the UST were not. Therefore, only the southernmost parking area was slated for investigation.

However, a decision was made to relocate the construction area to the area located between Mana Coach and the Maraeroa Marae Training Centre at 216 Warspite Avenue. Despite the relocation of the route, there was still concern regarding potential soil contamination from stormwater runoff from the Mana Coach southernmost parking area.

A judgmental sampling programme, which included surface (0 m to 0.1 m) and shallow subsurface (0.1 m to 0.3 m) sampling was proposed at four test locations. These four revised sampling locations were as follows:

- Three sample locations were along the grass verge area on the bus parking area's southern boundary; the first in the south eastern corner, the second midway along the southern boundary and the third in the south western corner

- One sample location was midway on the gravel verge on the bus parking area's western boundary

A total of ten samples were collected, a surface and shallow subsurface from each sample location. Duplicate surface and shallow subsurface samples were collected in the southeast corner location (see ***Figure 16.8*** in ***Appendix 16.A***).

Sampling methodology

Soil samples were collected with a decontaminated stainless steel trowel at surface level (0 m to 0.1 m) and then at a shallow subsurface level (0.1 m to 0.3 m). Samples were placed in clean, unpreserved, 300 ml glass and 250 ml plastic containers provided by the analytical laboratory. Once collected, the samples were stored immediately on ice and maintained under chain of custody.

The trowel was decontaminated following the procedures as outlined in the MfE CLMG No. 5 (2004a) prior to sample collection and between each sample depth and location.

Samples were collected using the stainless steel trowel on 16 April 2010. The duplicate samples taken for Mana Coach were collected at the first sampling location in the southeast corner of the site for quality control purposes. One duplicate sample was from the surface level (0.05 m) and the other from shallow subsurface level (0.1 m to 0.2 m). The details are as follows:

Primary sample name	Duplicate sample name
MC S1 @ 0.05 m	MC S2 @ 0.05 m
MC S3 @ 0.1 m to 0.2 m	MC S4 @ 0.1 m to 0.2 m

All samples were sent to RJ Hill Laboratories, an IANZ accredited laboratory, under chain of custody. All samples were analysed for TPH, PAH and heavy metals. Samples were collected and handled in accordance with MfE CLMG requirements.

6.3.8 GWRC former sheep dip site

The fieldwork for the intrusive investigation at the GWRC sheep dip site was carried out on 26 April 2010. The site was situated within a fenced and locked paddock at the time the fieldwork was undertaken.

Field observations

The weather during the site visit was partly cloudy, windy and mild, while the preceding days were generally fine. At arrival on site, a site walkover was conducted to confirm the location of the sheep dip structure, on-site services, general layout of the site and specific test pit locations.

The following was noted at arrival on-site:

- The site was covered in grass (with the exception of the disused structures) and generally sloped downward to the north towards Cannon Creek
- The remains of a concrete lined trench (approx 11 m by 0.9 m) and possibly concrete drip pads were located on-site adjacent to Takapu Road
- The remains of one derelict concrete shed with walls, was located immediately adjacent to the concrete lined sheep dip trench and one concrete building pad was located approximately 23 m to the west of the shed
- A gas pipeline was noted to be running directly through the site in an east-west direction between the derelict sheds and fence on the northern boundary

The ground conditions generally indicated surficial alluvial soils overlying in-situ Greywacke rock across the site. Silt was encountered in all of the soil sample locations at the site with one exception; sandy gravelly silt was encountered in one test pit at a depth of 0.9 m. Each soil sample was logged in accordance with NZ Geotechnical Society guidelines. A representative test pit log is provided in ***Appendix 16.G***.

Sampling strategy

Soil sampling was conducted using an excavator. Three test pits were excavated, which were located downgradient of the sheep dip trench and associated structures. The location of the test pits were chosen to evaluate whether contamination had migrated toward to the footprint of the proposed highway. Details of the sampling locations are presented in ***Figure 16.9*** in ***Appendix 16.A***.

Sampling methodology

Samples were collected at three depths from the walls of each test pit to evaluate the vertical extent of contamination, which included:

- near-surface material (0.1 m below ground level)
- shallow subsurface material (0.5 m below ground level)
- deeper material (0.9 m below ground level)

Samples were obtained directly from the excavator bucket using a gloved hand. Gloves were changed between each sample. Care was taken to ensure soil sampled had not touched the bucket. No groundwater was encountered during the field investigations. Samples were placed in appropriately labelled clean, unpreserved, 250 ml plastic containers and clean, unpreserved, 300 ml glass containers supplied by RJ Hill Laboratories. The samples were stored on ice and maintained under chain of custody until arrival at the laboratory.

At the time of the sampling, no obvious signs of contamination were noted.

One duplicate soil sample was taken from each test pit as shown below:

Test pit	Primary sample name	Duplicate sample name
1	GSD1 (0.5)	GSD4 (0.5)
2	GSD2 (0.9)	GSD4 (0.9)
3	GSD3 (0.1)	GSD5 (0.1)

All of the samples collected from surface depth of 0.1 m were analysed for ORC/ORP/ORN pesticides, select synthetic pyrethroids and heavy metals. One deep sample from each test pit was also analysed for the above parameters with the remainder placed on cold hold at the laboratory pending evaluation of the initial findings.

6.3.9 Former stockyard site

Soil samples were collected from the former stockyard and animal pen area on 26 and 27 April 2010. An historic sheep dip had been reported on the site; however, it had been reported as the "Kenning's sheep dip and former stockyard" site.

As previously described, anecdotal evidence provided by Mr Norm Cobb, an employee of Landcorp Farm for the last 25 years, indicated he did not believe that there was a sheep dip located at the cattle pens and deer pens/stockyard as these yards were primarily used as satellite yards for the main stockyard. Mr Cobb also stated that the sheep dip for the farm was located 1.5 km north of the Battle Hill Park office, at a farm settlement next to Paekakariki Hill Road, but was removed approximately two years ago. Based on this information, the work plan was amended as described below.

Field observations

The weather during the site visit was partly cloudy and mild, while the preceding days were generally fine.

On 26 April, Aurecon field staff met Mr Andrew Nevin of GWRC to gain access to the site. Access to the soil sampling area was through both council land and private land. Access to the private land was given by Mr Cobb.

At arrival on site and prior to undertaking the soil sampling, a site walkover was conducted to verify if the sheep dip structures or services were visible, review the general layout of the site and confirm the specific test locations. The following was noted at arrival on-site:

- The main (national grid) power cables run overhead across the cattle and deer pens in a north-south direction
- The cattle and deer pen structures are located in fenced paddocks on the edge of a river terrace. The river terrace is located at the base of the hill along the eastern side of Transmission Gully
- A stream runs down from the eastern hills into the valley in front of the northern edge of the cattle pens
- The deer pens are located approximately 50 m to 60 m southwest of the cattle pens
- A loading ramp for stock transport and a corrugated iron shed (currently being used as a hay barn) are located on the eastern side of the deer pens
- The site is covered in grass with the exception of the building structures
- Black plastic hosepipes were noted running around the outside of the cattle and deer pens to provide water to the animal troughs

The ground conditions generally indicated flood plain gravels overlying in situ Greywacke rock across the Battle Hill site. Silt was typically encountered in most of the soil sample locations across the site. Gravel was also encountered in soil sample locations around the southern and eastern side of the cattle pens. Each soil sample was logged in accordance with NZ Geotechnical Society guidelines. Representative hand auger logs are provided in ***Appendix 16.G***.

Sampling strategy

Based on Council and anecdotal information, an initial approach of a two day investigation was proposed to investigate 1 m to 3 m laterally from each cattle and deer pens structure and trowel/hand auger, with sampling carried out at surface (0 m to 0.1 m) and shallow subsurface (0.1 m to 0.3 m).

For the cattle pens, 14 soil samples and two duplicate soil samples were collected from seven locations (***Figure 16.10*** in ***Appendix 16.A***). The sampling locations are as follows:

- Two sample locations along the northern edge of the cattle pen, one located on the northeast corner of the pen and the other located in front of the drafting race
- Two sample locations along the southern side both located adjacent to the corners of the pen
- Two sample locations in front of the two cattle pen gates, along the western side of the site
- One sample location in front of the main gate to the small paddock that connects to both the cattle pens and deer pens/stockyard
- Duplicate samples were collected from the location in front of the northern cattle pen gate, along the western side of the site

For the deer pen/stockyard, 14 soil samples and two duplicate soil samples were collected from seven test locations (***Figure 16.10*** in ***Appendix 16.A***). The sampling locations are as follows:

- Two sample locations along the northern edge of the deer pen/stockyard, one located in front of the loading ramp for stock transport and the other located adjacent to the northwest corner of a corrugated iron shed (currently being used as a hay barn)

- Two sample locations along the western side of the site on the crest of the bank. The northernmost sample was collected in a localised depression, while the southernmost sample was collected at the southwest corner of the pen/stockyard adjacent to a stock fence
- Two sample locations along the southern edge of the deer pen/stockyard, one located approximately along the southern side of the site in front of a stock gate and the other at the southeast corner of the pen/stockyard in front of a stock fence
- One sample location approximately half way along the eastern side of the deer pen/ stockyard
- Duplicate samples were taken from the north-western corner of the pen/stockyard adjacent in a localised depression and edge of a bank

Sampling methodology

Soil samples were collected with a decontaminated stainless steel trowel. Samples were placed in clean, unpreserved, 250 ml plastic containers provided by the analytical laboratory. Once collected, the samples were stored immediately on ice and maintained under chain of custody.

The trowel was decontaminated following the procedures as outlined in the MfE CLMG No. 5 (2004a) prior to sample collection and between each sample depth and location.

Rinseate samples were collected from the stainless steel trowel on 26 and 27 April 2010. The duplicate samples taken for the cattle pens and deer pens/stockyard sites (BH03 and BH10) were collected at randomly selected locations. Four duplicate samples (two near-surface and two shallow subsurface) were collected from two sample locations at randomly selected locations for quality control purposes. The details are as follows:

Primary sample name	Duplicate sample name
BH02-0.1	BH03-0.1
BH02-0.3	BH03-0.3
BH09-0.1	BH10-0.1
BH09-0.3	BH10-0.3

All samples were sent to RJ Hill Laboratories under chain of custody. All shallow surface samples, one shallow subsurface sample and the corresponding duplicate samples for the cattle pens and the deer pens/stockyard were analysed for ORC/ORP/ORN pesticides, heavy metals and select synthetic pyrethroids. Samples were collected and handled in accordance with MfE CLMG requirements.

Deviation from the work plan

The work plan called for excavating test pits or trenches in accordance with the MfE guidance for investigation of sheep dip sites. However, based on information obtained from Mr Cobb and Mr Noble and review of historic aerial photos from the Kennings property, it was determined that it was unlikely that the former stockyard site contained a sheep dip facility.

Rather, it was considered more likely that the area was used only as a holding pen for cattle, sheep and deer. Had the area been utilised as a sheep dip site, it would be likely that surface and/or near-surface contamination would be present as the pesticide would have dripped from the animals whilst they were in the holding pen. Therefore, the work plan was amended to conduct surface and near-surface sampling for common sheep-dip pesticides. If high concentrations of pesticides were present, then it could indicate that a sheep dip had been present at the site and additional investigation would be warranted.

6.4 Quality assurance/quality control

Quality assurance/quality control (QA/QC) practices were applied to all field activities. Experienced qualified staff carried out all fieldwork tasks in accordance with Aurecon's standard operating procedures and MfE CLMG for:

- Soil sampling
- Field equipment decontamination
- Selection of sample containers
- Sample preservation, handling and documentation

Chain of custody documentation was prepared and samples were maintained under chain of custody in the field and during transport to the laboratory. Information included on the Chain of custody form included:

- Contact details for Aurecon staff
- Name of the person transferring the samples
- Time and date the samples were collected
- Analyses to be performed on each sample

Field duplicates of soil samples were also obtained following the MfE CLMG No. 5, *Site Investigation and Analysis of Soils* (2004a) for quality control purposes. Aurecon's internal standard operating procedures for soil sampling were followed to minimise data variability. All equipment was decontaminated before sample collection following the procedures outlined in the MfE CLMG No. 5 Section 3.8 (2004a) and Aurecon's internal standard operating procedures.

The methodology utilised for the collection of the duplicate samples included filling two jars with soil from the same location with the first jar being filled approximately one third full, then the second jar filled one third full and so on until the jars are both filled. The duplicate soils samples were submitted as blind duplicates.

With the exception of the Porirua Gun Club, rinseate samples were also collected at a minimum frequency of one per day or one per site. Where sampling was conducted over several days at one site, one rinseate sample was collected per day. Where multiple sites were sampled during one day, a rinseate sample was collected at each site. Rinseate samples were collected by pouring analyte-free water over sampling equipment and collecting the water in a laboratory supplied container. Where more than one implement was used, one rinseate per implement was collected. Note that due to a field error, only one rinseate sample was collected at the Porirua Gun Club; it was collected on the last day of sampling.

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7. Data evaluation and risk assessment

7.1 Introduction

Following receipt of laboratory results, the data were evaluated against adopted assessment criteria, which are described below. A preliminary risk assessment was conducted following completion of the Stage 1 assessment and was used to focus the Stage 2 investigation.

As part of the Stage 2 investigation, the preliminary risk assessment was updated. In the updated risk assessment, laboratory analytical data from the intrusive investigation are compared to adopted assessment criteria. This is used as a screening process to evaluate potential risk to human health or the environment. Parameters exceeding adopted criteria do not necessarily represent a risk but may require further consideration and evaluation.

This section:

- Details the adopted assessment criteria chosen for the intrusive investigation and provides justification for using such criteria
- Provides a summary of the laboratory results from each site of concern when compared to the adopted assessment criteria
- Provides commentary on the QA/QC results
- Provides a re-evaluation of risk assessment

7.2 Adopted assessment criteria

The GWRC does not specify numerical criteria for contaminants (e.g., remedial action goals, investigation levels, etc.). Instead, it requires evaluation when contaminants of concern are found above regional background concentrations or risk based guideline values. The risk based guideline values are not specified; instead, the NES SCVs and MfE guidelines are utilized.

Therefore, for the determination of potential risk to human health and the environment, results have been evaluated against applicable risk based guideline values. Comparisons were conducted in accordance with MfE CLMG No. 2, *Hierarchy and Application in New Zealand of Environmental Guideline Values.* This states that the hierarchy selection of guideline values for comparison is:

1. New Zealand documents that derive risk based guideline values
2. Rest of the world documents that derive risk based guideline values
3. New Zealand documents that derive threshold values
4. Rest of the world documents that derive threshold values

For the purpose of this investigation, the New Zealand NES, New Zealand Guideline documents (such as the guidelines for hydrocarbons and sheep dip sites), and MfE Environmental Guideline Value (EGV) Database were consulted to identify the applicable criteria that are relevant to potential pathways and receptors. For example, for evaluation of risk to human health, values related to construction and excavation workers (where available) were considered as the most appropriate comparison. Results were compared against accepted human health and ecological risk based criteria from both New Zealand and rest of the world guidance documents in accordance with the hierarchy from MfE CLMG No. 2.

A step-wise approach was adopted for determining which values were most appropriate as described below.

1. New Zealand Guidance documents, such as the "*Ministry of the Environment Report 775: Identifying and Managing Risks Associated with Former Sheep Dip Sites*" were consulted to

determine whether human health and ecological risk based guideline values were available. If so, these values were selected for comparison purposes.

2. The EGV Database was then consulted to determine whether risk based (rather than threshold based) values were available for a given contaminant of concern for human health and ecological receptors.

3. The guidance document associated with the most appropriate selection from the EGV Database was reviewed to determine which value was most appropriate for the land use and upcoming activities.

4. The SCVs contained in the 2010 NES Discussion Paper were also considered when preparing the initial report. In May 2011, the Cabinet Paper was released and data were re-evaluated and this report amended accordingly.

In general, the most conservative appropriate risk-based values were selected. With regard to ecological risk guidelines, the Canadian guideline values were utilised for commercial/industrial sites and for recreational/parkland sites for ecological receptors. It should be noted that the value given in the EGV database for ecological receptors is often lower than the value presented in the guideline document. While the highway itself is most appropriately considered a commercial/industrial site, the area adjacent to the highway could be considered open space with regard to ecological receptors. Therefore, recreational/parkland values were evaluated. These values are very conservative as they assume human use (including use by children).

It is unlikely that children will be playing next to the highway; the only people likely to be adjacent to the highway on a routine basis are highway maintenance workers. While it is acknowledged that children may be present adjacent to a highway during a vehicle breakdown or emergency, the exposures would be of very short duration. Even at Belmont Regional Park and Battle Hill Farm Forest Park, where recreational use occurs nearby, it is not likely that recreational activities will occur directly adjacent to the highway, within the designation.Therefore, the most appropriate guideline values to use are for commercial/industrial sites and maintenance/excavation workers for human health evaluation.

The applicable guideline values are presented alongside the tabulated data tables in ***Appendix 16.H*****.** References to each guideline value used are provided below**.** Full laboratory reports are provided on a CD included as ***Appendix 16.C***.

While undertaking the assessment of soils, reference has been made to the Wellington background concentrations from *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003). Typically, background concentrations found in Main Soil Type 1 (Sand) and Main Soil Type 2 (Greywacke) have been used, based on the soil type encountered at each site. Most of the fill material utilised in the Wellington Region (particularly away from the central business district) was obtained from quarries. The quarries are typically excavated in Greywacke areas; therefore, Greywacke was used in areas where alluvium and fill material was noted.

The data tables presented in ***Appendix 16.H*** utilise the NES SCV, which are applicable only to human health, followed by existing New Zealand guideline values as the primary basis for evaluation. Where no New Zealand guideline value was available, international risk based guideline values were utilised; if these were not available, then international threshold based guideline values were used.

7.2.1 Soil samples

Where soil samples have been collected and analysed, the following guidelines have been identified and are considered appropriate for use in this investigation. The guidelines are referenced below and the values are presented alongside the tabulated data tables in ***Appendix 16.H*****.** Guideline values utilized include:

- Canadian Environmental Quality Guidelines (CCME, 2002): Soil Quality Guideline Values
- Department of Environment, Food and Rural Affairs and the Environment Agency (DEFRA) 2002: Assessment of Risks to Human Health from Land Contamination: An overview of the development of soil guideline values and related research, Department of Environment, Food and Rural Affairs and the Environment Agency
- Ministry for the Environment (MfE) and Ministry of Health (MoH), 1997: Health and Environmental Guidelines for Selected Timber Treatment Chemicals (NZTTG)
- MfE, 1999: Ministry of the Environment Report 245: Guidelines for Managing and Assessing Petroleum Hydrocarbon Contaminated Sites in New Zealand
- MfE, 2006: Ministry of the Environment Report 775: Identifying and Managing Risks Associated with Former Sheep Dip Sites
- MfE, 2011: Cabinet Economic Growth and Infrastructure Committee Paper on A Proposed National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health
- Ministry of Housing, Spatial Planning and the Environment, 2000. Circular on Target Values and Intervention Values for Soil Remediation. Ministry of Housing, Spatial Planning and the Environment , Bilthoven, The Netherlands
- NEPC, 1999: *Guideline on the Investigation Levels for Soil and Groundwater,* National Environment Protection Council; Human Health Investigation Levels
- New Zealand National Environmental Standard Cabinet Paper, May 2011.
- New Zealand Water & Wastes Association, 2003. Guidelines for the Safe Application of Biosolids to Land in New Zealand. Developed in conjunction with MfE.
- USEPA, 2002b: EPA Region 9 Preliminary Remediation Goals, US Environmental Protection Agency
- United States Environmental Protection Agency (USEPA), 2002a: EPA Region 6 Human Health Medium Specific Risk based Screening Levels, US Environmental Protection Agency
- USEPA, 2000: EPA Ecological Soil Screening Level Guidance, US Environmental Protection Agency

In addition, documents consulted included:

- USEPA, 2001: Supplemental Guidance for Developing Soil Screening Levels at Superfund Sites. Washington, D.C. – used as a reference document when USEPA Soil Screening Levels were selected as appropriate guideline values
- World Health Organisation (WHO), 2005 Toxicity Equivalent Factors (TEFs) – utilised to calculate TCDD toxicity equivalent for dioxins in accordance with the NES

The benzo(a)pyrene equivalent (eq.) results shown in the summary data tables were calculated in accordance with *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand.*

The Wellington regional background concentration range (URS, 2003) is also shown (where applicable) in the data tables in ***Appendix 16.H.***

7.2.2 Water samples

The only water sample that was collected and analysed was a qualitative grab sample from the stream adjacent to the Pauatahanui Inlet Garden Supplies site. The adopted criteria were from the Australia New Zealand Environment and Conservation Council (ANZECC, 2000) freshwater water quality guidelines and these were used for comparison purposes.

The above guidelines are considered most appropriate for comparison of results from water samples. The guideline values are "trigger" values, because if exceeded, they are a prompt for further investigation or evaluation. These values demonstrate a measure of protection but allow for the possibility of some ecological degradation. The ANZECC 2000 guidelines provide for protection of 95%, 90% and 80% of species and are to be applied depending on stream health. In the interest of being conservative, it was intended to utilise the 95% trigger values. Unfortunately, due to a miscommunication with the laboratory, the reporting limits were generally above both the 95% and 90% trigger values. In some instances, the reporting limits were also above the 80% limits. Therefore, the data from the water sample can only be considered qualitative in nature as no true comparison with adopted criteria can be made.

7.3 Laboratory analytical results

7.3.1 General

Soil samples were collected from sites of concern based on the likelihood of contamination as discussed in previous sections, between 12 April 2010 and 28 April 2010. A summary of the soil samples taken at each site, including the number of duplicate and rinseate samples collected for QA/QC purposes, are as follows:

Summary of soil sample collection

Site name	Total number of samples collected[1]	Number of quality control samples collected		Number of samples analysed[1]
		Duplicates	*Rinseates*	
Sang Sue Market Garden	49	4	5	34
Gold Coast Nurseries	95	8	3	66
Car Haulaways	54	4	4	35
Porirua Gun Club	108	17	1[2]	100
Pauatahanui Inlet Garden Supplies	42	6	3	42
Mana Coach	11	2	1	11
GWRC former sheep dip	12	3	0	12
Former stockyard site	34	4	2	22

[1]Including duplicates and rinseates
[2]Only one rinseate sample was collected due to a field oversight

The MacKays Crossing area was evaluated for the potential presence of UXO; however, no intrusive investigation was undertaken in this area.

An evaluation of the duplicate samples was undertaken to assess data usability, precision, accuracy, comparability and completeness. Further details are provided in ***Section 7.4***, below.

Sample analytical results from all sites were compared to human health and ecological risk based guideline values for commercial/industrial land use. Results are summarised in tables provided in ***Appendix 16.H***. Results that exceed the relevant guideline value have been presented in bold and coloured red or blue where the exceedance is for human health risk or ecological guideline values, respectively. In addition, tables showing summary statistics for each location are provided at the end of ***Appendix 16.H***.

Cadmium was present above background levels at every site investigated except Mana Coach. The range of cadmium reported for samples at most of the sites was from less than the laboratory reporting limit of 0.10 mg/kg to more than five times the reported background range of <0.10 mg/kg to 0.10 mg/kg. Cadmium has been associated with use of phosphate fertilisers (NCMC, 2007).

Based on viewing results from all of the sites, it is believed that a combination of soil variability, the low concentration reported as a background level and routine application of fertiliser in agricultural areas are the most likely causes of the cadmium detections. It should be noted that cadmium detections were below both human health and ecological risk based guideline values.

A summary of the comparison of laboratory results with guideline values is discussed below on a site-by-site basis. For ecological risk, commercial/industrial and recreational/parkland values were considered and are presented as two values in the discussions below with the commercial/industrial value followed by the parkland recreational value (e.g., 26/17 mg/kg represents the commercial/industrial and recreational/parkland values for arsenic).

7.3.2 Sang Sue Market Garden

A total of 44 soil samples were collected at the Sang Sue Market Garden site (including duplicates). Of the samples collected, 25 primary samples were analysed for heavy metal screen (arsenic, cadmium, chromium, copper, lead, nickel and zinc) and 12 primary samples were analysed for ORC pesticides and all samples analysed for ORP/ORN pesticides. A total of 10 primary samples were analysed for PAH. Sample results are summarised in ***Table 16.13*** in ***Appendix 16.H***.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentrations below the NES SCV and ecological risk based guideline values of 70 mg/kg and 26 mg/kg and 17 mg/kg, respectively (hereafter indicated as 26/17 mg/kg). The majority of the results were within typical background levels for arsenic (URS, 2003).

Cadmium

All soil sample laboratory results returned cadmium concentrations below the NES SCV and ecological risk based guideline values of 1,300 mg/kg and 22/10 mg/kg, respectively.

When comparing the results against background soil concentrations documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS, 2003), the majority of cadmium concentrations are above typical background levels. This is most likely due to the application of fertiliser and possibly pesticides and/or fungicides.

Chromium

All soil sample laboratory results returned concentrations below the ecological risk based guideline values of 87/52 mg/kg. The NES SCV indicates no upper limit for chromium.

Chromium concentrations across the site ranged from 5.8 mg/kg to 31 mg/kg, with eight samples returning results higher than the upper range background concentration of 16 mg/kg (URS, 2003). The median chromium concentration of all soil samples is 13.9 mg/kg (excluding duplicates and rinseate samples). It is possible that anthropogenic activities could be the cause of the elevated chromium concentrations; however, based on chromium concentrations seen at the Car Haulaways and former Golden Coast Nurseries sites across existing SH1, it is also possible that the range is indicative of background levels for this particular area.

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline value of 91/63 mg/kg, except for SS39(0.1). Soil sample SS39-0.1 returned a copper concentration of 136 mg/kg, which exceeds the commercial/industrial ecological risk based guideline value of 91mg/kg. The NES SCV indicates no upper limit for copper.

While copper concentrations were within the typical background range for the majority of samples (3 mg/kg to 25 mg/kg), a few samples returned copper concentrations above typical background levels. The locations of samples above background levels are directly adjacent to and downgradient of existing SH1. It is possible that stormwater runoff from the existing highway may have impacted the soil in this area, as it is not uncommon to find elevated copper concentrations along highways due to copper-containing brake pads in vehicles. If the copper were the result of application of pesticide or fungicide, it would be expected that the elevated concentrations would be more evenly distributed across the site.

Lead

All laboratory results returned lead concentrations below SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively. In addition, results were within the typical background range of 5.9 to 78.6 mg/kg for lead (URS, 2003).

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guidelines of 500 mg/kg and 50 mg/kg respectively. They were also within the typical background range for nickel of 4 to 13 mg/kg (URS, 2003).

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values of 35,000 mg/kg and 360/200 mg/kg respectively. Zinc was also within typical background concentrations which range from 24 to 105 mg/kg (URS, 2003).

Pesticides

Organochlorine pesticides

All soil sample laboratory results returned concentrations below human health and ecological risk based guideline values for all ORC pesticide screened constituents.

Seven samples (excluding duplicates and rinseates) returned concentrations above effective detection levels for DDT isomers. However, the concentration of DDT in the soil samples is considered to be low, especially when compared to guideline values. Given that DDT was widely used in New Zealand, detections of DDT were not unexpected.

Organonitrogen and organophosphorus pesticides

All soil sample laboratory results indicate that concentrations of ORN and ORP pesticides were below the human health and ecological risk based guideline values.

The majority of soil sample laboratory results indicate that concentrations of ORN and ORP pesticides were present, but are well below guideline values. Detections of the above constituents are likely to be associated with market gardening activities (insecticide/herbicide use) on the site. However, the concentrations of residual ORN and ORP pesticides in the soils are not likely to present a risk to local ecology or human health based on comparison with guideline values.

PAH

All soil sample laboratory results indicate that PAH concentrations were below soil acceptance criteria for all PAH constituents reported when compared to values the NES SCVand in Table 4.11 ‘Commercial / Industrial Use - All Pathways’ from *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand,* (MfE, 1999).

The reported soil sample PAH results were also compared with background soil values documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington* Region (URS 2003).

The benzo(a)pyrene equivalent (eq.) result was calculated in accordance with *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*. Only two samples had benzo(a)pyrene eq. and pyrene results above laboratory reporting limits. All samples returned results within Wellington regional background levels. Naphthalene was not detected in any of the samples analysed for PAH.

The reported soil sample PAH results were also compared against the NES SCV and soil acceptance criteria for the Protection of Groundwater Quality (Table 4.20. Sandy Silt, Groundwater <4 m depth) in *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE, 1999)*. There were no exceedances of guideline values.

Summary of results

The number of samples analysed, minimum and maximum laboratory result and number of samples exceeding guideline values is given in the tables below for heavy metals, pesticides and PAH.

Summary heavy metals results at the Sang Sue Market Garden site

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
25 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	2	9.4	0	0
Cadmium	<0.1	0.5	0	0
Chromium	13.4	20	0	0
Copper	9.5	136	0	**1**
Lead	9.0	98	0	0
Nickel	6.6	13.1	0	0
Zinc	53	131	0	0

Summary pesticides results at the Sang Sue Market Garden site

Analyte[1]	Number of samples analysed[2]	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
DDT (Total)	11	7	BEDL[3]	0.1195	0	0
Alachlor	25	15	BEDL	0.53	NA[4]	NA
Pendimethalin	25	4	BEDL	0.33	NA	NA
Permethrin	25	1	BEDL	0.056	NA	NA
Pirimiphos-methyl	25	3	BEDL	0.45	NA	NA

Notes 1 - Only those analytes detected are reported in this table
2 - Excluding duplicate samples and rinseate samples.
3 - Below effective detection limit
4 - Not applicable as no guideline value established

Summary PAH results at the Sang Sue Market Garden site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
10 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	0	BEDL[1]	BEDL	0	0

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
Naphthalene	0	BEDL	BEDL	0	0
Pyrene	0	BEDL	BEDL	NA[2]	0

Notes 1 - Below effective detection limit
2 – Not applicable as no guideline value established

Summary of human health risk

All samples analysed for heavy metals, pesticides and PAH returned results below human health guideline values.

Pesticides (ORC/OPP/ONP) concentrations are below the relevant guideline values for human health.

Summary of ecological risk

One soil sample (SS39-0.1) exceeded the ecological guideline value for copper. Cadmium was also present above background concentrations, but was below the ecological guideline values. Metals that are above ecological risk based guideline values are not believed to present a risk to local ecology, particularly given the planned future construction at the site and the disturbed nature of the area.

Pesticides (ORC/OPP/ONP) were detected in some of samples at the site and are likely to be the result of past and present market garden activities. However, the residual pesticide concentrations are below the relevant guideline values for ecologic receptors.

The soil samples with contaminants present above ecological risk based guideline or background values appear to be largely limited to the upper 0.1 m of soil. This soil will be excavated during highway construction and will, by default, be blended with deeper soil. This will likely result in an overall lower concentration of contaminants of concern. In addition, a large portion of the area will be covered by the highway. Based on this construction scenario, the risk to ecology within the construction footprint of the proposed highway is therefore considered to be low and no remedial action or mitigation is required at this site. In addition, the risk to vegetation planted along the area as landscaping is considered to be low as the areas with contamination present above risk based guideline values are sporadic and do not appear to be indicative of overall site contamination.

7.3.3 Former Golden Coast Nurseries

A total of 95 soil samples were collected at the former Golden Coast Nurseries site, including duplicate samples and rinseates. A total of sixty two samples were analysed for heavy metal screen (arsenic, cadmium, chromium, copper, lead, nickel and zinc), while fifty eight samples were analysed for ORC/OPP/ONP pesticides and sixteen samples analysed for acid herbicides. A total of twenty five samples were analysed for PAH. In addition, four samples were collected from building materials and analysed for asbestos. A summary of the results is provided in ***Table 16.14*** in ***Appendix 16.H***.

Heavy metals

Arsenic

All but one of the soil sample laboratory results returned arsenic concentrations below the SCV risk based NES value of 70 mg/kg. One sample, GCN26 (0.1), exceeded the NES SCV with a result of 100 mg/kg. The result of a sample taken from the same location at 0.3m depth was 43 mg/kg, which is below the SCV.

Ten samples exceed the ecological risk based guideline values for arsenic of 26 and 17 mg/kg. Values exceeding ecological risk based guideline values in samples collected from 0.01 m – 0.1 m below ground surface ranged from 26 mg/kg to 100 mg/kg, although it should be noted that one duplicate sample had a value of 20 mg/kg. Samples GCN 2 (0.3), GCN 6 (0.3) and GCN 13 (0.3) returned values above the recreational/parkland ecological risk based guideline value and GCN 23 (0.3) returned a value above the commercial/industrial ecological guideline value. All other samples returned arsenic concentrations below the ecological risk based guideline value.

Reported background arsenic levels in soils around Wellington are between <2 to 7 mg/kg (URS, 2003). Evaluation of the results shows arsenic concentrations within the samples ranged from 2.7 mg/kg to 100 mg/kg with a median value of 7.7 mg/kg (excluding duplicates and rinseates). Comparison of soil samples taken at the former Golden Coast Nurseries site against background levels, indicate that arsenic levels are slightly above typical background concentrations and are likely present from past usage of fertilisers, pesticides, herbicides and/or fungicides.

Cadmium

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 1,300 mg/kg and 22/10 mg/kg respectively for cadmium. Cadmium concentrations ranged from <0.10 mg/kg to 1.08 mg/kg. The samples where cadmium was detected were generally above typical background levels of <0.1 to 0.1 mg/kg reported by URS (2003). This could be indicative of fertiliser usage and/or gardening activities conducted at the nursery site.

Chromium

The NES SCV indicates no upper limit for chromium. Chromium values ranged from 6.3 mg/kg to 310 mg/kg. The majority of the samples returned concentrations less than 30 mg/kg. Two samples from the sample location, GCN13-0.1 and GCN13-0.3, returned values of 310 and 160 mg/kg, respectively, which exceed the ecological risk based guideline values of 87/52 mg/kg.

The median concentration from 51 samples is 14.2 mg/kg, which is within the typical background range of 6 to 16 mg/kg (URS, 2003). This suggests that in most locations across the site, chromium is naturally occurring due to the original rock source.

However, the sample locations with the highest chromium concentrations (310 mg/kg and 160 mg/kg) also had elevated concentrations of several other metals. The highest cadmium concentration detected was in sample GCN13-0.1, as was the highest zinc concentration. This indicates that it is likely that activities at the nursery have resulted in higher than expected concentrations of metals at specific locations at the site. Because of its location (inside a building, near a bench) and because it appears to be relatively isolated, it is likely the result of past spillage.

Copper

The NES SCV indicates no upper limit for copper. Twelve samples exceed the ecological risk based guideline values of 91/63mg/kg. These samples are GCN10-0.1, GCN11-0.1, GCN13-0.1, GCN14-0.1, GCN15-0.1 and GCN15-0.3, GCN16-0.1, GCN26-0.1 and GCN26-0.3, GCN27-0.1, GN30-0.1 and GN35-0.1. The majority of these samples are located within the main nursery buildings on the eastern side of the property.

Evaluation of the results shows that copper concentrations ranged from 5.2 mg/kg to 1,910 mg/kg with a median value of 22 mg/kg. However, a high standard deviation (+/- 349 mg/kg) is apparent, which suggests copper is highly variable across the site. The highest copper concentration was found within sample GCN15-0.1, which also contains the highest concentration of Endosulfan I, Endosulfan II and Endosulfan sulphate. There is not an apparent direct correlation between copper and other metals. Copper-containing compounds are often utilised for control of pests and fungi at garden and nursery facilities. Based on the location of the higher than expected concentrations of copper (i.e., within the nursery buildings), it is likely that the copper is present as the result of past nursery activities.

Lead

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively.

Lead concentrations within the samples ranged from 3.7 mg/kg to 127 mg/kg (excluding duplicates and rinseates) with a median value of 22 mg/kg. Only two samples returned lead concentrations above typical background levels. As with many of the other metals detected, the highest concentration was found in sample GCN13-0.1, with a reported value of 127 mg/kg lead.

Nickel

All soil sample laboratory results for nickel returned concentrations below the human health and ecological risk based guideline values of 500 mg/kg and 50 mg/kg respectively, with the exception of GCN13-0.1. Soil sample GCN13-0.1 returned a nickel concentration of 107 mg/kg, which exceeds the ecological risk based guideline values and typical background concentrations found in Wellington region soils. Sample GCN13-0.3 also had nickel present at a concentration of 52 mg/kg, slightly above the ecological values. Note that the samples collected from GCN13 location had elevated concentrations of other metals as well. Only one other sample, GCN22-0.1 (18.3 mg/kg), exceeded the background range concentrations of 4 mg/kg to 13 mg/kg (URS, 2003).

Concentrations of nickel in soil samples ranged from 5.1 mg/kg to 107 mg/kg (excluding duplicates and rinseates) with a median value of 9.6 mg/kg.

Zinc

All soil sample laboratory results returned zinc concentrations below the human health based guideline values of 35,000 mg/kg.

Eleven samples exceed the ecological risk based guideline value of 360/200 mg/kg, including GCN1-0.1, GCN3-0.1, GCN6-0.3, GCN11-0.1, GCN13-0.1, GCN13-0.3, GCN14-0.1, GCN15-0.1, GCN26-0.1 and GCN26-0.3 and GN40-0.1. The majority of these sample sites are located within the main nursery sheds on the eastern side of the property.

Concentrations of zinc in soil samples ranged from 27 mg/kg to 1,690 mg/kg (excluding duplicates and rinseates) with a median value of 84 mg/kg. The highest zinc concentration of 1.690 mg/kg was found in sample GCN13-0.1. This sample also had elevated levels of cadmium, nickel, copper, chromium and lead. Heavy metals were also analysed from the deeper sample at this location (GCN13-0.3). Laboratory results returned zinc concentrations of 900 mg/kg, almost half of the concentration found within surface soil sample. Similarly, nickel, copper and chromium were also approximately half of the surface soil sample result.

Pesticides and herbicides

Organochlorine pesticides

All soil laboratory results returned ORC pesticide constituent concentrations below the human health and ecological risk based guideline values. The majority of soil sample laboratory results indicate that concentrations of ORC pesticides were below effective detection levels for all screened constituents. However, ORC pesticide constituents were detected in several samples as shown below.

ORC pesticide constituents	Sample numbers	General location
• Gamma-BHC (Lindane)	GCN12-0.1, GCN14-0.1, GCN26-0.1, GCN26-0.3	Within the main nursery sheds on the eastern side of the property.

ORC pesticide constituents	Sample numbers	General location
• DDT isomers	GCN1-0.1, GCN2-0.1, GCN3-0.1, GCN10-0.1, GCN11-0.1, GCN13-0.1, GCN14-0.1, GCN15-0.1, GCN15-0.3, GCN16-0.1, GCN25-0.1, GCN26-0.1, GCN26-0.3, GCN27-0.1, GN28-0.1 GN31-0.1, GN33-0.1, GN35-0.1, GN36-0.1	Within the main nursery sheds on the eastern side of the property. Within the mesh covered block immediately adjacent to the existing SH1 on western side of property.
• Endosulfans *including Endosulfan I, Endosulfan II, Endosulfan Sulphate*	Detected in all samples *except* GCN6-0.1, GCN9-0.1 and GCN9-0.3, GCN17-0.1, GCN24-0.1, GN34-0.1 to GN37-0.1 and GN38-0.1	Widespread across the site, both indoors and outdoors.

Organonitrogen and organophosphorus pesticides

All soil sample laboratory results had concentrations of ORN and ORP that were below the human health and ecological risk based guideline values.

In most of the soil samples, concentrations were below laboratory reporting limits for all screened ORN and ORP constituents. Ten samples returned concentrations above laboratory reporting limits for the following ORN and ORP constituents:

- Bromopropylate – GCN1-0.1, GCN2-0.1, GCN2-0.3, GCN14-0.1, GCN26-0.1, GCN27-0.1
- Oxadiazon – GCN26-0.1, GN30-0.1, GN39-0.1, GN40-0.1
- Permethrin – GCN14-0.1, GCN15-0.1
- Pirimicarb – GCN1-0.1
- Triazophos – GCN14-0.1

The above sample locations are within the main nursery buildings on the eastern side of the property.

Acid herbicides

All soil samples analysed for herbicides returned laboratory results below effective detection levels for all screened constituents.

PAH

All soil samples analysed for PAH returned laboratory results indicating that concentrations were below adopted guideline values for all PAH constituents reported when compared to values in the NES SCV and in Table 4.11 of "Commercial / Industrial Use - All Pathways" in *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (MfE, 1999).

Three samples returned benzo [a] pyrene eq. results above laboratory detection limits, while pyrene was detected in only one sample. Napthelene was not detected in any samples.

Comparison of PAH concentrations against documented background range concentrations (URS, 2003) show that the majority of the detected PAH results are within the typical background range concentrations. Only soil sample GN38-0.3 returned a benzo(a)pyrene concentration above the typical background level, with a result of 0.515 mg/kg. Elevated concentrations of other constituents were not detected at this location; therefore, the PAH detected may be the result of past paving operations or similar activities.

Asbestos

Two out of three samples of building material collected returned laboratory results showing a presence of asbestos material in the form of Chrysotile and Crocidolite. The samples sites were collected from the main nursery buildings on the eastern side of the property. These buildings house the main office and ancillary facilities associated with the nursery operations.

Summary of results

The number of samples analysed, minimum and maximum laboratory result and number of samples exceeding guideline values is given in the tables below for heavy metals, pesticides and PAH.

Summary heavy metals results at the Former Golden Coast Nurseries site

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value[1]	Samples exceeding ecological guideline value[1]
51 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	2.7	100	1	**12**
Cadmium	0.105	1.08	0	0
Chromium	6.3	310	0	**2**
Copper	5.2	1910	0	**13**
Lead	3.7	127	0	0
Nickel	5.1	107	0	**1**
Zinc	27	1690	0	**11**

Notes 1 - Excluding duplicate samples and rinseate samples. One duplicate sample had an arsenic value above the recreational/parkland ecological value, but the primary sample result was below the guideline value.

Summary pesticide results at the Former Golden Coast Nurseries site

Analyte[1]	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
48 samples analysed (excluding duplicate and rinseate samples)					
DDT (Total)	19	BEDL[2]	1.78	0	0
Gamma-BHC (Lindane)	4	BEDL	0.098	0	0
Endosulfan I	28	BEDL	0.9	0	0
Endosulfan II	34	BEDL	1.68	0	0
Endosulfan sulphate	38	BEDL	3.2	0	0

Notes 1- Only those analytes detected are reported in this table
2- Below effective detection limit

Summary PAH results at the Former Golden Coast Nurseries site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
15 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	3	BEDL[1]	0.51	0	0
Naphthalene	0	BEDL	BEDL	0	0
Pyrene	1	BEDL	0.04	NA[2]	0

Notes 1 - Below effective detection limit
2 - Not applicable as no relevant guideline value available

Summary of human health risk

One sample exceeded the NES SCV for arsenic, which is likely to be a result of past nursery operations. At this sample location (GCN26), analytical results indicate that the arsenic concentration above the human health NES is limited from surface to a depth of 0.3m.

All samples analysed for pesticides, herbicides, TPH and PAH returned results below applicable human health guideline values.

Detections of pesticide constituents are likely to be associated with past nursery operations. However, the concentrations of residual ORC/ORP/ORN pesticide constituents within the soils are considered to be relatively low. They are also below all relevant guideline values where guidelines are available.

Samples taken from fibrolite building material on the site have identified the presence of asbestos. Consideration should be given to utilising appropriate building demolition methods when dealing with asbestos-containing material.

Summary of ecological risk

A number of soil samples exceed the ecological guideline values for arsenic, copper, chromium, nickel and zinc, as shown in the previous table.

The highest concentrations of metals detected are associated with the surficial soil layer and metal concentrations appear to decrease with depth. The highest detections of zinc, copper and chromium occur concurrently, in a corner of the large greenhouse/office building. Based on the location of the detected heavy metals, the elevated concentrations are likely to be the result of past site activities within the greenhouses, such as application or spillage of pesticide or fertiliser. The higher detections seem concentrated near the edges of the greenhouses; it is possible that run off tended to accumulate near the walls.

Detections of pesticide constituents are likely to be associated with past nursery operations. However, the concentrations of residual ORC/ORP/ORN pesticide constituents within the soils are considered to be relatively low. They are also below all relevant guideline values where guidelines are available.

During highway construction, the upper layer of soil will likely be removed from the former Golden Coast Nurseries site. This will result in blending of contaminants of concern with unimpacted deeper soil, resulting in overall lower concentrations. In addition, the area with the highest concentrations of contaminants (i.e., heavy metals) will be directly under the highway and essentially capped. Based on this construction scenario, the heavy metals present above ecological risk based guideline values are not believed to pose a risk to local ecology or future landscaping. Note that the highway construction activities in this area are largely fill activities.

7.3.4 Car Haulaways

A total of thirty one soil samples were analysed for TPH, sixteen soil samples were analysed for PAH and sixteen samples for heavy metals. A summary of laboratory analytical results is provided in ***Table 16.15*** in ***Appendix 16.H***.***Heavy metals***The heavy metal screen laboratory analysis included arsenic, cadmium, chromium, copper, lead, nickel and zinc. All samples had detectable concentrations of metals present; however, none were above the risk based values for protection of human health. Some sample results were above the guideline values for protection of ecological receptors for zinc in CH2(0.1) and CH10(0.1). Sample locations where the guideline values were exceeded are summarised in the next table.

Wellington region background concentrations (URS, 2003) for chromium range from 6 to 16 mg/kg and for zinc range from 24 mg/kg to 105 mg/kg. Samples CH2 (0.1) and its duplicate sample

CH3(0.1) returned results of 310 mg/kg and 210 mg/kg, respectively, which is well above typical background concentrations for zinc, but well below human health risk based guidelines. Note that CH2 and CH3 are duplicate samples; this demonstrates the variability in metals concentrations within the soils at the site. In addition, TPH was found at detectable concentrations in CH3(0.1), CH2(0.3) and CH3(0.3), indicating that anthropogenic activities may have contributed to the elevated metals concentrations at this location.

Samples CH10(0.1) and CH10(0.3) and their duplicates, CH11(0.1) and CH11(0.3), also returned elevated concentrations of zinc, ranging from 220 mg/kg to 400 mg/kg.

The results for zinc across the site are highly variable, ranging from concentrations of 61 to 400 mg/kg. The zinc concentrations shown in the table below are above both ecological risk based concentrations (360/200 mg/kg) and typical Wellington region background concentrations (URS, 2003); however, there is no apparent direct correlation with detections of TPH or PAH. In addition, there does not appear to be a direct correlation with detections of other metals present above background concentrations. The zinc results are most likely indicative of runoff from galvanised structures around the site and general variability within the soil.

Sample CH5(0.3) returned a chromium result of 27 mg/kg and sample CH2(0.3) returned a result of 35 mg/kg. Sample CH3(0.3), a duplicate of CH2(0.3), returned a chromium result of 19.6 mg/kg. No hydrocarbons were detected above laboratory reporting limits in sample CH5(0.3).

Cadmium was also present above background concentrations in some of the samples, as were nickel, copper and arsenic. The site is largely covered with gravel from an unknown source (most likely a nearby quarry). It is possible that the gravel was impacted by metals contamination prior to its importation; however, it is more likely that the metals present are naturally occurring and highly variable because of the original rock source. Several of the elevated concentrations of zinc were detected in samples near galvanised structures; therefore, it is likely that the structures represent the source of the higher zinc concentrations.

TPH and PAH

Ten of the thirty one samples analysed for TPH had concentrations present above laboratory reporting limits. Of the reported concentrations, none were higher than the risk based guideline values for protection of ecological receptors or human health. With two exceptions, the detectable concentrations ranged from 47 mg/kg to 290 mg/kg. Only sample CH21 had C7 – C9 range TPH present; the remainder had only C15 – C36 range hydrocarbons present. The concentration of C7 – C9 range hydrocarbons was 8.2 mg/kg, which is much lower than the risk based guideline value of 500 mg/kg. Samples CH9(0.1) and CH18(0.1) had total TPH concentrations of 2,200 mg/kg and 11,600 mg/kg, respectively. Both were collected from areas of noticeable soil staining and represent a “worst realistic case” sample result. The assumption of “worst realistic case” is based on the fact that due to the light coloured soil, surface hydrocarbon releases are readily observable as the soil staining is quite apparent. However, both are well below the guideline risk based concentration of 20,000 mg/kg for protection of human health.

Pyrene was detected in two soil samples and naphthalene was not detected in any soil samples. Trace amounts of other PAH were detected in several other samples, but only sample CH5(0.1) had a benzo(a)pyrene equivalent above laboratory detection limits. In sample CH5(0.1), Benzo[b] fluoranthene + Benzo[j]fluoranthene was detected at a concentration of 0.033 mg/kg, giving a benzo(a)pyrene eq of 0.003 mg/kg. None of the PAH detected were above risk based guideline values.

Building material samples

Four samples of the fibre cement exterior wall cladding of the office building were collected, including one duplicate, for analysis for asbestos. No samples contained identifiable asbestos.

Summary of results

The number of samples analysed, minimum and maximum laboratory result and number of samples exceeding guideline values is given in the tables below.

Summary heavy metals results at the Car Haulaways site

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
12 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	3.9	9.6	0	0
Cadmium	0.177	0.460	0	0
Chromium	11.7	35.0	0	0
Copper	10.3	29.0	0	0
Lead	17.5	48.0	0	0
Nickel	9.6	20.0	0	0
Zinc	58.0	360.0	0	**3**

Summary PAH results at the Car Haulaways site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
12 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	1	BEDL[1]	0.003	0	0
Naphthalene	0	BEDL	BEDL	0	0
Pyrene	2	BEDL	0.027	NA[2]	0

Notes 1 – Below effective detection limit
2 - Not applicable as no guideline value available

Summary TPH results at the Car Haulaways site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
27 samples analysed (excluding duplicate and rinseate samples)					
C7-C9	1	BEDL[1]	8.2	0	NA[2]
C10-C14	0	BEDL	BEDL	0	NA
C15-C36	7	BEDL	11,600	0	NA
TPH Total	7	BEDL	11,600	NA	NA

Notes 1- Below effective detection limit
2- Not applicable as no guideline value available

Summary of human health risk

All samples returned metals, TPH and PAH results below the human health risk based guideline values.

Summary of ecological risk

Zinc was present at concentrations above ecological risk based guideline values at two sample locations. The zinc detected above ecological risk based guideline values was in samples near galvanised structures; fencing and a metal shed. The ecological risk based guideline values for zinc

are 360/200 mg/kg; elevated concentrations ranged from 210 mg/kg to 400 mg/kg. It is likely that the elevated zinc detections are the result of runoff from the galvanised structures.

The two elevated chromium detections appear to be localised in nature. The source is not known, but it is possible that the slightly elevated concentrations could be naturally occurring. Alternatively, it may be the result of some type of minor spillage.

The elevated zinc and chromium detections are in the upper layer of soil, at a depth of approximately 0.3m. During highway construction, soil will be excavated from the area and the majority of the site will be beneath the paved highway. During excavation, the upper layers of soil will be blended with deeper soil as part of construction. This will effectively dilute the concentrations currently seen. Completion of the highway will result in the area effectively being capped. The highway construction will largely consist of filling activities. Therefore, the risk to local ecology and future landscaping will be minimal.

7.3.5 Porirua Gun Club

Summary of sampled areas

A total of one hundred and twenty eight soil samples were collected at the Porirua Gun Club on 12 to 15 April 2010. Soil samples were collected from the seven main areas of concern, which included:

- Ammunition/target areas (lower and upper level)
- Ammunition burn pit
- Storage shed
- Drainage channel
- Wastewater (leachfield) area
- Rubbish disposal area
- Background areas

Results from each sample area are discussed below.

Ammunition/target areas (lower and upper level)

The ammunition/target areas comprise four main areas:

i) Lower level firing range
ii) Lower level target range area
iii) Upper level target/bullet catch area
iv) Upper level rifle range building structure

A total of 60 primary soil samples were collected on 12 to 14 April 2010. Results were compared to human health guideline values for commercial/industrial land use and ecological receptors in commercial/industrial and recreational/parkland settings. Note that eight of the sample locations are outside of, but directly upgradient of, the designation in an area with clay target and ammunition fragments present. Therefore, there are possible implications for stormwater management. No samples were collected from the upper level target/bullet catch area as it is outside of the designation.

A summary of the laboratory results is provided in ***Table 16.16*** in ***Appendix 16.H***.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentrations below SCV and ecological risk based guideline values of 70 mg/kg and 26/17 mg/kg, respectively. Arsenic concentrations ranged

from 2.5 mg/kg to 10.9 mg/kg, with a median value of 4.75 mg/kg (excluding duplicates and rinseates). Typical Wellington region background concentrations of arsenic range from 2 to 7 mg/kg (URS, 2003). While the arsenic detected in one of the samples exceeded typical background concentrations, the concentration is still well below risk based guideline values and may reflect soil heterogeneity.

Cadmium

All soil sample laboratory results returned cadmium concentrations below SCV and ecological risk based guideline values of 1,300 mg/kg and 22/10 mg/kg, respectively. Cadmium concentrations within the samples ranged from <0.1 mg/kg to 0.24 mg/kg. Typical background concentrations for the Wellington region are reportedly <0.1 to 0.1 mg/kg (URS, 2003). There is not a consistent pattern of cadmium detections above background concentrations compared with the presence of other metals. The cadmium may be present due to naturally occurring metals in the soil, use of fertilisers and/or leaching from ammunition or clay targets. However, in all instances, the concentrations are well below risk based guideline values.

Chromium

All soil sample laboratory results returned concentrations below and the ecological guideline values of 87/52 mg/kg for chromium. There is no human health SCV provided for total chromium or Chromium III in the NES.

Chromium laboratory results ranged from 10.6 mg/kg to 27 mg/kg. Background chromium concentrations in soil from the Wellington region range from 6 mg/kg to 16 mg/kg (URS, 2003). The median chromium concentration from the samples is 16.75 mg/kg (excluding duplicates and rinseates). As discussed in Section 7.3.5.8, samples collected from background areas around the site had chromium concentrations of 9.3 to 19.7 mg/kg, with a median concentration of 14.5 mg/kg, indicating that the chromium concentrations in soils in this particular area are likely somewhat higher than those reported in URS 2003. The highest chromium detections of 27 and 25 mg/kg, were reported in samples GC S57 and GC S58, respectively. The elevated chromium concentrations do not correlate with elevated detections of other metals and there is no apparent source of chromium contamination. Therefore, it is likely that the chromium reported is naturally occurring and that the soils are relatively heterogeneous.

Copper

There is no NES for human health for copper. Samples GC S83 collected from the 0.1 m to 0.2 m depth range and GC S87 collected at a depth of 0.03 m had concentrations of 8,400 mg/kg and 15,400 mg/kg respectively. Both samples were collected from the upper level rifle range building area. Sample GC S84 from the 0.1 m to 0.2 m depth range was a duplicate of sample GC S83 and had a copper concentration of 3,100 mg/kg. These values are below SCV value, but above the ecological risk guideline value.

Following evaluation of initial results, the deeper sample from the GC S87 sample location (i.e., sample GC S88 at 0.1 m to 0.2 m depth) was analysed. Sample GC S88 had a result of 690 mg/kg which was above the ecological risk based guideline values of 91/63 mg/kg. These sample locations are situated at the upper level rifle range building structure sheds, approximately 50 m up gradient of the proposed highway alignment.

The following samples exceeded the ecological risk based guideline value for copper of 91 mg/kg as shown in the following table:

General location	Sample number	Concentration (mg/kg)
Lower level firing range	GCS11	3,000
	GCS12 (Duplicate)	610
	GCS13	106
	GCS19	550
	GCS25	2,600
	GCS27	290
Lower level target range area (outside designation)	GCS51	152
	GCS53	143
	GCS54	100
	GCS55	330
Upper level rifle range building structure	GC S81	152
	GCS82 (Duplicate)	178
	GCS84	3,100
	GCS85	1,890
	GCS86	1,340
	GCS88	690

Lead

Numerous near-surface samples exceeded the NES SCV of 3,300 mg/kg and well above ecological risk-based guideline values. Because of these high concentrations detected in the shallow samples, the corresponding deeper (i.e., shallow subsurface) samples were analysed for lead as summarised in the table below. Three of the samples were above the NES SCV.

Samples with lead results above human health risk based guideline value and corresponding deeper sample results

Near-surface sample (> human health guideline value)	Result (mg/kg)	Corresponding shallow subsurface sample	Result (mg/kg)	General location
GCS11	2000	GCS13	320	Lower level firing range
GCS15	830	GCS16	200	Lower level firing range
GCS17	3000	GCS18	220	Lower level firing range
GCS19	2100	GCS20	350	Lower level firing range
GCS21	7000	GCS22	1,990	Lower level firing range
GCS23	6600	GCS24	530	Lower level firing range
GCS25	730	GCS26	510	Lower level firing range
GCS27	4200	GCS28	540	Lower level firing range
GCS29	3000	GCS30	500	Lower level firing range
GCS49	880	GCS51	260	Lower level target range

Near-surface sample (> human health guideline value)	Result (mg/kg)	Corresponding shallow subsurface sample	Result (mg/kg)	General location
GCS53	2400	GCS54	570	Lower level target range
GCS81	1260	GCS83	3,300	Upper level rifle range building structure
GCS85	1860	GCS86	250	Upper level rifle range building structure
GCS87	700	GCS88	33	Upper level rifle range building structure

With the exception of GCS83, the shallow subsurface samples returned lead results below the NES SCV and ecological guideline value of 3,300 mg/kg and 600 mg/kg, respectively. It is likely that the high lead result in GCS83 is due to the presence of ammunition fragments in the sample.

Six additional samples in the lower level firing range and four additional samples in the lower level target range exceeded the parkland/recreational ecological risk based guideline value.

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guideline values of 500 mg/kg and 50 mg/kg respectively. Nickel concentrations within the soil samples ranged from 4.5 mg/kg to 16.6 mg/kg, with a median value of 9.85 mg/kg (excluding duplicates and rinseates).

Zinc

All soil sample laboratory results returned zinc concentrations below the human health risk based guideline value of 35,000 mg/kg.

Ten samples exceeded the recreational/parkland ecological risk based guideline value of 200 mg/kg as shown below. All but two of these also exceeded the commercial/industrial ecological risk based guideline value of 360 mg/kg.

Samples exceeding ecological risk based guideline for zinc

Sample numbers and concentration	General location
GC S11 (700 mg/kg), GC S12 Duplicate (330 mg/kg), CG S15 (280 mg/kg) and CG S17 (250 mg/kg).	Lower level firing range
GC S81 (320 mg/kg), GC S82 Duplicate (440 mg/kg), GC S83 (1,560 mg/kg), GC S84 Duplicate (530 mg/kg), GC S85 (700 mg/kg) and GC S87 (10,400 mg/kg)	Upper level rifle range building structure

Antimony

Initially, antimony was not identified as a contaminant of particular concern, despite it being listed by MfE as a potential contaminant at firing ranges. Antimony is utilised as a hardening agent for ammunition; however, it is typically found in concentrations less than ten percent of the total metal

present in ammunition. If too much antimony is used, the ammunition becomes brittle and does not perform properly. However, a peer review of the report suggested that because antimony behaves differently in the environment than the primary contaminants of concern (i.e., copper and lead), it should be evaluated. The laboratory was able to retrieve antimony results from previously generated data. Results were requested for representative samples; i.e., those with both high and low lead and copper values.

Antimony was not present above the human health guideline value of 450 mg/kg in any of the samples evaluated. It was present above the commercial/industrial ecological risk based value of 21 mg/kg in five of the samples evaluated for the lower level firing range and none from the lower level target range. It was not evaluated for other areas as the lower ranges had the largest amount of ammunition present, it was assumed that they were “worst case” areas.

While antimony is present at the site, it is not considered a primary driver for remedial action as the elevated concentrations are co-located with elevated lead concentrations. The number of samples analysed for heavy metals, minimum and maximum laboratory result and number of samples exceeding guideline values is given in the tables below.

Summary of heavy metals results at the Lower Level Firing Range area

Analyte	Number of samples analysed[1]	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
Arsenic	17	2.7	10.9	0	0
Antimony	10	2.7	230	0	5
Cadmium	17	<0.1	0.230	0	0
Chromium	17	15.3	27.0	0	0
Copper	19	8.2	3000.0	0	**8**
Lead	25	17.6	7000.0	**3**	**17**
Nickel	17	7.1	14.6	0	0
Zinc	17	36.0	700.0	0	**3**

Note 1 - Excluding duplicate samples and rinseate samples.

Summary of heavy metals results at the Lower Level Target Range area

Analyte	Number of samples analysed[1]	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding Human health guideline value	Samples exceeding ecological guideline value
Arsenic	10	2.5	5.1	0	0
Antimony	4	1.3	8.1	0	0
Cadmium	10	<0.1	0.14	0	0
Chromium	10	9.3	13.9	0	0
Copper	12	5.2	330.0	0	**5**
Lead	11	128.0	2400.0	0	**6**
Nickel	10	4.5	8.5	0	0
Zinc	10	3.2	41.0	0	0

Note 1- Excluding duplicate samples and rinseate samples.

Summary of heavy metals results at the Upper Level Rifle Range Building Structure

Analyte	Number of samples analysed[1]	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
Arsenic	4	4.5	6.3	0	0
Cadmium	4	<0.1	0.2	0	0
Chromium	4	15.0	17.7	0	0
Copper	6	152	15400	0	6
Lead	6	33	3300	1	**4**
Nickel	4	10.5	16.6	0	0
Zinc	4	320	10400	0	**4**

Note 1 - Excluding duplicate samples and rinseate samples.

PAH

Nine soil samples exceeded the NES SCV of 35 mg/kg for benzo(a)pyrene eq. These samples are listed in the table below.

Sample numbers and concentration	General location
GC S41 (113.79 mg/kg), CG S43 (60.59 mg/kg), CG S44 (45.55 mg/kg), CG S45 (148.39 mg/kg), CG S47 (62.92 mg/kg), CG S49 (66.140 mg/kg), CG S53 (276.96 mg/kg) and CG S55 (79.87 mg/kg)	Lower level firing range
GC S81 (182.99 mg/kg)	Upper level rifle range structure

All remaining soil samples analysed for PAH returned laboratory results indicating that concentrations were below the human health soil acceptance criteria for all PAH constituents reported when compared to values in Table 4.11 'Commercial / Industrial Use - All Pathways' (*Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*) and to the NES SCV for benzo(a)pyrene eq. The highest PAH detection was 276.96 mg/kg benzo(a)pyrene eq. at the lower target range. The elevated PAH concentrations are likely to be from the clay targets, which are known to leach PAH into the soil.

The Canadian Environmental Quality Guidelines provide ecological risk based guideline values for benzo(a)pyrene eq., naphthalene and pyrene. The lowest risk based ecological value for benzo(a)pyrene eq. is 20 mg/kg for recreational/parkland sites and was not exceeded at any locations beyond those where human health guideline values were exceeded. One sample in the lower level target range exceeded the recreational/parkland value of 0.6 mg/kg and samples from the lower level firing range area, lower level target range area and upper level rifle range building structure exceeded pyrene ecological risk based values.

The number of samples analysed for PAH, minimum and maximum laboratory result and number of samples exceeding guideline values is given in the following tables.

Summary of PAH results at the Lower Level Firing Range area

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
Benzo(a)pyrene eq.	19	0.052	11.46	0	0
Naphthalene	1	BEDL[1]	0.31	0	0
Pyrene	19	BEDL	0.07	NA[2]	2

Note 1 - Below effective detection limit
2 – Not applicable as no guideline value available

Summary of PAH results at the Lower Level Target Range area[1]

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
10 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	10	7.20	276.9	**8**[3]	9
Naphthalene	6	BEDL[2]	4.9	0	1
Pyrene	10	7.6	280	NA[3]	9

Note 1 – Note that this area is outside of but upgradient of the designation
2 – Below effective detection limit
3 – Duplicate sample GC S50 was above the NES SCV, likely due to a clay target fragment present in the sample
4 - Not applicable as no guideline value available

Summary of PAH results at the Upper Level Rifle Range Building Structure

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
4 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	4	0.38	182.99	**1**	**1**
Naphthalene	1	BEDL[1]	0.52	0	0
Pyrene	4	0.29	198	NA[2]	1

Note 1 - Below effective detection limit
2 - Not applicable as no guideline value available

7.3.5.3 Ammunition Burn Pit analytical results

A total of 12 surface soil samples were collected on 14 April 2010. Two of the soil samples were duplicate samples. Laboratory results of soil samples were compared to human health guideline values for commercial / industrial land use and ecological receptors. Note no duplicates were taken for dioxin analysis at the time of sampling.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentrations below the NES SCV (70 mg/kg) and ecological (26/17 mg/kg) risk based guideline values. Arsenic concentrations within soil samples ranged from 2.7 mg/kg to 5.3 mg/kg, with a median value of 3.7 mg/kg (excluding duplicates and rinseates). Sample results were comparable with typical Wellington regional background values (URS, 2003).

Cadmium

All soil sample laboratory results returned cadmium concentrations below the NES SCV (1,300 mg/kg) and ecological (22/10 mg/kg) risk based guideline values. Cadmium concentrations within the samples were <0.1 mg/kg for all samples. Sample results were comparable with typical Wellington regional background values (URS, 2003).

Chromium

There is no NES SCV limit for total chromium. No soil samples exceeded the ecological risk based guideline values of 87/52 mg/kg. The reported soil sample chromium results were also compared against Wellington regional background values (URS, 2003). Results ranged from 18.7 mg/kg to 21 mg/kg, which is above the background chromium concentrations in soil, which range of 6 mg/kg to

16 mg/kg. The median chromium concentration from the samples is 19.35 mg/kg (excluding duplicates and rinseates).

Copper

All but one soil laboratory result returned concentrations below ecological risk based guideline values of 91/63 mg/kg. There is no SCV for copper. Copper concentrations in the soil samples ranged from 9.7 mg/kg to 65 mg/kg, with a median value of 11.65 mg/kg (excluding duplicates and rinseates). One sample exceeded the recreational/parkland ecological risk based guideline value of 63 mg/kg. The laboratory result for soil sample GC S107 returned a concentration of 65 mg/kg, which was an average of 54 mg/kg above the surrounding soil samples. With the exception of sample GC S107, copper results were consistent with typical Wellington background values (URS, 2003).

Lead

All laboratory results except one returned lead concentrations belowthe NES SCV and ecological risk based guideline value of 3,300 mg/kg and 600/300 mg/kg respectively. Lead concentrations within the soil samples ranged from 16.3 mg/kg to 460 mg/kg, with a median value of 23 mg/kg (excluding duplicates and rinseates). The laboratory results for soil sample GC S107 returned a concentration of 460 mg/kg, which was an average of 433 mg/kg above the surrounding soil samples and above the recreational/parkland ecological risk based guideline value of 300 mg/kg. With the exception of sample GC S107, lead results were consistent with typical Wellington background values (URS, 2003).

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guideline of 500 mg/kg and 50 mg/kg respectively. Nickel concentrations within the soil samples ranged from 6.8 mg/kg to 9.7 mg/kg, with a median value of 7.65 mg/kg (excluding duplicates and rinseates). Results were consistent with Wellington background values (URS, 2003)

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values of 35,000 mg/kg and 360/200 mg/kg respectively. Zinc concentrations within the soil samples ranged from 27 mg/kg to 43 mg/kg, with a median value of 32.5 mg/kg (excluding duplicates and rinseates). Results were consistent with Wellington background values (URS, 2003).

PAH

All soil samples analysed for PAH returned laboratory results indicating that concentrations were below adopted guideline values for all PAH constituents reported when compared to the NES SCV and applicable values in Table 4.11 ‘Commercial / Industrial Use - All Pathways’ (*Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*). Comparison of PAH concentrations with documented background levels show that PAH values are generally within the typical Wellington regional background ranges (URS, 2003).

Dioxins and Furans

All ten soil samples analysed for dioxins and furans returned results below the NEStSCV as shown in ***Table 16.17***, ***Appendix 16.H***.

Dioxins are generally found in mixtures containing several kinds of dioxins and dioxin-like compounds, each having its own degree of toxicity. To express the overall toxicity of such a mixture as a single number, the concept of TEQ has been developed. The TEQ scheme weighs the toxicity of the less toxic compounds as fractions of the toxicity of the most toxic compound: TCDD. Each

compound is attributed a specific TEF**.** This factor indicates the degree of toxicity compared to 2,3,7,8-TCDD, which is given a reference value of 1. To calculate the total TCDD TEQ of a dioxin mixture, the amounts of each toxic compound are multiplied by their TEF and then added together.

Based on the proposed NES for Assessing and Managing Contaminants in soil, the 2005 WHO TEFs were used to calculate the TEQ for the samples collected. The laboratory provided both lower bound and upper bound TEQs. The lower bound calculation evaluates only specific congeners. The highest reported upper bound result includes total congeners. For example, the lower bound only includes 2,3,7,8 TCDF while the upper bound includes total TCDF. The upper bound that was calculated with the WHO TEFs was utilised for comparison purposes to evaluate potential effects.

The highest TEQ upper bound concentration detected was 1.27 pg/g; the remaining samples returned results ranging from 0.61 to 1.0 pg/g (using the WHO TEQ). This is well below the SCV of 14 µg/kg (14,000 pg/g) for unpaved sites and paved sites with no management plan. The proposed NES guideline value for dioxin is 1,400 pg/g for commercial/industrial sites and 1,100 pg/g for recreational sites; the results are also well below these guideline values.

The number of samples analysed for heavy metals and PAH, minimum and maximum laboratory results and number of samples exceeding guideline values is given in the following tables.

Summary of heavy metals results at the Ammunition Burn Pit

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
10 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	2.7	5.3	0	0
Cadmium	<0.1	<0.1	0	0
Chromium	18.7	21.0	0	0
Copper	9.7	65.0	0	**1**
Lead	16.3	460.0	0	**1**
Nickel	6.8	9.7	0	0
Zinc	27.0	43.0	0	0

Summary of PAH results at the Ammunition Burn Pit

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
10 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	0	BEDL[1]	BEDL	0	0
Naphthalene	0	BEDL	BEDL	0	0
Pyrene	1	BEDL	0.04	NA[2]	0

Note 1 - Below effective detection limit
2 - Not applicable as no guideline value available

7.3.5.4 Storage shed analytical results

A total of four surface soil samples were collected on 12 April 2010. One of the soil samples was a duplicate sample. Laboratory results of soil samples were compared to human health guideline values for commercial / industrial land use and ecological receptors.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentrations below the NES SCV (70 mg/kg) and ecological (26/17 mg/kg) risk based guideline values. Arsenic concentrations within soil samples ranged from 3 mg/kg to 5.1 mg/kg, which is consistent with Wellington regional background values (URS, 2003).

Cadmium

All soil sample laboratory results returned cadmium concentrations below the NES SCV (1,300 mg/kg) and ecological (22/10 mg/kg) risk based guideline values. Cadmium concentrations within the samples ranged from <0.1 mg/kg to 0.23 mg/kg. Sample GC S1, with a concentration of 0.23 mg/kg, exceeded the Wellington regional background range of <0.1 to 0.1 mg/kg; the remainder of the samples were consistent with background values (URS, 2003).

Chromium

There is no NES SCV limit for total chromium. No soil samples exceeded the ecological risk based guideline values of 87/52 mg/kg. Samples returned concentrations from 19.6 mg/kg to 20 mg/kg.

The reported chromium soil sample results were also compared against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003*)*. Background chromium concentrations in soil from the Wellington region range of 6 mg/kg to 16 mg/kg. The soils samples exceeded the background concentration with values ranging from 19.6 mg/kg to 23 mg/kg.

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline values of 91/63 mg/, except for sample GC S1 at 0.025 m depth. There is no NES SCV limit for copper. Soil sample GC S1 returned a copper concentration of 360 mg/kg, which exceeded the ecological risk based guidelines values. Copper concentrations within the remaining soil samples ranged from 7.4 mg/kg to 11.5 mg/kg, with are within typical Wellington regional background ranges (URS, 2003).

Lead

All laboratory results returned lead concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively. Lead concentrations within the soil samples ranged from 28 mg/kg to 153 mg/kg. All but two samples exceeded the typical background concentrations of 5.9 to 78.6 mg/kg (URS, 2003), with results from 87 to 167 mg/kg.

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guideline of 500 mg/kg and 60 mg/kg respectively. Nickel concentrations within the soil samples ranged from 9.7 mg/kg to 10.6 mg/kg, well within the typical background range of 4 to 13 mg/kg (URS, 2003).

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values of 35,000 mg/kg and 360/200 mg/kg respectively. Zinc concentrations within the soil samples ranged from 40 mg/kg to 99 mg/kg, within the background range of 24 to 105 mg/kg (URS, 2003).

Pesticides

Organochlorine pesticides

All soil sample laboratory results indicated that concentrations of ORC pesticides were below effective detection levels for all screened constituents.

Organonitrogen and organophosphorus pesticides

All soil sample laboratory results indicated that concentrations of ORN and ORP pesticides were below effective detection levels for all screened constituents.

TPH

All soil sample laboratory results indicated that concentrations were below soil acceptance criteria for all TPH when compared to values in *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (MfE, 1999).

It should be noted that the laboratory result returned for sample GC S1 showed the presence of TPH, C15-C36 of 34 mg/kg. The background concentration for TPH ranges from <30 mg/kg to 190 mg/kg.

A data summary, showing the analyte, number of samples analysed, minimum and maximum laboratory results and number of samples exceeding guideline values, is provided below for heavy metals and TPH.

Summary of heavy metals results at the storage shed area

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
3 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	4	5.1	0	0
Cadmium	<0.1	0.23	0	0
Chromium	19.6	21	0	0
Copper	7.5	360	0	**1**
Lead	52	153	0	0
Nickel	9.7	10.3	0	0
Zinc	41	99	0	0

Summary of TPH results at the storage shed area

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
3 samples analysed (excluding duplicate and rinseate samples)					
C7-C9	0	BEDL[1]	BEDL	0	0
C10-C14	0	BEDL	BEDL	0	0
C15-C36	1	BEDL	34	NA[2]	0

Note 1 - Below effective detection limit
2 - Not applicable as no guideline value available

7.3.5.5 Drainage channel analytical results

A total of six surface soil samples were collected on 12 April 2010. One of the soil samples was a duplicate sample. Laboratory results of soil samples were compared to human health guideline values for commercial / industrial land use and ecological receptors.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentrations below the NES SCV (70 mg/kg) and ecological (26/17 mg/kg) risk based guideline values. Arsenic concentrations within soil samples ranged from 5.5 mg/kg to 7.6 mg/kg, with is generally consistent with the typical Wellington regional background range of <2 to 7.

Cadmium

All soil sample laboratory results returned cadmium concentrations below the NES SCV (1,300 mg/kg) and ecological (22/10 mg/kg) risk based guideline values. Cadmium concentrations within the samples ranged from <0.1 mg/kg to 0.56 mg/kg. Only one sample, GC S7, exceeded the typical background values or <0.1 to 1 mg/kg (URS, 2003).

Chromium

There is no NES SCV limit for total chromium.No soil samples exceeded the ecological risk based guideline values of 87/52 mg/kg. Chromium values ranged from 17.9 mg/kg to 28 mg/kg. The reported soil sample chromium results were also compared against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003). Background chromium concentrations in soil from the Wellington region range from 6 mg/kg to 16 mg/kg. The soils samples exceeded the background concentration by an average of 5.8 mg/kg, with values ranging from 17.9 to 28 mg/kg.

Copper

All soil laboratory results returned concentrations below ecological risk based guideline values of 91/63 mg/kg. There is no NES SCV limit for copper. Copper concentrations within the soil samples ranged from 10.3 mg/kg to 51 mg/kg. Two samples returned results is above the typical background values of 3 to 25 mg/kg (URS, 2003).

Lead

No soil samples exceeded the NES SCV of 3,300 mg/kg. Two samples exceeded the ecological risk based guideline values: GC S7 (2,200 mg/kg) and GC S9 (1,590 mg/kg) at 0.04 m and 0.05 m depth respectively. All other samples returned lead concentrations below the ecological risk based guideline values of 600/300 mg/kg.

Background lead levels in soils from Porirua and further north are between 5.9 to 78.6 mg/kg (URS, 2003). Statistical analysis of the results shows lead concentrations within the samples ranged from 87 mg/kg to 2,200 mg/kg with a median value of 167 mg/kg (excluding duplicates and rinseates).

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guidelines of 500 mg/kg and 50 mg/kg respectively. Nickel concentrations within the soil samples ranged from 9 mg/kg to 13.5 mg/kg, which is generally consistent with typical Wellington region background values of 4 to 13 mg/kg (URS, 2003).

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values 35,000 mg/kg and 360/200 mg/kg respectively. Zinc concentrations within the soil samples ranged from 43 mg/kg to 84 mg/kg, which is consistent with typical Wellington region background values of 24 to 105 mg/kg (URS, 2003).

Antimony

As previously described, antimony was not initially considered a primary contaminant of concern. However, antimony results were obtained for three samples (two primary and one duplicate). Antimony was present below the human health guideline value of 450 mg/kg. It was present above the commercial/industrial ecological risk based value of 21 mg/kg in one sample, with a result of 27 mg/kg. It was below ecological guideline values in all other samples, including the duplicate sample. No background values were available for antimony in soil.

PAH

All soil samples analysed for PAH returned laboratory results below soil acceptance criteria for all PAH constituents reported when compared to the NES SCV and applicable values in Table 4.11 'Commercial / Industrial Use - All Pathways' (*Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*). Comparison of PAH concentrations against documented background levels show that the majority of the PAH results are within the typical background levels for the Wellington region. Two samples (GC S7 (0.92 mg/kg at 0.04 m depth and GC S9 8.59 mg/kg at 0.05 m depth) returned a benzo(a)pyrene eq and pyrene concentration above the typical background range with concentrations of 0.92 mg/kg and 1.23 mg/kg.

Summary information regarding analytes, number of samples analysed, minimum and maximum laboratory results and the number of samples exceeding guideline values is provided in the following table for heavy metals, PAH and TPH.

Summary of heavy metals results at the drainage channel area

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
5 samples analysed (excluding duplicate and rinseate samples) for heavy metals, two primary and one duplicate sample analysed for Antimony				
Arsenic	5.5	6.2	0	0
Antimony	0.8	27	0	1
Cadmium	<0.1	0.56	0	0
Chromium	17.9	28.0	0	0
Copper	10.3	51.0	0	0
Lead	87.0	2200.0	0	**2**
Nickel	9.0	13.5	0	0
Zinc	43.0	84.0	0	0

Summary of PAH results at the drainage channel area

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
5 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	5	BEDL[1]	8.59	0	0
Naphthalene	1	BEDL	0.16	0	0
Pyrene	5	BEDL	4.8	NA[2]	0

Note 1 - Below Effective Detection Limit
2 - Not applicable as no guideline value established

Summary of TPH results at the drainage channel area

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
2 samples analysed (excluding duplicate and rinseate samples)					
C7-C9	0	BEDL[1]	BEDL	0	0
C10-C14	0	BEDL	BEDL	0	0
C15-C36	0	BEDL	BEDL	NA[2]	0

Note 1 - Below effective detection limit
2 - Not applicable as no guideline value available

7.3.5.6 Wastewater area analytical results

A total of six surface soil samples were collected on 13 April 2010. One of the soil samples was a duplicate sample. Laboratory results of soil samples were compared to human health guideline values for commercial / industrial land use and ecological receptors.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentration below the NES SCV (70 mg/kg) and ecological (26/17 mg/kg) risk based guideline values. Arsenic concentrations within soil samples (URS, 2003).

Cadmium

All soil sample laboratory results returned cadmium concentrations below the NES SCV (1,300 mg/kg) and ecological (22/10 mg/kg) risk based guideline values. Cadmium concentrations within the samples were <0.1 mg/kg for all samples, which is consistent with background concentrations (URS, 2003).

Chromium

No soil samples exceeded the ecological risk based guideline values of 87/52 mg/kg. There is no NES SCV limit for total chromium. Chromium values ranged from 10.9 mg/kg to 16.9 mg/kg. The reported soil sample chromium results were also compared against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003). Background chromium concentrations in soil from the Wellington region range of 6 mg/kg to 16 mg/kg and found to be generally consistent with background values.

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline values of 91/63 mg/kg. There is no NES SCV limit for copper. Copper concentrations ranged from 4.7 mg/kg to 8.2 mg/kg, consistent with background values of 3 to 25 mg/kg (URS, 2003).

Lead

All laboratory results returned lead concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively. Lead results ranged from 14.1 mg/kg to 81 mg/kg, which is consistent with background values of 5.9 to 78.6 mg/kg (URS, 2003).

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guideline of 500 mg/kg and 50 mg/kg respectively. Nickel results ranged from 5.9 mg/kg to 9.2 mg/kg, which is consistent with background values of 4 to 13 mg/kg (URS, 2003).

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values of 35,000 mg/kg and 360/200 mg/kg respectively. Zinc results ranged from 34 mg/kg to 167 mg/kg, with a median value of 45 mg/kg (excluding duplicates and rinseates), which is generally consistent with background values of 24 to 105 mg/kg (URS, 2003).

Faecal Coliforms and E. coli profile

All soil samples analysed for Faecal Coliforms and E. coli profile returned laboratory results below effective detection levels (<2 MPN/g) for all screened constituents, except sample GC S59 which had a concentration of 2MPN/g. This result was below the applicable guideline value of 100MPN/g referenced in the New Zealand Water and Waste Biosolids Guideline document[1].

Summary heavy metal results, showing the analytes, minimum and maximum laboratory results and the number of samples exceeding guideline values are shown in the following table.

Summary of heavy metal results at the wastewater area

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
5 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	3	4	0	0
Cadmium	<0.1	<0.1	0	0
Chromium	11	17	0	0
Copper	5	8	0	0
Lead	16	81	0	0
Nickel	6	9	0	0
Zinc	34	167	0	0

Rubbish disposal area analytical results

A total of eight surface soil samples were collected on 14 April 2010. Two of the soil samples were duplicate samples. Laboratory results of soil samples were compared to human health guideline values for commercial / industrial land use and ecological receptors.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentration below the NES SCV (70 mg/kg) and commercial/industrial ecological (26/17 mg/kg) risk based guideline values. Arsenic concentrations within soil samples ranged from 3 mg/kg to 18.8 mg/kg. One sample, GC S73, which returned a result of 18.8 mg/kg, was above the recreational/parkland ecological guideline value of 17 mg/kg. The remaining sample results were consistent with typical background values (URS, 2003).

[1] The NZ Water and Waste Association guide in regard to biosolids application to land is considered to be an appropriate guideline document.

Cadmium

All soil sample laboratory results returned cadmium concentration below the NES SCV (1,300 mg/kg) and ecological (22/10 mg/kg) risk based guideline values. Cadmium concentrations were <0.1 mg/kg for all samples, which is consistent with typical background values (URS, 2003).

Chromium

No soil samples exceeded the ecological risk based guideline value of 87/52 mg/kg. There is no NES SCV limit for total chromium. Chromium values ranged from 13.4 mg/kg to 22 mg/kg. The reported soil sample chromium results were also compared against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003*)*. Background chromium concentrations in soil from the Wellington region range from 6 mg/kg to 16 mg/kg. Three samples slightly exceeded background concentrations with results of 16.1 to 22 mg/kg. The median chromium concentration is 14.8 mg/kg (excluding duplicates and rinseates).

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline values of 91/63 mg/kg. There is no NES SCV limit for copper. Copper concentrations within the soil samples ranged from 6.2 mg/kg to 61 mg/kg, with a median value of 7.2 mg/kg (excluding duplicates and rinseates). Sample GC S73 exceeded typical background concentrations, with a result of 61 mg/kg. The remaining sample results are consistent with typical background values (URS, 2003).

Lead

All laboratory results returned lead concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively. Lead concentrations within the soil samples ranged from 16.7 mg/kg to 111 mg/kg, with a median value of 45.5 mg/kg (excluding duplicates and rinseates). Two samples, GC S71 and GC S 73, with results of 89 mg/kg and 111 mg/kg, respectively, exceeded typical background values of 5.9 to 78.6 mg/kg. The remaining sample results are consistent with typical background concentrations (URS, 2003).

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guideline of 500 mg/kg and 50 mg/kg respectively. Nickel concentrations within the soil samples ranged from 7.4 mg/kg to 12.9 mg/kg, with a median value of 7.85 mg/kg (excluding duplicates and rinseates). All were within the typical background range of 4 to 13 mg/kg (URS, 2003).

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values of 35,000 mg/kg and 360/200 mg/kg respectively. Zinc concentrations within the soil samples ranged from 33 mg/kg to 41 mg/kg, with a median value of 36.5 mg/kg (excluding duplicates and rinseates). All are within the typical background range of 24 to 105 mg/kg (URS, 2003).

Pesticides and herbicides

Organochlorine pesticides

All soil sample laboratory results returned ORC pesticide constituent concentrations below the human health and ecological risk based guideline values. One soil sample, GC S71, returned a concentration above effective detection levels for 4,4'-DDE with a concentration of 0.0113 mg/kg. This is well below the NES SCV of 1,000 mg/kg total DDT.

Organonitrogen and organophosphorus pesticides

All soil sample laboratory results indicate that concentrations of ORN and ORP pesticides were below effective detection levels for all screened constituents.

Acid herbicides

All soil samples analysed for herbicides returned laboratory results below effective detection levels for all screened constituents. A summary of the heavy metals, pesticides and TPH data is provided in the following tables which provide the minimum and maximum laboratory results and the number of times the guideline value was exceeded for each listed analyte.

Summary of heavy metals results at the rubbish disposal area

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
6 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	3	18.8	0	**1**
Cadmium	<0.1	<0.1	0	0
Chromium	13.4	22.0	0	0
Copper	6.2	61.0	0	0
Lead	16.7	111.0	0	0
Nickel	7.4	12.9	0	0
Zinc	33	41.0	0	0

Summary of pesticide results at the rubbish disposal area

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
6 samples analysed (excluding duplicate and rinseate samples)					
DDT (Total)	1	BEDL[2]	0.0113	0	0

Notes 1- Only those analytes detected are reported in this table
2- Below effective detection limit

Summary of TPH results at the rubbish disposal area

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
6 samples analysed (excluding duplicate and rinseate samples)					
C7-C9	0	BEDL[1]	BEDL	0	0
C10-C14	0	BEDL	BEDL	0	0
C15-C36	0	BEDL	BEDL	NA[2]	0

Notes 1 - Below effective detection limit
2 - Not applicable as no guideline value available

Background area analytical results

A total of eight surface soil samples were collected on 14 April 2010. Two of the soil samples were duplicate samples. Laboratory results of soil samples were compared to human health guideline values for commercial / industrial land use and ecological receptors.

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentration below the NES SCV (70 mg/kg) and ecological risk based guideline values (26/17 mg/kg). Arsenic concentrations within soil samples ranged from 2.1 mg/kg to 4.2 mg/kg, which is within the typical background concentration range (URS, 2003).

Cadmium

All soil sample laboratory results returned cadmium concentration below the NES SCV (1,300 mg/kg) and ecological risk based guideline values (22/10 mg/kg). Cadmium concentrations within the samples were <0.1 mg/kg for all samples, which is consistent with typical background values (URS, 2003).

Chromium

No soil samples exceeded the ecological risk based guideline values of 87/52 mg/kg. There is no NES SCV limit for total chromium. Chromium values ranged from 9.3 mg/kg to 19.7 mg/kg. The reported soil sample chromium results were also compared against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003). Background chromium concentrations in soil from the Wellington region range of 6 mg/kg to 16 mg/kg. The median chromium concentration is 14.55 mg/kg (excluding duplicates and rinseates). The results appear to indicate that the typical background concentrations in this area are somewhat higher than those reported in URS, 2003.

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline values of 91/63 mg/kg. There is no NES SCV limit for copper. Copper concentrations within the soil samples ranged from 3.2 mg/kg to 8.1 mg/kg, with a median value of 5.75 mg/kg (excluding duplicates and rinseates). The concentrations are typical of Wellington regional background concentrations (URS, 2003).

Lead

All laboratory results returned lead concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively. Lead concentrations within the soil samples ranged from 14.1 mg/kg to 67 mg/kg, with a median value of 27.5 mg/kg (excluding duplicates and rinseates). The concentrations are typical of Wellington regional background concentrations (URS, 2003).

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guideline of 500 mg/kg and 50 mg/kg respectively. Nickel concentrations within the soil samples ranged from 3.7 mg/kg to 11.3 mg/kg, with a median value of 7.1 mg/kg (excluding duplicates and rinseates). The concentrations are typical of Wellington regional background concentrations (URS, 2003).

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values 35000 mg/kg and 360/200 mg/kg respectively. Zinc concentrations within the soil samples ranged from 17.4 mg/kg to 38 mg/kg, with a median value of 29 mg/kg (excluding duplicates and rinseates). The concentrations are typical of Wellington regional background concentrations (URS, 2003).

PAH

All soil samples analysed for PAH returned laboratory results indicating that concentrations were below soil acceptance criteria for all PAH constituents reported when compared to the NES SCV and applicable values in Table 4.11 'Commercial / Industrial Use - All Pathways' (*Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*). Comparison of PAH concentrations against documented background levels show that, generally, PAH values are within the typical background levels for the Wellington region.

A summary of results for the background areas at the Porirua Gun Club are provided in the following table. The summary includes the minimum and maximum laboratory result for each analyte and the number of times the guideline values was exceeded.

Summary of heavy metals results for the background areas

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
10 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	2.1	4.2	0	0
Cadmium	<0.1	<0.1	0	0
Chromium	9.3	19.7	0	0
Copper	3.2	8.1	0	0
Lead	14.1	67.0	0	0
Nickel	3.7	11.3	0	0
Zinc	17.4	38.0	0	0

Summary statistics for PAH at the background areas, Porirua Gun Club site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
10 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	0	BEDL[1]	BEDL	0	0
Naphthalene	0	BEDL	BEDL	0	0
Pyrene	1	BEDL	0.03	NA[2]	0

Note 1 - Below effective detection limit
2 - Not applicable as no guideline value available

7.3.5.9 Summary of Porirua Gun Club analytical results

Soil samples were analysed for heavy metals, pesticides, herbicides, TPH, PAH, faecal coliforms and E. Coli as detailed in table below:

General Location	Analytes
Firing/target areas (lower and upper level)	Heavy metals and PAH
Ammunition burn pit	Heavy metals, PAH, dioxins and furans
Storage shed	Heavy metals, pesticides, herbicides, TPH and PAH

General Location	Analytes
Drainage channel	Heavy metals and PAH
Wastewater (leachfield) area	Heavy metals, faecal coliforms and E. Coli
Rubbish disposal area	Heavy metals, pesticides, herbicides and TPH
Background areas	Heavy metals and PAH

Summary of human health risk

All samples analysed from the ammunition burn pit, storage shed, wastewater (leachfield) area, rubbish disposal area and background areas returned results below human health guideline values.

Ammunition/target areas (lower and upper level) returned soil sample results exceeding the NES SCV for lead and several soil samples exceeded the NES SCV for benzo(a)pyrene. Corresponding deep samples were analysed for copper and lead and one sample exceeded the NES SCV for lead.

The drainage channel area returned no soil sample results exceeding human health guideline values for any of the constituents evaluated.

Pesticides (ORC/ORP/ORN) were all below the laboratory detection limit except sample GC S71 at 0.05 m depth. While pesticides were detected, the soil sample result was below guideline values.

TPH was below the laboratory detection limit in all samples except sample GC S1 at 0.025 m depth; however, the soil sample result was below guideline values.

Faecal coliforms and E. Coli were all below the laboratory detection limit except in sample GC S59 at 0.015 m to 0.025 m depth. It should be noted that the data may be questionable because the samples arrived at the laboratory with a temperature >10°C. This could lead to false negative results for these analytes. Faecal coliforms and E. Coli were detected in sample GC S59 at a concentration of 2 MPN/g

Dioxins and furans were below the NES SCV for TCDD.

Summary of ecological risk

The majority of chromium concentrations at the site generally fall within the typical background range concentrations for Wellington soils (URS, 2003); however, the background chromium concentration range in this area appears to be slightly higher than that reported by URS. None of the samples exceeded the ecological values for either commercial/industrial or recreational/parkland sites.

In the ammunition/target areas, numerous soil sample results exceeded the ecological risk based guideline values for lead, copper and zinc. Ecological risk based guideline values for PAH were also exceeded in some samples, particularly areas littered with clay targets. The samples that returned metals results above human health risk based guideline values also exceeded the ecological guideline values.

One soil sample in the storage shed area exceeded the ecological guideline value for copper; the remaining samples were generally below ecological guideline values.

Pesticides (ORC/ORP/ ORN) were all below the laboratory detection limit except in sample GC S71 at 0.05 m depth. While pesticides were detected in this sample, the result was below guideline values.

In the ammunition/target areas where metals are present above ecological risk based guideline values, human health guideline values are also exceeded in many of the samples and remedial action will be required for the entire area. The soil from storage shed area and drainage channel also should be properly managed as it contains concentrations of metals above ecological risk based guideline values.

As described later in this report, remedial action is warranted, particularly as the area is slated as a cut (rather than fill) area. The soil should be properly managed through on-site treatment or off-site disposal to an appropriately licensed landfill facility. The areas where ecological values are exceeded are generally co-located with areas where ammunition is present and where human health guideline values are exceeded. Because the majority of the target/firing range areas are impacted, it is not likely to be economically viable to conduct remediation only of the "hot spots" exceeding human health guideline values, the entire site will likely be remediated. Post-remediation sampling should be conducted to evaluate the contamination left in place (if any). These results should assist in formulating a management strategy for the site if contamination is left in place.

7.3.6 Pauatahanui Inlet Garden Supplies

A total of forty two samples were collected from the Pauatahanui Inlet Garden Supplies site including one surface water sample, six duplicate samples and three rinseate samples. All samples were analysed for heavy metals (arsenic, cadmium, chromium, copper, lead, nickel and zinc), while sixteen samples were analysed for pesticides (ORC/ORP/ORN). A total of twenty nine samples were analysed for PAH and thirty three samples were analysed for TPH. Laboratory results are summarised in ***Table 16.18*** in ***Appendix 16.H***.

Soil sampling

Eight soil samples were collected from random locations on and off the site and analysed for heavy metals and pesticides to establish overall site and background soil quality conditions. These samples include PIG20 (0.1), PIG21(0.1), PIG22 (0.1), PIG24 (0.1), PIG25-0.1, PIG26-0.1, PIG27-0.1 and PIG28-0.1. The results were compared to data documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region (URS 2003)*. With the exception of lead, calculated background concentrations of samples collected by Aurecon were within the ranges of those established already by URS in their 2003 report. This provides a good basis for comparison with those samples collected on site to determine the extent and magnitude of contamination from on site activities versus naturally occurring constituent concentrations.

The results of soil sampling across the remainder of the site are described in the following sections.

Heavy metals

Arsenic

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 70 mg/kg and 26/17 mg/kg respectively.

Arsenic concentrations within the soil samples ranged from 2.2 mg/kg to 8.7 mg/kg with a median value of 4.5 mg/kg (excluding duplicates and rinseates).

Three samples returned arsenic concentrations above typical background arsenic levels, which range from <2 mg/kg to 7 mg/kg (URS, 2003).

Cadmium

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 1,300 mg/kg and 22/10 mg/kg respectively for cadmium.

Cadmium concentrations within the samples ranged from <0.10 mg/kg to 0.27 mg/kg. When comparing the results against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region (URS 2003)*, the majority of cadmium concentrations within the samples collected are above typical background levels. This could be indicative of the anthropogenic activities occurring onsite or be naturally occurring due to the original rock source. It is not unusual to find slightly elevated cadmium concentrations where fertilisers have been utilised. Because the facility is used for the processing of green waste, it is possible that residual cadmium has been deposited from materials which contained elevated cadmium levels due to fertiliser use.

Chromium

No soil samples exceeded the ecological risk based guideline value 87/52 mg/kg. Chromium values ranged from 8.1 mg/kg to 25 mg/kg. The median chromium concentration from thirty two samples taken from the site is 12.45 mg/kg. Note that there is no NES SCV limit for total chromium.

The laboratory results from the intrusive investigation were also compared against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region (URS 2003)*. Although the majority of the soil samples are above ecological risk based guideline values, the concentrations generally fall within the typical background levels of 6 mg/kg to 16 mg/kg. However, six samples were above the typical background levels and these samples were collected from a stained area at the site.

Copper

Copper concentrations within the soil samples ranged from 3.4 mg/kg to 87 mg/kg. Sample PIG8(0.1) had a result of 87 mg/kg, above the recreational/parkland ecological risk based value of 63 mg/kg. This sample was collected from an obviously stained area. There is no NES SCV limit for copper.

Comparison of copper concentrations against documented background levels (URS 2003) show that, in the main, copper values are within the typical background levels of 3 mg/kg to 25 mg/kg. The median value of soil samples taken as part of this investigation is 11.4 mg/kg. Three samples (PIG1 (0.1), PIG3 (0.1) and PIG8-(0.1)) were above background levels. These samples are located within the AST and spill areas.

Lead

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively.

Lead concentrations within the samples ranged from 8.8 mg/kg to 210 mg/kg (excluding duplicates and rinseates).

Comparison of lead concentrations against documented background levels (URS 2003) show that all but four soil samples taken as part of this investigation have lead values that are below the typical background levels (5.9 mg/kg to 78.6 mg/kg). The samples above typical background levels were collected from the spill area. The median value of soil samples taken as part of this investigation is 20.5 mg/kg.

Nickel

All soil sample nickel laboratory results returned concentrations below the human health and ecological risk based guidelines of 500 mg/kg and 50 mg/kg respectively.

Concentrations of nickel in soil samples ranged from 3.7 mg/kg to 13.7 mg/kg with a median value of 8.35 mg/kg. With the exception of three soil samples, all samples tested for nickel returned results that were within the bounds of typical background levels (4 mg/kg to 13 mg/kg).

Zinc

All soil sample laboratory results returned zinc concentrations below the human health and ecological risk based guideline values of 35000 mg/kg and 360/200 mg/kg respectively, with the exception of soil samples PIG2 (0.1) and PIG3 (0.1).

Soil samples PIG2 (0.1) and PIG3 (0.1) exceeded the recreational/parkland ecological risk based guideline value returning results of 270 mg/kg and 320 mg/kg respectively. These samples are located adjacent to the existing shed and AST.

Concentrations of zinc in soil samples ranged from 19.1 mg/kg to 320 mg/kg. Comparison of zinc concentrations against documented background levels (URS 2003) show that, in the main, zinc values are within the typical background levels of 24 mg/kg to 105 mg/kg. The median value of soil samples taken as part of this investigation is 57.5 mg/kg. Eight samples located within the AST and spill areas were above background levels.

Pesticides

Organochlorine pesticides

Twelve soil samples were analysed for ORC pesticides. Of these, four soil samples returned laboratory results with ORC pesticide constituent concentrations above effective detection levels for DDT, but below the NES SCV and ecological risk based guideline values. These sample sites (PIG20, PIG22, PIG27 and PIG28) were located outside of the active garden supply site. There does not appear to be any direct correlation with elevated metals or other pesticides at these locations. The concentrations of DDT are relatively low and are likely the result of past anthropogenic activities occurring in the area.

The laboratory results for all remaining soil samples were below effective detection levels for all screened constituents.

Organonitrogen and organophosphorus pesticides

All soil sample laboratory results indicate that concentrations of ORN and ORP pesticides were below effective detection levels for all screened constituents.

TPH and PAH

All soil sample laboratory results indicate that concentrations were below soil acceptance criteria for all TPHs when compared to the NES SCV for benzo(a)pyrene and applicable values in *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (MfE, 1999).

It should be noted that the laboratory results returned for samples PIG1 to PIG8 and PIG 11 showed the presence of TPH, particularly in the C15-C36 range. Sample PIG3 (0.1) returned the highest TPH concentration with values of 750 mg/kg and 8900 mg/kg for C10-C14 and C15-C36 respectively. This sample was collected from soil near the AST located adjacent to the existing storage shed. An analysis of the chromatogram for this sample suggests that the product is weathered diesel fuel. Chromatograms from other samples appear to indicate that the product is either aged diesel fuel or mixed with other product (such as petrol).

All soil sample laboratory results indicate that concentrations were below soil acceptance criteria for PAH constituents reported when compared to the NES SCV and applicable values in Table 4.11 ‘Commercial / Industrial Use - All Pathways’ (*Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*). Comparison of PAH concentrations against documented background levels show that, in the main, PAH values are within the typical background levels for the Wellington region.

One sample (PIG6-0.3) returned a benzo(a)pyrene and pyrene concentration above the typical background range with a benzo(a)pyrene equivalent concentration of 0.7563 mg/kg and pyrene concentration of 1.05 mg/kg. In addition, soil sample PIG2 (0.3) returned a naphthalene concentration above typical background levels with a result of 0.46 mg/kg, while sample PIG3 (0.1) returned a pyrene concentration of 1.21 mg/kg, also above typical background levels.

Water sample from Pauatahanui Stream

The laboratory results returned for the water sample were below effective detection levels for heavy metals, ORC/ORP/ORN pesticides, PAH and TPH constituents. For the majority of the analytes, the results could not be compared to the selected evaluation criteria, which were the trigger values for the protection of 95% of fresh water species in the ANZECC Water Quality Guidelines as the laboratory reporting limits were above the guideline value in most instances due to a communication error with the laboratory. Where the reporting limits were below the guideline value, the constituents of concern were present below guideline values. Arsenic and lead reporting limits were below the adopted evaluation criteria and the nickel reporting limit was equal to the adopted evaluation criteria. Chlordane, DDT, Endrin and Heptachlor reporting limits were above the 95% trigger level and Lindane and Endosulfan reporting limits were equal to the 95% trigger level.

Cadmium, copper, DDT and Endrin had reporting limits above the 80% trigger level. The remaining constituents of concern had reporting limits below the 80% trigger level.

While it is unfortunate that data were not consistently reported below the 95% trigger level, it should be noted this sample was intended only to be a qualitative grab sample to see if there was a direct correlation between concentrations on site and in the stream, rather than a thorough evaluation of stream conditions. Surface water throughout the project route is being evaluated under another work stream (SKM, 2010). Therefore, while the data are indicative only, this does not present a significant data gap with regard to this assessment.

Summary of results

A summary of the analyses is provided in the following tables, which show the number of samples analysed for each analyte, minimum and maximum laboratory results and number of samples exceeding guideline values.

Summary of heavy metals results at the Pauatahanui Inlet Garden Supplies site

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
32 soil samples analysed (excluding duplicate and rinseate samples)				
Arsenic	2.2	8.7	0	0
Cadmium	<0.10	0.27	0	0
Chromium	8.1	25	0	0
Copper	3.4	87	0	**1**
Lead	8.8	210	0	0
Nickel	3.7	13.7	0	0
Zinc	19.1	320	0	**2**

Summary of pesticides results at the Pauatahanui Inlet Garden Supplies site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
12 soil samples analysed (excluding duplicate and rinseate samples)					
DDT (Total)	4	BEDL[1]	0.0592	0	NA

Note 1 - Below Effective Detection Limit

Summary of PAH results at the Pauatahanui Inlet Garden Supplies site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
21 soil samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	11	BEDL[1]	0.7563	0	0
Naphthalene	2	BEDL	0.46	0	0
Pyrene	10	BEDL	1.21	NA[2]	0

Note 1 - Below effective detection limit
2 - Not applicable as no guideline value available

Summary of TPH results at the Pauatahanui Inlet Garden Supplies site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
24 soil samples analysed (excluding duplicate and rinseate samples)					
C7-C9	1	BEDL	8.4	0	NA[2]
C10-C14	2	BEDL	750	0	NA
C15-C36	16	BEDL	8100	0	NA
TPH Total	14	BEDL	8900	NA	NA

Note 1 - Below effective detection limit
2 - Not applicable as no guideline value available

Summary of human health risk

All samples analysed for heavy metals, pesticides, TPH and PAH returned results below human health guideline values. Sample PIG3 (0.1), taken from within the vicinity of the AST, returned elevated TPH and pyrene concentrations but the concentrations are below the relevant guideline values.

Summary of ecological risk

Two samples exceeded the recreational/parkland ecological guideline value for zinc and one sample exceeded the recreational/parkland ecological guideline value for copper. The remaining samples returned results below the ecological guideline values for all other heavy metals analysed.

The zinc exceedances are near the AST, with the samples returning results of 320 mg/kg and 270 mg/kg, as compared to a recreational/parkland ecological risk based value of 200 mg/kg. It is likely that the zinc is present as the result of minor spillage in the area or stormwater runoff from galvanised materials stored at the site. While slightly elevated, the zinc concentration is not likely to present a significant ecological risk as it is localised and will be excavated as part of establishing the highway and ancillary construction facilities.

The copper exceedance is in a sample collected from a stained area and is also likely to be the result of spillage as it appears to be limited in extent.

Detections of pesticide constituents in soil are likely to be associated with the historic anthropogenic activities on and surrounding the site. The concentrations of residual ORC pesticide constituents in the soils are well below all relevant guideline values. Therefore, their presence is not considered to be a risk to local ecology.

The material that appears to be waste asphalt that was noted during the August 2010 site visit should be properly managed. It should not be placed in areas where stormwater run off could lead to contamination of adjacent areas. The debris piles, debris, outhouse and storage shed should be removed from the site and properly disposed of at a licensed facility. While these features may not represent a significant threat to local ecology, proper disposition will ensure that they do not contribute to environmental degradation.

7.3.7 Mana Coach

A total of ten surface soil samples were collected on 16 April 2010. All samples were analysed for heavy metals, TPH and PAH. Two of the soil samples were duplicate samples. Laboratory results of soil samples were compared to human health guideline values for commercial/industrial land use and ecological receptors. A summary of laboratory analytical results is provided in ***Table 16.19*** in ***Appendix 16.H.***

Heavy metals

Arsenic

All soil sample laboratory results returned arsenic concentration below the NES SCV and ecological risk based guideline values of 70 mg/kg and 26/17 mg/kg respectively. Arsenic concentrations within soil samples ranged from 3.2 mg/kg to 4.7 mg/kg, with a median value of 3.7 mg/kg (excluding duplicates and rinseate samples).

Cadmium

All soil sample laboratory results returned cadmium concentration below the SCV (1,300 mg/kg) and ecological (22/10 mg/kg) risk based guideline values. Cadmium concentrations within the samples were <0.1 mg/kg for all samples.

Chromium

No soil sample results exceeded the ecological risk based guideline values of 87/52 mg/kg. Chromium values ranged from 10.8 mg/kg to 17.6 mg/kg, with a median value of 13.7 mg/kg (excluding duplicates and rinseate samples). There is no NES SCV limit for total chromium.

The reported soil sample chromium results were also compared against background soil quality levels documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003). Background chromium concentrations in soil from the Wellington region range from 6 mg/kg to 16 mg/kg; the results are generally consistent with the typical Wellington region background range for chromium. However, two samples exceeded the published value (URS, 2003) with concentrations of 16.6 and 17.6 mg/kg.

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline values of 91/63 mg/kg. Copper concentrations within the soil samples ranged from 8 mg/kg to 17.0 mg/kg, with a median value of 11.6 mg/kg (excluding duplicates and rinseate samples). There is no NES SCV limit for copper.

Lead

All laboratory results returned lead concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively. Lead concentrations within the soil samples ranged from 13.5 mg/kg to 22 mg/kg, with a median value of 16.8 mg/kg (excluding duplicates and rinseate samples).

Nickel

All laboratory results returned nickel concentrations below the human health and ecological risk based guideline of 500 mg/kg and 50 mg/kg respectively. Nickel concentrations within the soil samples ranged from 8.3 mg/kg to 15.3 mg/kg, with a median value of 11 mg/kg (excluding duplicates and rinseate samples). Two primary and one duplicate sample exceeded the typical Wellington region background values of 3 to 13 mg/kg, with concentrations ranging from 13.1 to 15.3 mg/kg.

Zinc

All soil sample laboratory results returned zinc concentrations below human health and ecological risk based guideline values of 35000 mg/kg and 360/200 mg/kg respectively. Zinc concentrations within the soil samples ranged from 41 mg/kg to 77 mg/kg, with a median value of 56.5 mg/kg (excluding duplicates and rinseate samples).

TPH and PAH

All soil samples analysed for TPH and PAH returned laboratory results indicating that concentrations were below the laboratory effective detection limit for all TPH and PAH constituents. All results are also below the relevant guideline values when compared to the NES SCV and applicable values in Table 4.11 'Commercial / Industrial Use - All Pathways' (*Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*).

Summary of results

The following tables present minimum and maximum laboratory analytical results and the number of samples exceeding guideline values.

Summary of heavy metals results at the Mana Coach site

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
8 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	3.2	4.7	0	0
Cadmium	<0.1	<0.1	0	0
Chromium	10.8	17.6	0	0
Copper	8.0	17.0	0	0
Lead	13.5	22.0	0	0
Nickel	8.3	15.3	0	0
Zinc	41.0	77.0	0	0

Summary statistics for PAH at the Mana Coach site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
8 samples analysed (excluding duplicate and rinseate samples)					
Benzo(a)pyrene eq.	0	BEDL[1]	BEDL	0	0
Naphthalene	0	BEDL	BEDL	0	0
Pyrene	0	BEDL	BEDL	NA[2]	0

Notes 1- Below effective detection limit
2- Not applicable as no guideline value established

Summary of TPH results at the Mana Coach site

Analyte	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
8 samples analysed (excluding duplicate and rinseate samples)					
C7-C9	0	BEDL	BEDL	0	NA
C10-C14	0	BEDL	BEDL	0	NA
C15-C36	0	BEDL	BEDL	0	NA
TPH Total	0	BEDL	BEDL	NA	NA

Notes 1- Below effective detection limit
2- Not applicable as no guideline value established

Summary of human health risk

All samples analysed for heavy metals, TPH and PAH returned results below human health guideline values.

Summary of ecological risk

No soil samples exceeded the ecological guideline values for metals. Three samples exceeded the typical Wellington region background values for nickel and chromium; however, the exceedances are not considered to be significant as they are only slightly above the background value.

7.3.8 GWRC former sheep dip site

A total of twelve samples were collected from three test pits located downgradient of a former sheep dip site. Three samples collected were duplicate samples. All samples were analysed for heavy metals, while six samples were analysed for ORC/ORP/ORN pesticides and select synthetic pyrethroids. A summary of laboratory analytical results is provided in ***Table 16.20*** in ***Appendix 16.H***.

Heavy metals

Arsenic

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 70 mg/kg and 26/17 mg/kg respectively for arsenic. Arsenic concentrations within the samples ranged from 2.2 mg/kg to 15.9 mg/kg with a median value of 5.4 mg/kg (excluding duplicates). Three of the nine samples collected returned arsenic concentrations above typical background levels (<2 mg/kg to 7 mg/kg).

Cadmium

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 1,300 mg/kg and 22/10 mg/kg respectively for cadmium. Cadmium concentrations within the samples ranged from <0.10 mg/kg to 0.24 mg/kg. With the exception of three samples, all other results were below the laboratory limits of detection for cadmium.

Chromium

No soil samples exceeded the ecological risk based guideline values of 87/52 mg/kg. Chromium values ranged from 12.5 mg/kg to 18.1 mg/kg with a median value of 14.0 mg/kg. The reported soil sample chromium results were also compared with background ranges documented in *Determination of Common Pollutant Background Soil Concentrations for the Wellington Region* (URS 2003). Chromium within the soil samples is consistent with the typical background concentration range of 6 mg/kg to 16 mg/kg. Only one sample, GSD3-0.9 (18.1 mg/kg), exceeded the upper background concentration. There is no NES SCV limit for total chromium.

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline values of 91/63 mg/kg. There is no NES SCV limit for copper. Copper concentrations within the samples ranged from 7.3 mg/kg to 26 mg/kg.

Lead

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively.

Lead concentrations within the samples ranged from 11.1 mg/kg to 35 mg/kg. The results are with the typical background concentration range of 5.9 mg/kg to 78.6 mg/kg (URS, 2003).

Nickel

All soil sample nickel laboratory results returned concentrations below the human health and ecological risk based guideline values of 500 mg/kg and 50 mg/kg respectively. Concentrations of nickel in the soil samples ranged from 8.3 mg/kg to 15.4 mg/kg.

Zinc

All soil sample laboratory results returned concentrations below human health and ecological risk based guideline values 35000 mg/kg and 360/200 mg/kg respectively. Concentrations of zinc in soil samples ranged between 43 mg/kg and 161 mg/kg with a median value of 78 mg/kg (excluding duplicates). All samples returned results below typical background levels (URS 2003) with the exception of soil samples GSD1-0.1 and GSD3-0.1, which returned zinc results slightly above typical background levels. These samples also had detections of ORC pesticide constituents, specifically dieldrin.

Pesticides

Organochlorine pesticides

All soil samples laboratory results returned ORC pesticide constituent concentrations below the human health based guideline values, including the NES SCV for total DDT and Dieldrin.

Although the majority of soil sample laboratory results indicate that concentrations of ORC pesticides were below effective detection levels for all screened constituents, three samples (GSD1 - 0.1, GSD3-0.1 and GSD5-0.1) returned concentrations of 0.02 mg/kg, 0.051 mg/kg and 0.072 respectively which are above effective detection levels for Dieldrin. The results were SCV of 160 mg/kg, but above ecological risk based guideline value of 0.011 mg/kg.

Organonitrogen and organophosphorus pesticides

All soil sample laboratory results indicate that concentrations of ORN and ORP pesticides were below laboratory detection limits and therefore below the human health and ecological risk based guideline values.

Synthetic pyrethroids

A range of synthetic pyrethroids was analysed as part of the ORN/ORP pesticide analytical suite. All constituents were below laboratory detection limits.

Summary of results

The following tables present minimum and maximum laboratory analytical results and the number of samples exceeding guideline values.

Summary of heavy metals results at the GWRC former sheep dip site

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
9 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	2.2	15.9	0	0
Cadmium	<0.1	0.24	0	0
Chromium	12.5	18.1	0	0
Copper	7.3	26	0	0
Lead	11.1	35	0	0
Nickel	8.3	15.4	0	0
Zinc	43	161	0	0

Summary of pesticides results at the GWRC former sheep dip site

Analyte[1]	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
6 samples analysed (excluding duplicate and rinseate samples)					
Dieldrin	2	BEDL[2]	0.051	0	**2**

Note 1- Only those analytes detected are reported in this table
2- Below effective detection limit

Summary of human health risk

All samples analysed for heavy metals and pesticides returned results below human health guideline values.

Summary of ecological risk

Three surface soil samples returned concentrations that exceeded the ecological risk based guideline value of 0.011 mg/kg for dieldrin. Sample GSD1 had a dieldrin result of 0.02 mg/kg. Samples GSD3 and GSD5 were duplicate samples and had results of 0.051 mg/kg and 0.072 mg/kg respectively. The remaining samples, including the deeper samples, returned dieldrin results below laboratory reporting limits. While the ecological risk based guideline value for dieldrin was exceeded, it is not believed to present a significant risk to local ecology as it was limited to the near-surface soil samples. When highway construction takes place, the soil will be excavated and will be blended with deeper soil. This will effectively dilute the concentration of the dieldrin present. There was no sign of distressed vegetation in the area; therefore, it does not appear likely that the dieldrin has a significant adverse effect on plants in the area.

All soil sample laboratory results indicate that concentrations were below soil acceptance criteria for all synthetic pyrethroid constituents analysed.

All samples returned heavy metals results below the ecological guideline values and consistent with background concentrations.

7.3.9 Former stockyard site

A total of thirty four samples were collected from former stockyard site, including four duplicate samples and two rinseate samples which were collected for quality control purposes. Twenty two samples were analysed for heavy metals and ORC/ORP/ORN pesticide constituents, while the

remaining samples were placed on cold hold at the laboratory. Laboratory analytical results are summarised in ***Table 16.21*** in ***Appendix 16.H***.

Heavy metals

Arsenic

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 70 mg/kg and 26/17 mg/kg respectively for arsenic. Arsenic results ranged from 3.6 mg/kg to 12.2 mg/kg with a median value of 4.9 mg/kg (excluding duplicates). Generally, these results are comparable to background levels of <2 mg/kg to 7 mg/kg recognised by GWRC (URS, 2003).

Cadmium

All soil sample laboratory results returned concentrations below NES SCV and ecological risk based guideline values of 1,300 mg/kg and 22/10 mg/kg, respectively, for cadmium. Cadmium results ranged from <0.10 mg/kg to 0.25 mg/kg.

Chromium

No soil samples exceeded the ecological risk based guideline value 87/52 mg/kg. Chromium results ranged from 10.8 mg/kg to 18.4 mg/kg with a median value of 13.3 mg/kg. The results were also compared against background soil quality levels (URS 2003). The soil sample results generally fall within the Wellington region background chromium concentration range of 6 mg/kg to 16 mg/kg. There is no NES SCV limit for total chromium.

Copper

All soil laboratory results returned concentrations below the ecological risk based guideline value of 91/63 mg/kg. There is no NES SCV limit for copper. Copper concentrations within the samples ranged from 7.4 mg/kg to 43 mg/kg. The median concentration is 10.9 mg/kg.

Lead

All soil sample laboratory results returned concentrations below the NES SCV and ecological risk based guideline values of 3,300 mg/kg and 600/300 mg/kg respectively.

Lead concentrations within the samples ranged from 10.4 mg/kg to 37.0 mg/kg with a median concentration of 12.95 mg/kg. Lead concentrations within all samples analysed are within the range of typical Wellington region background levels of soil in the region (5.9 mg/kg to 78.6 mg/kg) (URS 2003).

Nickel

All soil sample laboratory results for nickel returned concentrations below the human health and ecological risk based guidelines of 500 mg/kg and 50 mg/kg respectively. Concentrations of nickel in the soil samples ranged from 4.1 mg/kg to 9.2 mg/kg. Nickel results are within the range of typical background levels of soil in the region (4 mg/kg to 13 mg/kg) (URS 2003).

Zinc

All soil sample laboratory results returned concentrations below the human health risk based guideline value of 35000 mg/kg. One sample (BH13-0.1) exceeded the recreational/parkland ecological risk based guideline value of 360/200 mg/kg.

Concentrations of zinc in soil samples ranged between 36 mg/kg and 210 mg/kg with a median value of 61 mg/kg (excluding duplicates).

Pesticides

All soil sample laboratory results returned ORC pesticide constituent concentrations below the human health risk based guideline values, including the NES SCV for total DDT. It should be noted however, that all samples returned DDT concentrations above effective detection levels. Concentrations of DDT constituents within soil sampled ranged from 0.0133 mg/kg to 1.4906 mg/kg. These concentrations are considered to be low level contamination when compared to the relevant guideline values and are likely the result of past land use practices around the stockyards. The NES SCV for DDT is 1,000 mg/kg; all results were well below this guideline value.

Organonitrogen and organophosphorus pesticides

All soil sample laboratory results indicate that concentrations of ORN and ORP pesticides were below laboratory reporting limits.

Summary of results

The tables below present minimum and maximum laboratory analytical results and the number of samples exceeding guideline values.

Summary of heavy metals results at the former stockyard site

Analyte	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
16 samples analysed (excluding duplicate and rinseate samples)				
Arsenic	3.6	12.2	0	0
Cadmium	<0.1	0.25	0	0
Chromium	10.8	18.4	0	0
Copper	7.4	43	0	0
Lead	10.4	37	0	0
Nickel	4.1	9.2	0	0
Zinc	36	210	0	**1**

Summary of pesticides results at the former stockyard site

Analyte[1]	Number of times detected	Minimum (mg/kg dry weight)	Maximum (mg/kg dry weight)	Samples exceeding human health guideline value	Samples exceeding ecological guideline value
16 samples analysed (excluding duplicate and rinseate samples)					
DDT (Total)	16	0.013	1.49	0	**6**

Note 1 - DDT, DDE and DDD were detected

Summary of human health risk

All soil samples analysed for heavy metals and pesticides returned results below human health risk based guideline values. DDT was detected in all samples. Although DDT is present at the site, the risk to human health and ecological environment is not considered to be high due to the low concentrations returned within the samples which are all well below the relevant guideline values.

Summary of ecological risk

All soil samples analysed for heavy metals and pesticides returned results below human health risk based guideline values.

Arsenic is present above background concentrations in several samples, with concentrations ranging from 3.6 to 12.2 mg/kg, compared with typical background concentrations of 2 to 7 mg/kg (URS 2003). However, the arsenic concentrations detected are well below the ecological guideline value of 37 mg/kg. Cadmium is also present above background values, with concentrations ranging from <0.01 to 0.25 mg/kg. However, all samples had concentrations well below the ecological risk based guideline values of 22 and 10 mg/kg. The same is true for chromium; three samples returned values slightly above typical background levels.

One sample slightly exceeded the zinc recreational/parkland ecological guideline value, with a concentration of 210 mg/kg compared with the risk based guideline value of 200 mg/kg. This is likely due to the presence of galvanised structures.

While one sample had a zinc concentration slightly above the ecological risk based guideline value, the site does not appear to pose a threat to local ecology. There was no sign of distressed vegetation. The area will be excavated as part of highway construction and surface soil metals concentrations will be essentially be diluted due to the mixing that occurs during typical construction. In addition, the highway construction in this area will be primarily fill activities.

Total DDT is present above recreational/parkland ecological risk based guideline values in six samples collected from across the site. DDT was detected in all of the samples collected at the site, in concentrations varying from 0.0133 mg/kg to 1.4906 mg/kg. The recreational/parkland ecological guideline value is 0.7 mg/kg, the commercial/industrial guideline value is 12 mg/kg.

Although total DDT is present above recreational/parkland ecological risk based guideline values, it is not thought to present a significant risk to local ecology as the area will largely be subjected to fill activities during construction and soil will be managed in accordance with the CSMP.

7.4 QA/QC evaluation of analytical data

QA/QC procedures relevant to this investigation were carried out in general accordance with the relevant MfE CLMG No.5, *Site Investigation and Analysis of Soils* and internal Aurecon Standard Operating Procedures.

Aurecon considers that adequate QA/QC has been achieved by meeting the following DQOs:

- Collection of an adequate number of samples to allow for statistical evaluation of data
- Redundancy in laboratory-specific procedures and analytical methods
- Redundancy in field analytical methods
- Use of QC samples to check the precision and accuracy of the data obtained

Field QC procedures for the present investigation included standardised sample collection, decontamination, handling and transfer protocols. In addition, the laboratories selected for conducting the chemical analyses hold IANZ accreditation.

When evaluating data usability, precision, accuracy, comparability and completeness are evaluated.

7.4.1 Precision

Precision is a measure of agreement among individual measurements of the same parameter under the same or similar conditions. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been. Precision is expressed in terms of relative percent difference (RPD) between replicate samples using the following equation:

$$RPD = \frac{(S-D)X100}{(S+D)/2}$$

Where:

S = original sample value
D = duplicate sample value

If control limits criteria are not met, a careful examination of the sampling techniques, sample media and analytical procedures should be conducted to identify the cause of the elevated RPD and determine usability. The typically accepted RPD acceptance criterion for soil field duplicates is ±50%.

A total of 56 duplicate soil samples were collected from eight sites investigated for this project. A summary of the RPD between soil samples collected and their duplicates is provided in the following tables on a site by site basis. Further details of the RPD values are provided in ***Tables 16.20*** through ***16.27*** in ***Appendix 16.H*****.**

Sang Sue Market Garden

A total of four duplicate soil samples were taken from Sang Sue Market Garden. The average RPD values were below 50% for all metals.

The ORN and ORP results were above 50% RPD for two constituents in the duplicate samples from location SS28. These differences can be attributed to the low concentrations of the analytes present within the samples. When very small numbers are compared, small differences in concentration can lead to large RPD values. Because of these factors data usability is not believed to be compromised and data are considered fit for purpose. A summary of RPD calculations is provided in ***Table 16.22*** in ***Appendix 16.H***.

Former Golden Coast Nurseries

A total of eight duplicate soil samples were taken from the former Golden Coast Nurseries site. Sample set GCN6 and GCN41, with duplicates collected at depths of 0.1 m and 0.3 m, had high RPDs for all of the heavy metals analysed, except nickel which had an RPD less than 30%. The RPDs for the other metals ranged from 83% to 149%. Arsenic, chromium, cadmium, copper and zinc were present above typical background values in most of the samples. While the results returned are below human health guideline values and generally below ecological guideline values, the slightly elevated metals concentrations are likely the result of some form of contamination, such as from galvanised metals or pesticides. It is not uncommon to find highly variable results and high RPDs where metal contamination is present, as the contamination is typically in particulate form. This is like the case for these samples.

Pesticides in several samples and PAH in one sample had RPD values above 50%; however, in all instances, the results indicated very low concentrations. Low concentrations of analytes tend to return large RPD values; this is like the case in this instance.

One duplicate sample was also taken from the building material and analysed for asbestos. The returned laboratory result was consistent with the original sample result.

A summary of the RPD calculations for the former Golden Coast Nurseries is provided in ***Table 16.23*** in ***Appendix 16.H***.

Car Haulaways

A total of four duplicate soil samples were taken from the Car Haulaways site. The average RPD value for each sample and corresponding duplicate were all below 50%. However, the RPD values for individual analytes between the original and duplicate samples did reveal some differences.

The RPD between samples CH2(0.1) and CH3(0.1) and between CH10(0.3) and Ch11(0.3) were within acceptable criteria (i.e., <50%). For duplicates CH10(0.1) and CH11(0.1), all RPDs were within acceptable criteria except pyrene, which was detected in CH10(0.1) at a concentration of 0.027 mg/kg and was below laboratory reporting limits in CH11(0.1). This gave an RPD of 57%.

The RPD between CH2(0.3) and CH3(0.3) were within acceptable criteria for arsenic, copper, lead, nickel and zinc. The results were also identical for the two samples for naphthalene and benzo(a)pyrene eq as well as for C7 to C9 and C10 to C14 range hydrocarbons. However, the RPD for cadmium was 96%, with the CH2(0.3) result below laboratory reporting limits and the CH3(0.3) result reported at 0.143 mg/kg. The chromium results had an RPD of 56%, with CH2(0.3) returning a result of 35 mg/kg and CH3(0.3) having a result of 19.6 mg/kg. Pyrene was detected at a concentration of 0.039 mg/kg in CH3(0.3) but was below laboratory reporting limits in CH2(0.3), with an RPD of 89%. C15 to C36 range hydrocarbons were present at 161 mg/kg in CH2(0.3) and at 270 mg/kg in CH3(0.3), giving an RPD of 51%.

While the DQOs specify an RPD of less than 50%, it should be noted that it is not uncommon to have RPDs outside of this range. This may be due to several factors, including soil heterogeneity, sample collection and laboratory analysis methods and the low concentrations present. Because of the quality controls in place, it is most likely due to soil heterogeneity and an artefact of comparing very low concentrations.

One duplicate sample was also taken from the building material and analysed for asbestos. The returned laboratory result was consistent with the original sample result.

A summary of the RPD calculations is provided in ***Table 16.24, Appendix 16.H***.

Porirua Gun Club

A total of 13 duplicate soil samples were taken from the Porirua Gun Club site. Numerous analytes exceeded the threshold RPD of 50%. A summary of the RPD calculations is provided in ***Table 16.25, Appendix 16.H***.

The storage shed area duplicate samples (GCS3 and GCS4) returned RPDs of less than 50% for all constituents except lead, which had an RPD of 60%. This is likely due to soil heterogeneity; the sample results are within typical background ranges for the Wellington region.

The RPD results from the drainage channel were within 50% with the exception of lead, benzo(a)pyrene eq. and pyrene. The lead RPD was 131%, with results of 2200 mg/kg and 460 mg/kg in the primary and duplicate samples, respectively. The overall results are indicative of contamination in the drainage channel, with lead concentrations ranging from 87 mg/kg to 2200 mg/kg. It is likely that the large RPD is due to soil heterogeneity and uneven distribution of contamination through the soil horizon. Weathering generally occurs when bullets are exposed to air and water. The bullet begins to break down and metals are transported into nearby soil as particulates. According to Ma, et. al, 2002, “All of the metallic lead in bullets will be ultimately transformed into particulate and molecular lead species and will be dispersed through the environment to some degree.” Because the metals are dispersed as particles, it is not uncommon to see a high degree of variability where discrete sources of contamination (e.g., ammunition) are present.

For the drainage channel, the benzo(a)pyrene RPD was 162% and the pyrene RPD was 190%. The PAH results are below guideline values and are at relatively low concentrations. Low concentrations frequently lead to large RPD values and are not indicative of compromised data quality.

The RPD results from GCS11 and GCS12 at the lower firing range were greater than 50% for copper, lead, zinc, benzo(a)pyrene eq and pyrene. The remaining RPDs were below 50%. The RPDs for copper, zinc, benzo(a)pyrene and pyrene were above 50% for the shallow subsurface samples (GCS13 and GCS14) from the same location. The large RPDs for the metals are likely due to uneven distribution of contamination through the soil horizon. The benzo(a)pyrene and pyrene RPDs of 89% and 84%, respectively, are likely due to soil heterogeneity as the concentrations are relatively low.

For samples GCS31 and GCS33, which were shallow samples, the metals returned RPD values of less than 50%; however, the PAH RPD values were elevated. The benzo(a)pyrene RPD was 181%, with results of 3.915 mg/kg and 80.27 mg/kg in the primary and duplicate samples, respectively. The pyrene results were 4.9 mg/kg and 133 mg/kg in the primary and duplicate samples and the naphthalene results were 0.13 mg/kg and 1.52 mg/kg in the primary and duplicate samples, respectively. It is likely that the discrepant results are the result of non-homogeneous distribution of contaminants in the soil; a finding that is consistent with the presence of clay target fragments throughout the area.

The RPD results for samples GCS31 (primary) and GCS33 (duplicate) from the lower firing range, as well as GCS50 (primary) and GCS49 (duplicate) from the lower target range are similar to those from GCS31 and GCS33, with high RPDs associated with detected PAHs.

The RPDs for samples GCS52 and GCS51 from the lower target range are less than 50% for all analysed constituents. These samples were collected directly beneath samples GCS50 and GCS49.

The RPDs for samples GCS59 and GCS60 from the wastewater treatment area are all below 50%; however, it should be noted that E. Coli and faecal coliforms were detected in Sample GCS59 but below laboratory detection limits in Sample GCS60.

The RPD is also below 50% for all constituents analysed in samples GCS69 and GCS70 from the rubbish disposal area.

The RPDs for samples GCS81 and GCS82 from the upper level rifle range were below 50% for the metals, but were very high for the PAHs:

- Benzo(a)pyrene eq. – 199%
- Naphthalene – 120%
- Pyrene – 199%

The benzo(a)pyrene results were 182.99 mg/kg and 0.274 mg/kg in the primary and duplicate samples, respectively. Pyrene results were 198 mg/kg and 0.25 mg/kg in the primary and duplicate samples, respectively and naphthalene results were 0.52 mg/kg and 0.31 mg/kg in the respective primary and duplicate samples. As with other duplicate sample sets where a large number of clay target fragments are present, this is likely due to the heterogeneous distribution of contamination across the site.

The RPD results for GCS83 and GCS84, which are deeper samples from the same location as GCS81 and GCS82, were below 50% for all constituents except copper and zinc, which had RPDs of 92% and 99%, respectively. Given the elevated metals results at this location, the elevated RPDs are likely due to the particulate nature of the contamination present at the site.

The RPDs for the samples from the background sampling locations (GCS95 and GCS96, GCS97 and GCS98) were all below 50% RPD.

Given that the RPDs greater than 50% are typically associated with areas with evidence of contamination, it is believed that the large RPDs are due to the heterogeneous nature of the

contamination as it is likely present as particulate. The data are therefore suitable for the intended use (overall site characterisation).

Pauatahanui Inlet Garden Supplies

A total of six duplicate soil samples were taken from the Pauatahanui Inlet Garden Supplies site. The average RPD value for each sample and corresponding duplicate were all below 50%. Total TPH in one sample set (PIG1-0.3 and its duplicate PIG5-0.3) returned a RPD of 61%, which could be attributed to heterogeneity of the material within the sample, collected from a visibly stained area. A summary of the RPD calculations is provided in ***Table 16.26, Appendix 16.H***.

Mana Coach

A total of two duplicate soil samples were taken from the Mana Coach site. The RPD values for each analyte in each sample and its corresponding duplicate were all below 50%. The RPD calculations are summarised in ***Table 16.27, Appendix 16.H***.

GWRC former sheep dip site

A total of three duplicate soil samples were taken from the Former Sheep Dip site. The average RPD value for each sample and corresponding duplicate were all below 50%. One duplicate pair returned an RPD of 68% for cadmium, with results of 0.101 mg/kg and <0.1 mg/kg. As previously indicated, these low concentrations frequently lead to high RPD values. The RPD calculations are summarised in ***Table 16.28, Appendix 16.H***.

Former stockyard site

A total of four duplicate soil samples were taken from the Former Stockyard site. The RPD value for each analyte in each sample and its corresponding duplicate were all below 50%. The RPD calculations are summarised in ***Table 16.29, Appendix 16.H***.

7.4.2 Accuracy

Accuracy is defined as the degree of agreement of an observed measurement with an accepted reference or true value for the parameter being measured. It is a measure of system bias and is usually expressed as a percentage of the true value. Field sampling accuracy is maintained by the implementation and adherence to strict procedural protocols. For this project, soil sampling procedures and field protocols were followed; however, two exceptions were noted: (1) rinseate samples were only collected on the last day of the sampling at the Porirua Gun Club and (2) samples were not adequately packaged in one shipment from Car Haulaways, resulting in a broken sample jar.

The failure to collect rinseate samples at the Porirua Gun Club is not expected to adversely affect data quality because standard decontamination procedures were followed throughout the process. The broken sample from Car Haulaways was discarded and a duplicate sample collected the following day. Packaging procedures were reviewed and additional packing material was added to future shipments to help prevent breakage.

Based on a review of the overall results and field procedures followed, data are usable for their intended purpose and data quality does not appear to have been compromised.

7.4.3 Representativeness

Representativeness expresses the degree to which a sampling design adequately reflects the environmental conditions of the site. Representativeness also reflects the ability of the sample team to collect samples and laboratory personnel to analyse those samples in such manners that the data generated accurately and precisely reflect the conditions at the site. Representativeness is

determined by the program design, with consideration of elements such as proper well locations, drilling and installation procedures and sampling locations. Objectives for representativeness are defined for each sampling and analysis task and are a function of the investigative objectives.

Assessment of representativeness shall be achieved through use of the standard field, sampling and analytical procedures. Grab samples were taken for this project and such samples are, by definition, representative of only the conditions at the point in time collected, within sampling and analytical error. The sampling rationale was designed to provide data representative of site conditions. Consideration was given to past site practices, existing analytical data, the choice of standard sampling and analytical methods, the physical setting at the site and constraints inherent to the performance of specific objectives.

7.4.4 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalising results to standard conditions and using standard and comprehensive reporting formats. Historical comparability can be achieved through consistent use of methods and documentation procedures throughout the project.

By using sampling and analysis procedures consistent with MfE CLMG and other accepted protocols where possible, data should be comparable within a specific site and between sites to ensure that a consistent database is used from which decisions concerning remedial action are made. Data appear to be comparable and usable.

7.4.5 Completeness

Completeness is a measure of the amount of valid data obtained compared to the amount expected to be collected under normal correct conditions. It is expressed as a percentage of valid measurements that should have been collected. Completeness is calculated using the following equation:

$$\%C = 100 \times \frac{V}{n}$$

where:

%C = percent complete
V = number of measurements judged valid
n = total number of measurements

The objectives of the investigation are to obtain samples for all analyses required at each sampling point. It is expected that the analytical laboratory and field measurements will provide data that meet QC acceptance criteria of greater than ninety percent.

All planned samples were collected. Because the calculated completeness is greater than ninety percent, the soil data are considered usable for their intended purpose and it is believed that an adequate number of samples were collected and analysed.

7.4.6 Additional QA/QC

Breakage

The accidental breakage of one sample container (CH4-0.1) occurred during transport of the samples to the laboratory and sample integrity was compromised as a result. RJ Hill Laboratories notified Aurecon upon receipt of the samples. Field staff resampled the same location and submitted the replacement sample to the laboratory the following day. The original CH4-0.1 soil sample was destroyed. Therefore, overall data integrity was not compromised.

Rinseate samples

Rinseate samples were collected from the equipment used to collect the samples (e.g., trowel and hand auger) at the end of sampling activities each day. Rinseate samples were analysed for the constituents of concern at each site. Below is a summary of the rinseate sample results.

Sang Sue Market Garden

Five rinseate samples were collected from the Sang Sue Market Garden site and analysed for heavy metals, pesticides and PAH. All rinseate samples collected from hand trowels returned results below detection limits for all contaminants analysed except for rinseate sample SS Rinseate 1, which indicated the presence of zinc, lead and copper at a concentrations marginally above the laboratory detection limits. This is likely indicative of less than adequate decontamination; however, subsequent rinseate samples did not have detectable concentrations of zinc, lead and copper present.

Former Golden Coast Nurseries

Three rinseate samples were collected from the Golden Coast Nursery site and analysed for heavy metals, pesticides and PAH. All rinseate samples collected from the hand trowel returned results below detection limits for all contaminants analysed except for rinseate sample GCN Rinseate 2, which indicated the presence of cadmium at a concentration of 0.00123 mg/L. This concentration is marginally above the laboratory detection limit of 0.0011 mg/L. Subsequent rinseate samples did not have detectable concentrations of cadmium present.

Car Haulaways

A total of four rinseate samples were collected from the Car Haulaways site and analysed for heavy metals, PAH and TPH. All rinseate samples collected from the hand trowel returned results below detection limits for all contaminants analysed. The rinseate sample from the peg bar returned detectable levels for lead and zinc (see ***Table 16.15, Appendix 16.H***). The peg bar is not stainless steel and some of the contaminants could have been present from the metal itself. Alternatively, the bar may not have been adequately decontaminated. It should be noted that the peg bar was not utilised to directly collect samples; it was used to loosen gravel around the area where the samples were collected.

Rinseate sample R1CH Rinseate 1 had naphthalene present at a concentration of 0.00152 mg/L. This may be indicative of less than adequate decontamination; however, subsequent rinseate samples did not have detectable concentrations of naphthalene present.

Pauatahanui Inlet Garden Supplies

Three rinseate samples were collected from the Pauatahanui Inlet Garden Supplies site and analysed for heavy metals, pesticides, PAH and TPH. All rinseate samples collected from the hand trowel returned results below detection limits for all contaminants analysed except for rinseate sample PIG Rinseate 2, which indicated the presence of zinc at a concentration of 0.029 mg/L. This concentration is marginally above the laboratory detection limit of 0.021 mg/L. Subsequent rinseate samples did not have detectable concentrations of zinc present.

Mana Coach

One rinseate sample was collected from the Mana Coach site and analysed for heavy metals, PAH and TPH. Rinseate sample MC R1 returned trace levels of PAH, TPH and zinc. The reported concentration is low but it may be indicative of less than adequate decontamination. However, because all analysed constituents were well below guideline values, the rinseate sample result is not believed to have compromised data useability.

Porirua Gun Club

Due to a field error, only one rinseate sample was collected from the Porirua Gun Club sampling activity. The sample was analysed for heavy metals and PAH. Rinseate sample GC R1 returned trace levels of lead (0.0022 mg/L) and zinc (0.049 mg/L). The reported concentrations are low but could be indicative of less than adequate decontamination procedures. However, because of the low concentrations detected and that there were no detections of other metals, such as copper, which are present at the site in relatively high concentrations, the rinseate sample result is not believed to have compromised data useability.

GWRC former sheep dip site

No rinseate samples were collected from the former sheep dip site as samples were collected directly from an excavator bucket using a gloved hand with gloves changed between each sample.

Former stockyard site

Two rinseate samples were collected from the former stockyard site and analysed for heavy metals and pesticides. All rinseate samples collected from the hand trowel returned results below detection limits for all contaminants analysed.

Summary

While some constituents were detected in rinseate samples, they were present at low concentrations and are not believed to adversely impact overall data usability. Summary statistics for metals results, including maximum and minimum detected, median and mean concentrations, standard deviation, variance and confidence levels, are provided in ***Table 16.30, Appendix 16.H***.

7.4.7 Laboratory QA/QC summary

Analytical data reported by Hills Laboratories and AsureQuality Limited was judged to have met the essential criteria for data quality.

The following comments can be viewed as an overall summary of the quality of the analytical component for this project.

- Sample integrity and container requirements were documented as acceptable with the exception of the broken sample reported above
- Holding time compliances were documented as acceptable
- Matrix spike duplicate recovery %R values indicated that sample accuracy was acceptable
- Laboratory surrogate recovery %R values (despite some low recoveries) were all acceptable indicating that laboratory accuracy was acceptable
- The laboratory noted that the samples analysed for E. coli and faecal coliforms (Porirua Gun Club) had a temperature above 10°C and therefore the results should be interpreted with caution
- The laboratory noted that for the Mana Coach samples, the duplicate samples for chromium and nickel run as part of their in-house QC procedure showed greater variation than would normally be expected. The laboratory also noted that this “may reflect the heterogeneity of the sample.”
- The laboratory noted that samples from Sang Sue, Car Haulaways and the Porirua Gun Club had slightly elevated temperature (i.e., 10°C) when received

While some of the temperatures were noted as slightly elevated in sample batches received, the data are not believed to have been significantly compromised. The samples were packaged and shipped on ice; it is not known why the temperature was elevated in some of the containers received, particularly as a conversation with the laboratory indicated that ice was still present in the shipping containers.

The surface water laboratory analytical results were not usable for their intended purpose, which was comparison with the adopted guideline value (ANZCC Water Quality Guideline for 95% species protection in freshwater environments). Due to a miscommunication with the laboratory, screening level reporting limits were provided, rather than trace level reporting limits. While no constituents were detected above screening level reporting limits, these reporting limits are, in many instances, higher than the adopted guideline value. Therefore, no comparison could be made. This is not considered to represent a significant data gap. The surface water sample was intended to be more qualitative than quantitative; it was hoped that a surface water grab sample might provide correlation to on-site soil contamination conditions. Because very little soil contamination was found at the site, this proved to be a somewhat moot point. In addition, under a separate work stream, numerous surface water samples have been collected directly upstream and downstream of the site and these data provide reliable, defensible data regarding surface water quality in the area.

7.5 Geophysical survey results

The results of the EM61 survey show that the large areas immediately adjacent to the existing SH1 appear to be generally clear of metallic anomalies that might be indicative of UXO. Local cultural effects due to metal crash barriers, metal fence wires and metal gates are considered to have caused the majority of the anomalies detected in these areas (Areas 1, 5, 6 and 7). The exception is Area 8 which appears to have a significant number of buried metallic anomalies in addition to the effects of local cultural features.

By contrast the currently farmed paddock areas on the west side of the existing SH1 (Areas 2, 3 and 4) exhibit a significant number of detected metallic anomalies which are considered possible UXO.

A summary of the results from each area searched is provided below; detailed results and figures are presented in ***Appendix 16.F***.

Area 1 – Considered to be clear of any buried metallic anomalies that might be UXO.

Area 2 – This farmed paddock has two suspected underground services crossing the paddock in a NW to SE direction and these can be seen on the resultant plotted results. There are also a number of small response buried metallic anomalies evident. These would have to be considered possible UXO and treated as such.

Area 3 – This farmed paddock shows indications of a number of buried metallic anomalies which are considered to be possible UXO and should be treated as such. The four (4) larger responses seen are suspected to be due to agricultural buried waste such as rolls of buried fence wire and/or pieces of roofing iron. However, at this stage they would need to be considered as possible UXO and treated as such.

Area 4 - This farmed paddock shows indications of a large number of buried metallic anomalies and is the 'busiest' looking paddock of all the areas searched. It is considered that all of the detected anomalies are possible UXO and should be treated as such.

Area 5 **–** This area, adjacent to the current sealed farm access road, shows evidence of a few buried metallic anomalies, however the larger anomalies are most likely due to local cultural effects such as metal fence wire and metal gates. The anomalies considered due to cultural effects are noted in ***Appendix 16.F***. It is considered that all of the smaller response detected anomalies are possible UXO and should be treated as such.

Area 6 **–** This area shows two areas with large metallic anomalies which are considered to be due to local cultural features such as metal fence wire and metal gates. The area is considered clear of detected anomalies that are possible UXO.

Area 7 **–** Although there are a large number of significant sized anomalies indicated in this area, these anomalies are considered to be due to local cultural effects and this has been noted as such in ***Appendix 16.F***.

Area 8 **–** In a similar manner to Area 7, there are large anomalies in this area which are considered due to local cultural effects and these have been noted as such in ***Appendix 16.F***. There are also however, some small to medium response detected anomalies, which are possible UXO and should be treated as such.

Note that false positive data is a possibility with the equipment utilized. Over-reporting of anomalies means that carefully controlled excavation by UXO specialists could be conducted and reveal farm implements, tools and fencing. While there is a potential cost impact associated with too much specialized excavation, this is minor in the context of the cost of the highway project. The risk to the project comes from false negative data; i.e., missing anomalies that are UXO which could result in an uncontrolled detonation and possible personnel injury. Therefore, using equipment that potentially over-reports anomalies is not considered to be problematic. It should also be noted that based on information from UXO and geophysics specialists in the United States, the EM61 MKI is routinely used today for UXO surveys, particularly in situations where there is (or will be) public access since over-reporting is not considered to be a problem because every anomaly must be treated as UXO to err on the side of caution.

7.6 Re-evaluation of risk

Following completion of the data evaluation, risk was re-evaluated and the preliminary risk valuation information presented in ***Table 16.11*** in ***Appendix 16.B*** was updated to reflect the appropriate risk classification based on laboratory results.

As previously noted, ***Table 16.11*** in ***Appendix 16.B*** showing preliminary risk assessment results was constructed assuming the worst possible case; i.e., assuming that contaminants of concern were present above risk based concentrations, pathways were completed and receptors were exposed.

While the potential health or ecological effects from the contaminants of concern remain the same in the preliminary evaluation and re-evaluation of risk, the likelihood of encountering the contaminant in a concentration above risk based guideline values has been revisited based on laboratory analytical results. Where sampling and analysis has shown that the contaminants are not present above guideline values, the likelihood of exposure has been rated as unlikely or rare, depending on the potential source. This has resulted in a revised risk ranking (e.g., from high to moderate or from moderate to low). The revised risk assessment is provided in ***Table WS-31, Appendix 16.B.*** The risk classification for each site is summarised as follows:

Summary of risk re-evaluation

Site	Revised Risk Assessment	Comment
MacKays Crossing	Moderate	The geophysical survey noted anomalies which could be UXO. These areas should be considered high risk and investigated in detail prior to construction. Areas where there does not appear to be possible UXO are considered low risk.

Site	Revised Risk Assessment	Comment
Sang Sue Market Garden	Low – Minor	Risk requires re-evaluation if proposed highway alignment includes the market garden sheds. There are detections of metals above ecological risk based guideline values. Therefore, the excavated soil should not be placed in an ecologically sensitive area. The soil could be used under the highway without undue risk to future site workers.
Golden Coast Nursery	Soil: Low – Minor Buildings: Moderate - High	Laboratory results from soil samples are all below human health risk based values, Asbestos was detected in two of the building samples collected. Therefore, the building structure is considered high risk if the buildings are not demolished correctly. The remainder of the site is classified as low risk. Surface soil from the area should not be placed in ecologically sensitive areas as metals were detected that were above ecological risk based guideline values. The soil could be placed under the highway without undue risk to future maintenance workers.
Car Haulaways	Low - Minor	Due to detections of zinc and hydrocarbons, excavated surface soil should not be placed in ecologically sensitive areas. The soil is suitable for use under the highway without undue risk to future site workers.
Pauatahanui Inlet Garden Supplies	Low – Minor	Areas of low to minor risk include the outhouse and possible leachfield associated with the outhouse, areas where timber was burned, the former AST area and areas where waste asphalt was spread across the site.
Porirua Gun Club	Minor – Moderate	Moderate risk areas include: • Firing range areas • Drainage ditch All other areas at the Porirua Gun Club site are considered minor risk. Remedial action is required for areas with metals and PAH above human health risk based guideline values. Soil with contaminants above ecological risk based values should also be properly managed; it is likely that this soil will be remediated along with the soil with contamination present above human health guideline values.
Mana Coach	Low	Unless there is a significant release at this site, the risk is considered to be low.
GWRC Former Sheep Dip	Minor	It does not appear that the former sheep dip site has contributed to significant contamination within the highway footprint. Dieldrin was detected in two surface soil

Site	Revised Risk Assessment	Comment
		samples above ecological risk based guideline values. Therefore, the excavated soil should not be placed in an ecologically sensitive area. It is suitable for use under the highway or a structure.
Former stockyard site	Minor	The former stockyard site appears to present minor risk for the presence of contamination. DDT was detected in all samples and zinc was detected above ecological risk based guideline values in one sample. Therefore, the excavated soil should not be placed in an ecologically sensitive area. It is suitable for use under the highway or a structure.
Buildings	Low – High	Buildings constructed after 1990 have a low risk of asbestos. Buildings constructed earlier have a moderate to high risk of asbestos. In addition, hazardous materials may have been stored or spilled in the buildings slated for demolition.
Farm sites	Low	There is a risk that rubbish or offal pits, unidentified livestock dips, or other contaminating activities may exist along the highway route. However, based on available information, the risk is considered relatively low.
Other sites	Low	There is a reported landfill in the plantation forest area near Ribbonwood Tce. The landfill was not located during the investigation and persons knowledgeable of the area were not aware of a landfill in this location. However, it is documented in Council records and may exist. The area should be excavated with caution as landfill materials and landfill gas may be present. Alternatively, after the forest is harvested, an investigation (e.g., geophysical survey or test pitting) should be conducted to determine whether the landfill is present. There are transformer sites near the route. While there was no visual evidence of contamination and Transpower indicated that there have been no significant releases, it is possible that a release could occur, resulting in contamination impacting the Main Alignment. A visual inspection should be conducted prior to construction. The Pauatahanui Golf Course was not investigated in detail and is still in operation. The Stage 1 assessment did not indicate that contamination was likely; however, it is possible that contamination could be discovered during construction operations. A

Site	Revised Risk Assessment	Comment
		more detailed inspection of the areas that may be affected should be conducted prior to construction. Due to adjustments of the Main Alignment following the completion of the Stage 2 investigation, three areas were identified where contamination may be present: • Along SH1 where it is to be lowered • Undeveloped area adjacent to Mana Coach • The Lewis's Fabric facility on Kenepuru Road These sites will be investigated and results reported in a separate letter report.

8. Recommendations

8.1 Summary

The Transmission Gully Highway route is comprised largely of greenfields sites; areas which are (or have historically been) used as pastures for grazing, forests and undisturbed lands. However, there are sites along the route where farming, commercial or industrial activities may have led to site contamination.

The objectives of this investigation were to assess potential contamination issues from previous and current land uses along the proposed route and to provide data to allow an assessment of potential exposure risks to construction workers and the environment. The investigation was also undertaken to facilitate the management of contaminated material on the site (if any) during construction of the project and to provide data which is appropriate to support the resource consent application. The work was also undertaken to evaluate potential environmental effects from construction of the Transmission Gully Highway Project with regard to contaminated land.

The scope of works undertaken to achieve the objectives included a review of existing information relating to this sites where activities may have led to site contamination, development of a sampling and analysis plan and undertaking an intrusive soil investigation. In addition, a non-intrusive geophysical investigation was conducted near MacKays Crossing.

A preliminary environmental risk assessment was carried out based on the outcomes of the Stage 1 land contamination assessment findings. The risk assessment was developed by assigning a score associated with the likelihood of an occurrence and the potential consequence of the occurrence. The scores were based on the risk matrix developed for the overall project so that the consequences were regarded in the context of the project. The preliminary risk assessment identified several sites of concern that required more detailed investigation prior to construction. Characterisation was conducted at those sites where the preliminary risk evaluation identified risk as 'moderate to high'. This risk evaluation formed the basis for the Stage 2 intrusive investigation. The intrusive investigation included sampling and analysis at the following properties:

- Sang Sue Market Garden (Pt Lot 4 DP4269)
- Former Golden Coast Nurseries (Lot 1 DP47726)
- Car Haulaways (Lot 1 DP53032)
- Porirua Gun Club (Section 1 SO Plan 36634)
- Pauatahanui Inlet Garden Supplies (Section 4 SO38167)
- Mana Coach (Lot 1 DP 40411 and Section 353-354 Porirua District)
- GWRC former sheep dip site (Pt Lot 1 DP51158)
- Former stockyard site (Section 1 SO Plan 402089)

The land contamination assessment and investigation of the above sites has been undertaken in general accordance with MfE CLMG and other relevant MfE guidelines.

Subsequent to the completion of the Stage 2 investigation, the highway route was adjusted slightly. Based on this adjustment additional investigation requirements were identified as follows:

- Characterisation of the area along the existing SH1 where fuel spills, pesticide or herbicide use, or metals from vehicle components or leaded fuel could have impacted the soil
- The Lewis's Fabric facility where construction of the Kenepuru interchange will take place

- The area north of the Maraeroa Marae and south and west of Mana Coach where imported fill of unknown quality could have been utilised

These areas were investigated separately and are covered in separate reports.

In addition, subsequent to completion of this investigation, the tenant vacated the Pauatahanui Inlet Garden Supplies site. A follow-up inspection was conducted; however, no samples were collected at this time.

Following a comparison of results to conservative guideline values identified from the MfE's EGV Database, the risk to human health and the environment from potential contaminating activities identified during the Stage 1 land contamination assessment preliminary risk assessment was revised and updated based on evaluation of laboratory results against risk-based guideline values. The findings are summarised in ***Table 16.31, Appendix 16.B*** and recommendations are provided below.

8.1.1 MacKays Crossing

Historic military activities occurred at the MacKays Crossing area. These activities included firing practice. Reportedly, the area from MacKays Crossing to approximately 1 km to the south was used for firing mortar and cannon rounds. Historic UXO has been found at adjacent properties and a farmer in the area reported being "blown off the tractor" by an unexploded round.

To identify potential UXO, a geophysical survey was conducted of the area to identify anomalies that could be UXO. No intrusive investigation was conducted due to safety considerations and because the exact area to be disturbed by the Transmission Gully Highway Project has not yet been determined.

The geophysical survey indicated that it is possible that UXO is present in the paddocks adjacent to the existing SH1. While UXO is unlikely to spontaneously explode, certain activities which could create large pressure waves, sudden impact or sparking could cause detonation. This would of course pose a hazard to construction workers and the public. Proper excavation and management/disposal is required for those areas which contain suspect UXO and where construction is slated to be conducted. It is likely that the UXO is present at a depth of less than 1 m below ground surface; therefore, extreme caution should be exercised when conducting activities in the area that could lead to vibration or similar disturbance of the UXO.

A protocol was developed for accidental discovery of UXO. NZTA Risk Register was updated as was the list of "Hazards Known to the Client." The protocol is included in ***Volume 5*** with the CSMP.

It is recommended that NZTA coordinate with the New Zealand Police to arrange for excavation of potential unexploded ordnance as part of enabling works, following finalisation of the highway design.

8.1.2 Sang Sue Market Garden

The Sang Sue Market Garden is utilised for growing and selling vegetables. The site consists of vegetable growing areas as well as ancillary buildings for sales and storage of equipment and produce. The Transmission Gully Highway Project will affect the area directly adjacent to the existing SH1, which is located in the vegetable growing (horticulture) area. The buildings and storage areas are well beyond the highway designation and are downgradient. The horticulture area was investigated using a grid-based strategy.

Summary of human health risk

The samples collected returned results well below NES SCV and other relevant human health guideline values. However, several metals were present above typical background values (URS, 2003). The results appear to be consistent with application of pesticides, herbicides and fertilisers. While evidence of metals and pesticides was found, the results were below human health risk based guideline values and the risk to construction workers is low.

Summary of ecological risk

Copper was present in one sample above the commercial/industrial ecological risk based guideline value. The sample was located near the existing SH1 and may be the result of run-off from the highway. This appears likely as the copper concentrations across the site are not above guideline values. The copper concentration was 136 mg/kg as compared to a risk based guideline value of 91 mg/kg. These elevated concentrations are not likely to pose a significant risk to local ecology, particularly as the extent is limited.

Several metals, including cadmium, are routinely present above background concentrations. The concentrations appear to be consistent with application of herbicides, fertilisers and pesticides. There was no sign of distressed vegetation at the site; the plants in the market garden appeared to be healthy.

During highway construction, the ecological risk is not considered to be significant. The upper layer of soil will be excavated as part of highway construction and by default will be mixed with deeper layers which are not impacted. This will essentially dilute any elevated concentrations. The area is slated to be filled, rather than cut, as part of highway construction. The area with the elevated concentrations of arsenic, copper and zinc will likely be beneath the highway, further limiting exposure. Stormwater runoff from the area will be treated and landscaping is not likely to be affected. Therefore, the post-construction ecological risk is also expected to be low.

While the ecological risk is believed to be low, it would not be prudent to place the excavated soil in an ecologically sensitive environment, such as an area with pristine native bush. It is not likely that the soil would present a hazard, per se, but due to the evidence of anthropogenic activities, the most appropriate course of action would be to place any excavated soil under a road or structure, or in a disposal area that is situated in an area that has previously been disturbed and where stormwater runoff will be treated. The CSMP (***Volume 5***) provides additional details on the management of impacted soil.

8.1.3 Former Golden Coast Nurseries

The former Golden Coast Nurseries facility was in operation for several years. There are numerous greenhouse structures, including glass houses and structures with framing and netting. There are concrete pathways between tables inside the greenhouse structures, with bare ground beneath the tables. Samples were collected on a grid-based pattern across the site, with locations adjusted as required to avoid the concrete pathways. Samples of building materials were also collected from the largest structure present at the site.

Summary of human health risk

One sample exceeded the NES SCV for arsenic, which is likely to be a result of past nursery operations. At this sample location (GCN26), arsenic levels above the NES SCV were to be limited to a depth of 0.3m. The arsenic contamination appears to be limited in lateral extent as well. The sample is within one of the glass house structures and is likely the result of localised spillage. The glass houses will be removed from the site prior to highway construction and the area will be cleared and graded.

Because the arsenic contamination appears to be localised, remedial action is not recommended for the site. However, the soil needs to be properly managed and workers need to be informed of the

potential risk. It is not likely that the soil would present a hazard, per se, but due to the evidence of anthropogenic activities, the most appropriate course of action would be to place any excavated soil under a road or structure, or in a disposal area that is situated in an area that has previously been disturbed. The CSMP (***Volume 5***) provides additional details on soil management.

Detectable concentrations of pesticides and higher than background concentrations of metals were detected at the former Golden Coast Nurseries. However, no constituents returned laboratory results above human health risk based guideline criteria.

Asbestos was detected in two of the building samples collected. The samples collected are indicative that asbestos is present in some of the building materials. Not all building materials were sampled; additional investigation should be conducted prior to building demolition. An asbestos management plan should be developed and implemented prior to disturbing or demolishing any of the structures on site.

Summary of ecological risk

Arsenic, chromium, copper, nickel and zinc concentrations at several locations were well above ecological risk based criteria and several times above expected background concentrations. Pesticides were also detected at numerous locations across the site. The presence of these contaminants is likely due to past site activities.

During highway construction, the upper layer of soil will likely be excavated as part of site clearing and grading. As part of this process, the soil with elevated concentrations of metals will likely be blended with unimpacted soils. This will essentially dilute the concentration of metals present. The majority of the area with elevated metals concentrations will be contained beneath the highway and highway construction will largely be comprised of filling activities (rather than cutting). In addition, stormwater treatment and controls will be in place and have considered the presence of metals and pesticides at the site. These factors should result in a relatively low ecological risk.

While the ecological risk is believed to be low, it would not be prudent to place the excavated soil in an ecologically sensitive environment, such as an area with pristine native bush. It is not likely that the soil would present a hazard, per se, but due to the evidence of anthropogenic activities, the most appropriate course of action would be to place any excavated soil under a road or structure, or in a disposal area that is situated in an area that has previously been disturbed. The CSMP (***Volume 5***) provides additional details on soil management.

8.1.4 Car Haulaways

The Car Haulaways site was used for the storage of imported vehicles pending their distribution to dealerships across New Zealand. In addition, car haulers were stored at the site. Activities at the site included fueling from a UST and vehicle washing. The UST was removed and replaced with an AST which was situated in a bunded area. A report prepared for Shell Oil by MWH indicated that no contamination above commercial/industrial guidelines remained in place following the UST removal. The AST was removed when the site was vacated. The majority of the site is surfaced with gravel; however, some areas, such as the former UST and AST areas, are paved with asphalt or concrete. There are several small storage buildings and an office building on site.

Soil samples were collected on a judgmental basis, focussing on the storage buildings, former AST area, drainage areas and stained locations across the site. A sample of the building material from the office exterior was also collected.

Summary of human health risk

None of the samples collected at the Car Haulaways site returned results above human health risk based criteria. One sample, CH18-0.1, returned a TPH result of 11,600 mg/kg, which is indicative of a hydrocarbon release. However, the sample collected was of visibly stained soil and the detected hydrocarbons were in the C15 – C36 range which is typical of degraded fuel. Sample CH9-0.1

returned a TPH result of 2,200 mg/kg (all in the C15 – C36 range) which is also indicative of a past hydrocarbon release. Based on the overall site results, it appears that the TPH present is from relatively isolated minor hydrocarbon releases (such as leaks from vehicles).

The former UST removal report prepared by MWH indicates that the UST pit was free of contamination above commercial/industrial risk-based guideline values. Clean fill material was noted in the samples collected in the vicinity of the former UST pit.

Summary of ecological risk

Slightly elevated metals concentrations were detected across the site, with zinc above ecological risk based values in three samples analysed for heavy metals. The location of the elevated zinc concentrations indicates that it is likely to be due to the presence of adjacent galvanised structures.

The upper layer of soil will be excavated as part of clearing and grading for highway construction and by default will be blended with deeper soil. This will effectively result in dilution of concentrations of metals detected in the near-surface samples. In addition, much of the site will be covered by the road, which will assist in sequestering any elevated metals concentrations from local ecology. Note that this area will primarily be subjected to fill, rather than cut, activities. The concentrations of metals detected at the site have been considered in stormwater treatment system design. Therefore, the ecological risk is not expected to be significant.

While the ecological risk is believed to be low, it would not be prudent to place the excavated soil in an ecologically sensitive environment, such as an area with pristine native bush. It is not likely that the soil would present a hazard, per se, but due to the evidence of anthropogenic activities, the most appropriate course of action would be to place any excavated soil under a road or structure, or in a disposal area that is situated in a previously disturbed area. The CSMP (***Volume 5***) provides additional details on soil management.

8.1.5 Porirua Gun Club

The Porirua Gun Club is a facility utilised for target practice with both stationary targets and clay targets (i.e., skeet shooting). The lower portion of the range is primarily used for pistols and shotguns and the upper portion is primarily used for rifles. Waste ammunition is burned in a pit at the site and there is a wastewater/leachfield area present that supports the facility's septic tank system. In addition, there is a storage shed, rubbish disposal area and a drainage ditch present.

Samples were collected on a judgmental basis at the ammunition burn pit, wastewater area, storage shed, rubbish disposal and drainage ditch. A generalised grid-based sampling programme was implemented for the shooting ranges.

Summary of human health risk

At the Porirua Gun Club, numerous near-surface samples in the firing range areas returned results above NES SCVs for lead and benzo(a)pyrene. Several of the corresponding deeper samples were analysed; all but one returned results below the NES SCV of 3,300 mg/kg for lead.

Based on the potential risk to human health, remedial action is recommended, as described in more detail in Section 8.2 of this report. The CSMP (***Volume 5***) also provides additional details on soil management.

Summary of ecological risk

The ecological risk based guideline values for antimony, lead, copper, zinc and PAH were exceeded in numerous locations across the site. Because human health guideline values are also exceeded for lead, copper and PAH, remedial action in the form of soil removal and/or treatment is recommended (see Section 8.2). Because the elevated concentrations of antimony, copper and zinc generally are collocated with the concentrations of lead that are above human health guideline

values, the remedial action will address potential ecological risk concurrently with addressing the human health risk. The CSMP (***Volume 5***) also provides additional details on soil management.

8.1.6 Pauatahanui Inlet Garden Supplies

The Pauatahanui Inlet Garden Supplies facility took green waste and composted it for sale as garden supplement material. In addition, the facility sold bark and decorative rock. An AST had been located at the site and a long-drop toilet was also present at the site. Spillage was noted in the form of stained soil around the site. There were several berms present, comprised primarily of waste soil, timber, concrete and similar debris. Storage bins were also present when the business was in operation. The site is adjacent to a stream and is subject to flooding.

Samples were collected on a judgmental basis at areas where spillage had been noted (i.e., stained soil) and where the AST had been located. Samples were also collected along the stream bank to determine whether it had been impacted by site activities. A surface water grab sample was collected in an area where the site appeared to drain to the stream to help qualitatively evaluate whether site activities were directly impacting the stream. Samples were also collected at pseudo-random locations across the site and two off-site soil samples were collected for comparison purposes.

Summary of human health risk

Hydrocarbons were present at the AST and spillage areas. One of the stream bank samples also contained detectable hydrocarbons. However, all samples were well below human health risk based criteria.

Both 4,4'-DDE and 4,4'-DDT were detected in the background samples collected; but not in the samples collected from the stream bank. The DDT results were well below the NES SCV for total DDT. Slightly elevated zinc concentrations were detected in some of the samples from around the AST area, but the concentrations were below human health risk based guideline values.

Based on the samples collected, the site does not appear to present a risk to future road construction workers.

After completion of the intrusive investigation, NZTA was notified that the tenant at the site had brought treated timber to the site to be stored, used and possibly burned. It is not known what timber treatment method was used, if any.

On 21 August 2010, a follow up inspection was conducted. The tenant had vacated the site and the bins and other facilities that had previously been at the site were absent. There was evidence of burned wood; a wood pile was present and some of the wood was charred. While it is not possible to determine what timber treatment method was used (if any) based solely on visual inspection, the wood did not have the dark stained appearance that is typical of pentachlorophenol or creosote treatment. The timber appeared relatively fresh and was comprised of round logs which had been cut to length.

Other site features of note included large piles of soil and debris, general site debris, an excavator, a outhouse which drains to the ground and an empty storage shed. There was also what appeared to be waste asphalt spread across the site, as well as some gold coloured gravel. Ponded water was apparent, but no hydrocarbon sheen was noted.

In February 2011, the debris was cleared from the site. Photos are provided in Appendix 16.D. Verification sampling may be warranted (see ***Volume 5)*** and should be considered during enabling works. There may be a leachfield present (associated with the outhouse); this could contain biological constituents and the area should be treated with appropriate caution and personal protective equipment worn when handling. While faecal coliforms typically present little or no risk after six to eight months, viruses can linger for several years. Therefore, appropriate precautions should be taken when excavating the area.

The surface water sample had no contaminants of concern present above laboratory reporting limits. Additional sampling of the stream was conducted as part of the water quality portion of this project; more detailed information is available in the water quality report.

Summary of ecological risk

Two zinc results (270 mg/kg and 320 mg/kg) were above the recreational/parkland ecological guideline value of 200 mg/kg. The zinc appears to be associated with the adjacent galvanised structure. The isolated elevated concentrations of zinc are not believed to present a significant threat to local ecology. The area is slated for development first as a construction office area and then as a roundabout. The construction planned is primarily fill (rather than cut) activities.

While there is not believed to be significant ecological risk, several features at the site may present a minor degree of risk to human health and the environment. These features should be properly addressed during enabling works to reduce potential risk to construction and maintenance workers as well as to local ecology and the adjacent stream.

8.1.7 Mana Coach

The Mana Coach facility is used for parking and maintenance of buses and related vehicles. The portion of the facility closest to the link road is the bus parking area, which is paved with asphalt and surrounded by a curb. There is significant staining present in the parking lot, but it appears confined to the asphalted area. There are maintenance facilities and current and former UST present at the site. However, these features are downgradient of the link road alignment. Soil samples were collected from two edges of the parking area to determine whether the observed vehicle leakage had migrated beyond the curb.

Summary of human health risk

The samples collected from the edges of the Mana Coach bus parking area returned results below human health guideline values.

Summary of ecological risk

All results were below ecological guideline values. There is staining apparent on the adjacent asphalt parking lot; the purpose of obtaining samples from the outer perimeter of the bus parking area was to determine whether contaminants of concern were migrating off-site either through the soil or from stormwater runoff. Based on the sampling conducted, it appears that the hydrocarbon releases have not impacted the area on the southern side and south-western corner of the parking area. Therefore, the site does not appear to present a risk to local ecology.

8.1.8 GWRC former sheep dip site

The GWRC former sheep dip site is part of Belmont Regional Park and is situated uphill and upgradient of the highway route. The actual highway will be constructed in an area of plantation forest; however, this area was not readily accessible. Therefore, samples were collected from test pits between the former sheep dip site and the highway route to determine whether pesticides had migrated downgradient and could impact the highway. Three test pits were excavated and samples collected from three depths in each test pit.

Summary of human health risk

At the area downgradient of the GWRC former sheep dip site, all samples returned results below human health guideline values. Two samples returned zinc results slightly above typical background levels. These samples also had detections of dieldrin; however, the values were well below the NES SCV.

Summary of ecological risk

No metals were present above ecological risk based guideline values; however, all metals except lead returned results slightly above the typical Wellington regional background range (URS, 2003). Dieldrin was present above ecological risk based guideline values in two surface soil samples, but was below laboratory detection limits in the remaining samples.

While dieldrin is present above ecological risk based guideline values, is appears to be limited to the near surface. Highway construction will result in the excavation of soil and, by default, surface soil will be mixed with deeper soil and concentrations of detected constituents will be diluted. Because of the limited extent of the dieldrin and because the soil containing the dieldrin will be mixed with other soil, it is not believed to present a risk to local ecology. In addition, the stormwater treatment plan has taken the potential presence of contamination into consideration to further limit the possibility of ecological damage.

While the ecological risk is believed to be low, it would not be prudent to place the excavated soil in an ecologically sensitive environment, such as an area with pristine native bush. It is not likely that the soil would present a hazard, per se, but due to the evidence of anthropogenic activities, the most appropriate course of action would be to place any excavated soil under a road or structure, or in a disposal area that is situated in a previously disturbed area. The CSMP (***Volume 5***) provides additional details on soil management.

8.1.9 Former stockyard site

The former stockyard site was initially identified as a site of concern because it was reportedly a sheep dip site. However, further information indicated that it had not contained a sheep dip facility, but had housed cattle, deer and sheep in holding pens. Soil samples were collected from within and around the pens to evaluate the potential presence of pesticides and metals. Samples were collected based on a judgmental sampling strategy within and around the pens.

Summary of human health risk

All soil samples analysed returned results below human health risk based guideline values for all constituents of concern.

Summary of ecological risk

With one exception, metals were not present above ecological risk based guideline values in all samples analysed and most of the samples were in the range of typical Wellington background values (URS, 2003). Zinc was present in one sample at a concentration of 210 mg/kg, which is slightly above the recreational/parkland ecological risk based concentration of 200 mg/kg. While the recreational/parkland ecological risk based concentration is slightly exceeded, it appears to be localised and is likely due to the presence of galvanised structures at the site.

Total DDT recreational/parkland ecological risk based guideline values were exceeded in six near-surface samples; however, concentrations were well below commercial/industrial ecological guideline values. DDT was detected in all of the samples collected from across the site and is likely to be the result of past application of the pesticides in the general area. While the ecological guideline is exceeded, the risk is likely to be low for local ecology (i.e., grazing land).

The majority of the site will be covered by the highway and during excavation (i.e., this area will be filled), the shallow soil will be blended with deeper soil, diluting the concentration of zinc. Therefore, this slight exceedance is not believed to pose a threat to local ecology.

While the ecological risk is believed to be low, it would not be prudent to place the excavated soil in an ecologically sensitive environment, such as an area with pristine native bush. It is not likely that the soil would present a hazard, per se, but due to the evidence of anthropogenic activities, the most appropriate course of action would be to place any excavated soil under a road or structure, or in a

disposal area that is situated in an area that has previously been disturbed. The CSMP (***Volume 5***) provides additional details on soil management.

8.2 Recommendations

The following recommendations are made with regard to mitigation and remediation along the Transmission Gully Highway route.

8.2.1 General

Some of the sites investigated, such as the Sang Sue Market Garden and Porirua Gun Club, are still in use. Other sites have been purchased by NZTA and are no longer in use (e.g., Car Haulaways and former Golden Coast Nurseries). Some of the sites purchased by NZTA are reasonably secure; others are generally open to the public. Even at the secure sites, however, it is possible that unauthorised activities that could result in contamination could take place.

Therefore, is recommended that the Stage 1 land contamination assessment be updated after the site activities have ceased and before construction begins as part of enabling works. Should it be discovered that potentially contaminating activities beyond those investigated have taken place at these sites, additional sampling and analysis should be conducted to verify that the status of the sites reported herein is still applicable.

A CSMP is provided in ***Volume 5***; however, more detail should be added to the plan prior to construction when the route has been well established and when detailed design and construction plans are available.

Where future geotechnical investigations are conducted, it is recommended that an experienced contaminated land specialist be available and consulted and that samples be collected if any visual or olfactory evidence of contamination is observed. During construction, it is important that workers understand that contamination may be present and that work is stopped immediately if visual or olfactory evidence of possible contamination is observed. Construction should not resume in the area until an experienced contaminated land specialist has evaluated the area. This is detailed in the CSMP in ***Volume 5***.

In addition, due considerations should be given to NZTA's Risk Management Process Manual AC/Man/1 ISBN 0-478-10560-6 and the Risk Register should be updated to reflect any additional findings or changes in conditions.

If additional property acquisitions take place prior to or during construction, NZTA Contaminated Land Acquisition Protocol (2010a) should be followed. If hazardous or contaminated materials spills or releases occur, NZTA Standard Operating Procedure, Response to Spills Arising from Transport Incidents on the State Highway Network (2010b) should be followed.

The majority of the sites did not have contamination present above human health risk based guideline values for commercial/industrial sites. Most of the sites did have metals present above ecological risk based guideline values and/or Wellington region background values. Therefore, in all instances, it is recommended that if soil is removed from the site that it not be used as fill material for sites other than commercial/industrial sites. It should not be placed in areas where ecologically sensitive receptors could be adversely impacted and it should not be used as fill material for residential dwellings or where children may be present (e.g., schools, child care facilities). If the material is used as fill for either the Highway or another facility, consideration should be given to the potential impacts from stormwater runoff. For example, soil with contaminants above ecological risk based criteria should not be used to construct soak pits for stormwater treatment, or placed in areas where stormwater would impact a sensitive area (e.g., next to a stream or native bush).

8.2.1 Greenfields, farm sites and buildings

It is not practical or appropriate to conduct a detailed sampling and analysis programme at regular intervals along the entire route; this would extremely costly and difficult to justify on the basis of the low potential risk associated with greenfields sites. Note that portions of the route is characterised by steep hillsides rising on either side of shallow valleys. Other portions of the route are characterised by steep hills with challenging terrain. There are large areas that are heavily vegetated with plantation forest and native bush. These areas are not likely to be well suited for tanks, rubbish pits, offal pits, or livestock dips. Therefore, the risk is considered very low.

However, it is recognised that there could be areas of contamination along the route that were not discovered by this investigation, particularly in areas near farm structures and where the terrain is relatively flat. For example, historic offal pits, rubbish pits and livestock dips could be present within the construction footprint. While this investigation did include an evaluation of all of the properties along the route with the goal of identifying such activities, it is possible that some were not discovered. No ASTs were observed during the site visits; however, they could be brought onto the sites subsequent to the visits. In addition, no evidence was seen of USTs; however, there is a small possibility that they are present. The CSMP (***Volume 5***), addresses accidental discovery of contamination and should help to minimise risk to human health and the environment.

In addition, not all buildings slated for possible demolition were fully investigated with regard to hazardous materials storage, lead-based paint and asbestos. Limited investigations were conducted of those buildings which are likely to be demolished, i.e., Car Haulaways and former Golden Coast Nurseries. However, since the buildings may be utilised for construction related activities prior to demolition, detailed asbestos investigations were not conducted as thorough asbestos investigations typically result in breaches in roofing materials, walls and floors. These breaches could result in leakage and mould growth or other building damage. Other buildings along the route may or may not be demolished; therefore, no additional investigation was done at this time as it was not considered appropriate to expend funds and time on buildings that may not be affected by construction. It is recommended that an asbestos management plan be developed prior to any demolition or disturbance of structures.

It is recommended that walk-through inspections for hazardous materials be conducted prior to demolition. These inspections should address potential presence of PCB-containing light ballasts, light bulbs and tubes containing hazardous materials, containers of hazardous materials and asbestos. Where asbestos may be present, sampling and analysis should be conducted. Alternatively, building materials should be managed as though they are known to contain asbestos, in accordance with an asbestos management plan. Hazardous materials discovered should be properly removed and disposed of or recycled at an appropriate facility.

8.2.2 MacKays Crossing

Several locations in the vicinity of MacKays Crossing have possible UXO present. The areas where UXO may be present should be investigated and treated in an appropriate manner. At this point in time, it is not appropriate to conduct an intrusive investigation for UXO because the exact design and areas that may be impacted have not yet been determined. The investigation identified geophysical anomalies that may be UXO. As part of enabling works, additional geophysical investigation to provide a higher level of detail, or intrusive investigation, should be conducted to determine whether the identified anomalies are UXO.

Volume 5 contains a protocol for accidental discovery of UXO. The potential for UXO is also noted in “hazards known to the client” documentation maintained by NZTA. The UXO protocol involves notifying the Kapiti Coast Police Station of the presence of the potential UXO. The Police will then arrange for appropriate investigation and disposal of the ordnance. The field activities are typically conducted by the New Zealand Army; however, it is up to the Police to evaluate the situation and make the determination as to whether the Army should be notified and involved.

There is a possibility that, following detonation of UXO (assuming it is detonated in place) that residual contamination could be present. Following UXO detonation, samples should be collected and analysed for explosives constituents to evaluate the potential risk to construction workers. If so, remedial action may be required, with appropriate soil treatment and disposal.

8.2.3 Sang Sue Market Garden

Specific remedial action is not warranted based on laboratory analytical results. The possible presence of contamination is addressed in the CSMP (***Volume 5***) and the site should be re-evaluated as described above prior to start of construction. There was one sample location near the existing SH1 where copper was identified above ecological risk based guideline values. In addition, pesticides and metals above typical Wellington regional background values (URS, 2003) were identified within the horticultural area.

Soil excavated from the site should be utilised as part or construction of disposed of in an area which has already been disturbed. Because there are metals and pesticides present above background concentrations, placement of excavated soil in an ecologically sensitive area is not recommended. In addition, the soil should not be used in an area where stormwater runoff from the soil could lead to ecological damage. Instead, the soil can be reused in an industrial or commercial area, as fill beneath the highway or structure, or disposed of in an appropriate area where stormwater treatment has considered the presence of metals and pesticides. Management of impacted soil is addressed in the CSMP (***Volume 5***).

8.2.4 Former Golden Coast Nurseries

Detectable concentrations of pesticides and heavy metals were found at former Golden Coast Nurseries; however, with one exception no constituents returned laboratory results above human health risk based guideline criteria. Arsenic was detected in one sample at a concentration of 100 mg/kg, above the NES SCV of 70 mg/kg. The corresponding deeper sample returned a result well below the NES SCV. Operations at the site have ceased and continued releases are not anticipated.

Because the arsenic concentration above the NES SCV was localised and within a glass house structure, it is likely that the “hot spot” is the result of past spillage of arsenic-containing products, such as pesticides. Due to the localised nature of the contamination, remedial action is not recommended.

However, because samples did return results for metals well above ecological risk based guideline values, above the NES SCV (in one instance), and above typical background concentrations, any soil removed from the site should not be placed in an area where ecologically sensitive receptors are present or where stormwater runoff could lead to ecological damage. The soil could be re-used in an industrial or commercial area, as fill beneath the highway or structures, or disposed of in an appropriate area where stormwater treatment has considered the presence of metals and pesticides above ecological risk-based guideline values. In addition, workers should be notified of the potential risk. Management of impacted soil is addressed in the CSMP (***Volume 5***).

8.2.5 Car Haulaways

While hydrocarbons above laboratory reporting limits were found in some of the samples at Car Haulaways, none were above NES or human health risk based guideline values. The hydrocarbons detected appeared to be consistent with minor past releases from vehicles. The zinc concentrations above ecological risk based guideline values are likely to be due to the presence of galvanised structures at the site. Chromium is also present at concentrations above expected background concentrations in two locations. Operations at the site have ceased and continued releases are not anticipated.

Because there are ecological risk based guideline value exceedances, it is recommended that the soil be used beneath the highway or structure or in a commercial or industrial area. Disposal of the

soil in an ecologically sensitive area is not recommended. If placed in a disposal area, consideration of the presence of metals and hydrocarbons should be included as part of the stormwater treatment programme. Management of impacted soil is addressed in the CSMP (***Volume 5***).

8.2.6 Porirua Gun Club

Remedial action will be required at the Porirua Gun Club, particularly in the firing range areas. Based on the laboratory analytical results, the contamination appears to be present due to discharge of ammunition and clay targets.

A preliminary evaluation of remedial options has been conducted; however, a detailed evaluation of options and cost analysis has not been conducted. It is recommended that an evaluation of remedial action alternatives be conducted that considers cost, public and regulatory acceptance, technical feasibility, potential risk and highway design constraints. The alternatives evaluation will form the basis for development of a detailed remedial action plan that will be implemented prior to start of construction. As an example, remedial action alternatives could include:

- Excavation with on-site treatment and off-site disposal
- Excavation with on-site treatment and on-site reuse or disposal
- Capping
- Excavation with off-site treatment and disposal at a landfill

A few of the benefits and drawbacks of each are briefly described below. However, a detailed and more formal evaluation of remedial action alternatives and techniques should be conducted to help select the most appropriate alternative.

On-site reuse or disposal of the material is not likely to be a viable alternative as this is a “cut” area rather than a “fill” area. The soil that requires remedial action is heavily laden with spent ammunition and clay targets. These items would likely require removal prior to soil re-use; this would require use of equipment for separating the spent ammunition and targets from soil. This technique has been successfully utilised at large firing range sites; the metal recovered in the form of spent ammunition is recycled, the clay targets are disposed of off-site and the soil is treated on-site and reused or disposed of off-site. However, given the elevated concentrations of metals and PAH present, it is not likely that on-site reuse would be a viable option without some form of treatment (such as soil washing or stabilisation). While the impacted soil could be essentially capped by placing it under the road, without treatment, the soil will remain above human health risk based guideline values. This means that the soil could present a risk to future site workers during maintenance if excavation is required.

Alternatively, it may be possible to separate spent ammunition and targets from the soil and transport the soil to the nearby Transmission Gully Highway soil disposal area. A bed of compacted clean soil could be established, with the impacted soil blended with clean soil and placed on the compacted soil, then covered with clean soil. With this alternative, protection of groundwater would need to be verified and the covering material would need to be inspected periodically to verify that significant erosion has not occurred. If the spent ammunition and targets were not removed prior to disposal of the soil in this area, a continuing source of contamination would be present and would present a potential future risk to the environment. In addition, if maintenance were required in the form of excavation, there could be a risk to site workers. However, this risk would need to be weighed against cost and other considerations, such as potential airborne contamination from the separation process.

There are other areas which require fill material; therefore, one possibility considered could be to remove the material and use it in another area, where it could be covered with “clean” soil and effectively capped. However, the excavated soil would contain grass, weeds and debris (such as

ammunition and clay targets) and may not have the appropriate soil properties to be used as fill material elsewhere.

Another alternative is shipping the soil to an appropriately licensed and consented landfill for treatment and disposal.

Several samples exceeded the NES SCV for lead and benzo(a)pyrene. Numerous sample results exceeded the ecological guideline values for lead and copper and several exceedances for antimony and PAH were also noted. The potential ecological impact should be considered as well as human health, particularly as the ammunition and targets present an ongoing source of contamination at the site. Therefore, it is highly likely that some form of treatment will be required for the soil to mitigate potential ecological impacts.

Because this is a "cut" rather than a "fill" area, treatment (either on-site or off-site) and off-site disposal will be the most likely appropriate option. As part of enabling works, a detailed remedial action plan should be developed and submitted to GWRC for concurrence. Following GWRC's approval, the remedial action plan should be implemented. It is most likely that the soil will be remediated on-site or sent to an appropriately licensed landfill; therefore, consent is not likely to be required for site remediation. The residual risk following appropriate remedial action should be low to minor. Note that as part of the remedial action plan, air quality, erosion control, and stormwater management will need to be addressed to assure that contaminated soil does not leave the site. In addition, airborne dust should be carefully controlled to protect human health (particularly of nearby residents) and the environment.

In general, soil to a depth of approximately 0.3m should be removed from the upper and lower firing range areas as well as the drainage ditch. While contaminant concentrations were not above guideline values in the ammunition burn pit area, it should also be excavated and managed appropriately as there is a potential risk associated with the presence of metals and dioxins. Verification samples should be collected following soil removal. Note that the sample results were highly variable for contaminants of concern in impacted areas. Therefore, the verification sampling programme should provide thorough coverage of the area. It should be noted that the Porirua Gun Club is still in operation and the extent and magnitude of contamination could continue to increase over time. This should be taken into consideration in the remedial action plan. The potential ecological risk should also be considered as part of remedial action planning and implementation.

Because there is evidence of contamination upgradient of the lower level firing range area, it is recommended that appropriate stormwater control measures be implemented to prevent contamination run-on during storm events.

8.2.7 Pauatahanui Inlet Garden Supplies

The 21 August 2010 site inspection revealed the presence of what appeared to be waste asphalt, gold coloured gravel, various types of debris, soil piles with debris, timber, wood chips, charred wood, an outhouse, an empty storage shed and a digger. Ponded water was present, but there was no noticeable hydrocarbon sheen.

In August, it was recommended that the digger, outhouse, storage shed and debris be removed from the site and properly disposed of. It was further recommended that the waste asphalt, gold coloured gravel, wood chips and timber be removed from the site and properly disposed of. In February 2011, the site was cleared of debris. Photos were provided to NZTA (see ***Appendix 16.D***), and the areas shown appear to be free of contamination. However, a detailed inspection should be conducted as part of enabling works, and a determination made as to whether additional sampling should be conducted.

As there was some contamination noted at the site, as with other sites, the material removed should not be placed in an ecologically sensitive area.

8.2.8 Mana Coach

The vehicle leakage observed at Mana Coach does not appear to have led to off-site contamination toward the highway route. However, as operations are continuing at the site, it is recommended that the Stage 1 assessment be updated prior to the start of construction.

8.2.9 GWRC former sheep dip site

While pesticides were detected in samples collected during the investigation of this site, they were present only in the relatively shallow samples. It is possible that they are residual pesticides that may have dripped from livestock or pesticides that were sprayed in the area. The detections of pesticide were below NES SCV and only slightly above ecological risk based guideline values. Therefore, no remedial action is recommended at this time.

However, the potential for contamination still exists at the site. Accidental discovery of contamination is addressed in the CSMP (***Volume 5***). In addition, soil excavated from this area should be placed in areas beneath roads or structures or in areas where stormwater treatment devices are in place which will ensure that adverse ecological effects do not occur.

8.2.10 Former stockyard site

As all samples returned relatively low and consistent pesticide concentrations inside and outside the pens, it is not considered likely that this area was a sheep dip site. One zinc detection above ecological guideline values is not considered to present a significant risk, nor are the detections of DDT above ecological risk values, particularly as they appear to be limited to surface contamination.

Accidental discovery is possible as addressed in the CSMP (***Volume 5***) as other farming activities (e.g., disposal of rubbish or offal) could have taken place in the area and could represent a risk to construction or maintenance workers. Soil excavated from this area should be placed in areas beneath roads or structures or in areas where stormwater treatment devices are in place which will ensure that adverse ecological effects do not occur.

8.3 Summary

The majority of the areas investigated do not present a significant risk to human health or local ecology. The highest risk areas are the portions of MacKays Crossing where potential UXO was identified, the soil contamination at the Porirua Gun Club and presence of asbestos in building materials at the former Golden Coast Nurseries. There is some risk also associated with the detection of arsenic above the NES SCV in one shallow sample at the former Golden Coats Nurseries.

Concentrations of several contaminants of concern were present at concentrations above expected background values at most of the sites, with the exception of Mana Coach. This is likely to be indicative of anthropogenic activities at the sites, such as application of fertiliser, pesticides and herbicides and the presence of galvanised structures. However, the presence of these constituents does not present a risk to human health.

Although ecological guideline values were exceeded in some instances, the concentrations are not likely to pose a threat to local ecology because the areas are highly disturbed and slated for development as the highway. Stormwater treatment and management plans have taken the potential for contamination into consideration. The CSMP (***Volume 5***) addresses management of material with contaminants present above ecological guideline values.

The information from this study has been provided to the project's ecologists and landscape architects and evaluated as to the potential risk. It is recommended that any soil removed from these sites be placed either under the road or within a structure (such as an embankment) and not utilised in ecologically sensitive areas.

Stormwater has also been considered and the information from this study was provided as input into the stormwater treatment and management plan and design criteria (SKM,2010). Lastly, air quality has been considered, particularly with regard to potential dust generation during remediation at the Porirua Gun Club. The Project Air Quality Management Plan (Beca, 2010b) addresses overall dust control; however, extra measures should be put in place at the Porirua Gun Club to assure that contaminated dust does not adversely impact on adjacent properties, particularly nearby residents.

Remedial action will be required to evaluate the UXO at MacKays Crossing and to manage the contaminated soil at the Porirua Gun Club. A protocol for UXO has been developed and it is recommended that a remedial action plan be developed for the Gun Club and submitted to GWRC for approval as part of enabling works.

Appropriate care should be exercised during building demolition as a detailed asbestos investigation was not conducted of all buildings along the route. Thorough asbestos surveys should be conducted of all buildings slated for demolition and Department of Labour guidelines and regulations should be followed where asbestos is present. An asbestos management plan should be developed and implemented.

As previously mentioned, due to minor adjustments in the highway alignment, additional investigation requirements were identified subsequent to completion of this investigation. These investigations will be addressed in separate letter reports.

A CSMP has been developed and is included as ***Volume 5***. Once construction planning and design activities are more fully developed, additional detail should be added to the CSMP. This plan should be implemented during construction and should also address any precautions to be taken during highway maintenance.

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