NZ TRANSPORT AGENCY
WAKA KOTAHI

Technical Report No 16

Christchurch Southern Motorway Stage 2 and Main South Road Four Laning

Contaminated Land Assessment

November 2012

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Quality Assurance Statement			
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This technical report has been produced in support of the Assessment of Environmental Effects (AEE) for the Main South Road Four Laning and Christchurch Southern Motorway Stage 2 Project. It is one of 20 Technical Reports produced (listed below), which form Volume 3 of the lodgement document. Technical information contained in the AEE is drawn from these Technical Reports, and cross-references to the relevant reports are provided in the AEE where appropriate.

A Construction Environmental Management Plan (CEMP) has been prepared to provide the framework, methods and tools for avoiding, remedying or mitigating environmental effects of the construction phase of the Project. The CEMP is supported by Specialised Environmental Management Plans (SEMPs), which are attached as appendices to the CEMP. These SEMPs are listed against the relevant Technical Reports in the table below. This Technical Report is highlighted in grey in the table below. For a complete understanding of the Project all Technical Reports need to be read in full along with the AEE itself; however where certain other Technical Reports are closely linked with this one they are shown in bold.

For further information on the structure of the lodgement documentation, refer to the 'Guide to the lodgement documentation' document issued with the AEE in Volume 1.

No.	Technical Report Title	Primary AEE Chapter Reference	SEMPs
1	Design philosophy statement	4	
2	Traffic and transportation effects report	11	Construction Traffic Management Plan
3	Assessment of stormwater disposal and water quality	19	Erosion and Sediment Control Plan, Accidental Aquifer Interception Management Plan
4	Landscape and visual effects	15	Landscape Management Plan
5	Assessment of effects – urban design	14	Landscape Management Plan
6	Urban and landscape design framework	14, 15	Landscape Management Plan
7	Landscape context report	15	Landscape Management Plan
8	Assessment of operational noise effects	17	
9	Assessment of construction noise & vibration	17	Construction Noise and Vibration Management Plan
10	Assessment of air quality effects	18	Air Quality Management Plan
11	**Geotechnical engineering and geo-hazards assessment**	**3, 21**	
12	Assessment of archaeological effects	24	
13	Social impact assessment	26	
14	Economic impact assessment	25	
15	Cultural impact assessment	23	
16	Contaminated land assessment	22	
17	Aquatic ecology assessment	20	
18	Terrestrial ecology assessment	20	
19	Lighting assessment	16	
20	Statutory provisions report	6, 28	
–	Construction Environmental Management Plan	5	

Contents

Appendices

Appendix A
Investigation Location Plans

Appendix B:
Sample Register

Appendix C
Laboratory Results

Acronyms

Acid herbicides	AH
asbestos-containing materials	ACM
benzo(a)pyrene toxic equivalence	BaP TEQ
Christchurch Southern Motorway Stage 1	CSM1
Christchurch Southern Motorway Stage 2	CSM2
combined toxic equivalent	TEQ
Construction Environmental Management Plan	CEMP
Contaminated Land Management Guidelines	CLMG
Detailed Site Investigation	DSI
Environment Canterbury	ECan
Environmental Guideline Value	EGV
Environmental Protection Authority	EPA
heavy metals	HM
Main South Road Four Laning	MSRFL
Ministry for the Environment	MfE
New Zealand Map Grid	NZMG
New Zealand Transport Agency	NZTA
Operative Canterbury Natural Resources Regional Plan, 2011	NRRP
organochlorine pesticides	OCP
Pentchlorophenols	PCP
Polycyclic Aromatic Hydrocarbons	PAH
Preliminary Site Investigation	PSI
relative percentage difference	RPD
Remedial Action Plan	RAP
Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011	Soil NES
Resource Management Act 1991	RMA
roads of national significance	RoNS
Site Validation Report	SVR
Soil Contaminant Standard (health)	$SCS_{(health)}$
State Highway 1	SH1

1. Executive Summary

Soil contamination investigations have been undertaken along and adjacent to the designated route of the proposed Stage 2 of the Christchurch Southern Motorway (CSM2) and Main South Road Four Laning (MSRFL) (together known as the project). The route passes over greenfields and orchards, and adjacent to railway and landfill sites. The investigations included a route inspection, the development of a soil sampling plan, soil sample collection, laboratory analyses and the assessment and reporting of laboratory results against the soil contaminant standards ($SCSs_{(health)}$) of the *Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (the Soil NES).*

A total of thirty-three (33) soil samples and three duplicate soil samples were collected from near-surface depths and analysed for a range of contaminants based on past or current land uses. Sampling locations were selected on a judgemental basis after consideration of known current and historic land uses. The results were assessed on a land use basis for risks to human health.

The concentrations of soil contaminants in all soil samples collected within the designated zone for the CSM2 and MSRFL project were less than the $SCSs_{(health)}$ for the relevant land use. A Tier 1 Risk Assessment of the investigation results demonstrate that any contamination arising from historic land use activities along the designated route will have little or no measurable effect on human health or the environment.

Several locations along the CSM2 and MSRFL route are identified as Hazardous Activities and Industries List sites. The NES (which came into effect on 1 January 2012) identifies contaminated soil disturbance as a controlled activity, and as such, the NZTA are required to apply for a controlled activity resource consent. As a controlled activity, the activity must be managed under a site management plan. It must also be monitored and reported on, including the transport, disposal and tracking of materials taken away in the course of the activity.

Where a soil investigation finds that the Soil Contaminant Standards for the protection of human health ($SCSs_{(health)}$) are exceeded, for a given land use, the activity becomes a restricted discretionary activity under Regulation 10 of the Soil NES and therefore remediation is required. The results of the soil investigations undertaken for the Project do not exceed the land use ($SCSs_{(health)}$) and therefore, the activity remains a controlled activity under the Soil NES. Remedial action resulting from the measured soil contaminant concentrations is therefore not required.

If contaminated land is discovered during construction of the Project, the contingency action for mitigation provided in Section 11.6 of this report and in the draft CEMP must be followed.

2. Introduction

In November 2010, GHD was engaged by the NZ Transport Agency (NZTA) to undertake a preliminary contaminated land investigation in relation to Phase 2 of the Christchurch Southern Motorway and Main South Road Four Laning project. Most of the land that will be disturbed during the construction works for the project is rural in nature, comprising open flat paddocks used for pasture, cropping and other agricultural enterprises. The preliminary investigation identified several locations where the proposed route intersected, or was in close proximity to, potentially contaminated land. This technical report summarises the preliminary investigation and provides the findings of an intrusive investigation that was carried out to investigate the presence of contaminated land and assess the potential risk posed by soil contaminants to human health and the environment from the construction of the CSM2 and MSRFL project.

2.1 Previous Reports

As part of the scheme assessment process for the Project, the following contamination investigations have been reported:

- Christchurch Southern Motorway – Stage 2 and Main South Road Four Laning: Contaminated Land Preliminary Assessment: GHD Limited, April 2011;
- Report for Springs Road Quarry – Soil Contamination Assessment, GHD Limited June 2012; and
- Springs Road Quarry Aerial Photo Review (Letter Report). GHD Limited, 10 September 2012.

2.2 Purpose

The NZTA has prepared applications for:

- notices of requirement to designate land in Christchurch and Selwyn Council Districts for CSM2;
- notices of requirement for alterations to an existing designation for MSRFL; and
- applications for resource consents for activities which require consent from Environment Canterbury.

The NZTA will lodge the applications with the Environmental Protection Authority (EPA).

The purpose of this report is to:

- Meet the requirements of the Soil NES that came into force on 1 January 2012;
- Assess the likelihood of adverse effects of soil contaminants on human health and the environment;
- Provide information to support the controlled activity resource consent application; and
- Outline any recommended contaminant mitigation measures.

2.3 Scope of Contamination Investigation

In order to investigate the presence of contaminated land within the alignment of the Project, the following scope of work was undertaken:

- Regulatory assessment of contamination compliance;
- Review of information collected during the Preliminary Site Investigation (GHD, April 2011);
- Site walkover to determine sampling locations;
- Consultation with the Environment Canterbury Contaminated Sites Team Leader and notification of proposed sampling locations;
- Design of a site investigation targeted on obtaining data to evaluate the potential for contamination based on the contamination sources identified in the preliminary investigation;
- Preparation of a health and safety plan to cover the proposed works;
- Supervision and collection of samples for laboratory analysis;
- Laboratory analytical testing of samples;
- Interpretation of results and comparison with accepted guideline values; and
- Assessment of mitigation and contingency methods for contaminant management (if any).

3. Contaminated Land: Regulatory Controls

Historic and current land use along the proposed route includes orchard, horticultural, livestock, quarry, rail and landfill activities. These activities are scheduled in both the Hazardous Activity Industries List (HAIL) and Schedule WQL3 of the Canterbury Natural Resources Regional Plan (NRRP) Ch5. Specific sites where these activities are, or have occurred are identified in Tables 1 – 3.

As such, the construction phase of the Project is subject to:

- The contaminated land rules of the NRRP Ch4; Rules WQL 46 and 47; and
- The Soil NES.

3.1 Canterbury Natural Resources Regional Plan

The NRRP addresses sustainable management of air, land and water resources in the Canterbury Region. Policy WQL 12 requires contaminated land to be identified, and where necessary, investigated, managed or remediated, in accordance with national guidelines to address potential risks to the environment and human health. The measured extent and nature of the contamination is not to exceed relevant national environmental acceptance criteria for the current or proposed land use. Any discharges of contaminants beyond the site to groundwater, surface water, or soil, cannot have significant adverse effects on the environment, and monitoring and management of the site is to be undertaken to ensure that this is achieved.

In summary, Rule WQL46 controls the investigation of contaminated land and Rule WQL 47 controls the remediation of contaminated land. The rules state:

In June 2011 Environment Canterbury made the water and land chapters (Chapters 4 to 8) of the NRRP operative. To ensure it is, and remains, appropriate for this changing environment, Environment Canterbury has decided to develop a new Land and Water Regional Plan that will build on, improve, and in some instances replace, Chapters 4 to 8 of the NRRP.

3.2 Proposed Canterbury Land and Water Regional Plan

In the Proposed Canterbury Land and Water Plan (Notified 11 August 2012) Rule 5.168 will only be relevant if future site investigations are required during construction and it is anticipated that all conditions could be met and that any future site investigations would be a permitted activity.

Under Rule 5.168 the use of land for a site investigation to assess concentrations of hazardous substances that may be present in the soil is a permitted activity provided the following conditions are met:

- The site investigation is to be undertaken in accordance with Contaminated Land Management Guidelines No. 5: Site Investigation and Analysis of Soils (Ministry for the Environment, February 2004) and reported on in accordance with Section 4 of the Contaminated Land Management

Guidelines No. 1: Reporting on Contaminated Sites in New Zealand, (Ministry for the Environment, November 2003); and

- The person or organisation initiating the site investigation provides a copy of the site investigation report to the Canterbury Regional Council within two months of the completion of the investigation.

3.3 Soil NES

3.3.1 General Overview

The Soil NES includes, by reference, the following Ministry for the Environment (MfE) guidance documents:

- Contaminated Land Management Guidelines (CLMG) No. 1: Reporting on Contaminated Sites in New Zealand, (revised 2011);
- Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values, 2001 (revised 2011);
- Contaminated Land Management Guidelines No. 5: Site Investigation and Analysis of Soils (revised 2011); and
- Contaminated Land Management Guidelines: Schedule B – The Hazardous Activities Industries List (HAIL) (revised 2011).

As these guidelines are incorporated by reference in the NES, they are deemed as having regulatory status in New Zealand.

The Soil NES mandates the methods for setting applicable numerical standards for contaminants in soil that are protective of human health. It contains a national set of soil contaminant standards (SCS) for 12 priority contaminants for five standard land use scenarios (rural residential, residential, high density residential, recreational and commercial/industrial). For any land on which any activity (current or historic) included in the Hazardous Activity Industry List (HAIL) has occurred the Soil NES also regulates:

- Site investigation and reporting (Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI));
- The sampling of soils for contamination assessment; and
- Contamination investigations and health risk assessments when disturbing soil, subdividing land and changing land use.

The Soil NES prevails over any district plan contaminated land rules for the protection of human health. MfE has provided guidance on the decision process for determining if a resource consent is required[1]. Environment Canterbury has advised that it accepts the numerical standards for

[1] Users' Guide, National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health, Ministry for the Environment ME 1078, 2012.

contaminants in soil to protect human health set by the Soil NES as compliance with the contaminated land rules of the NRRP[2].

In the absence of Soil Contaminant Standard (health) for selected contaminants (or other applicable guidelines), the MfE Contaminated Land Management Guidelines No. 2[3] provide the hierarchy for the application of New Zealand and International acceptance criteria.

3.3.2 Applicability

The Soil NES was gazetted on 13 October 2011, and came into effect on 1 January 2012.

The intention of the Soil NES is to enable safe use of contaminated land through:

- Establishing regulations for five land use scenarios;
- Ensuring that contaminated land is appropriately assessed prior to development, and if necessary that the land is remediated to make it safe for human use

Under the Soil NES, the following activities are permitted[4]:

- Removal or replacement of underground fuel storage tanks and soil associated with these systems;
- Soil sampling;
- Small scale (<25m^3 per 500m^2 of affected land) and temporary (<2 months duration) soil disturbance activities; and
- Subdividing or changing land use where a preliminary site investigation shows that it is highly unlikely the proposed activity will pose a risk to human health.

Activities that require resource consent under the Soil NES include:

- Development of land where the risk to human health from soil contamination does not exceed the applicable soil contaminant standard for the given land use (controlled activity);
- The development of land where the risk to human health from soil contamination exceeds the applicable soil contaminant standard for the given land use (restricted discretionary activity); and
- The development of land where the activity does not meet the requirements of restricted discretionary, controlled or permitted activities (discretionary activity).

The Soil NES does not apply to contaminated sites or past/current HAIL sites where a detailed site investigation demonstrates that contaminants in or on the piece of land are at or below "natural background" concentrations[5]. Environment Canterbury has published a study of the region that documents the range of background trace element concentrations found in naturally occurring soils (refer section 8.4.4).

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[2] Teleconference between Peter Nelson and Brett Mongillo, ECAN 14/05/2012.

[3] Hierarchy and Application in New Zealand of Environmental Guideline Values, 2001 (revised 2011).

[4] Regulation 8, National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health, Ministry for the Environment, 2011.

[5] Regulation 5(9), National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health, Ministry for the Environment, 2011.

3.4 Operational Phase

Some contaminants such as trace elements and polynuclear aromatic hydrocarbons (PAHs) are generated from bitumen road surfaces and the particulate deposits from vehicles. Once the construction phase is completed and the CSM2 Project becomes operational, stormwater discharges from the road will be subject to controls under Rule WQL6 of the Operative Canterbury NRRP.

3.5 Reporting

This report has been prepared with reference to the MfE's *Contaminated Land Management Guidelines No. 1: Reporting on Contaminated Sites in New Zealand, (revised 2011)*. These guidelines recommend a report structure and content for each of the contaminated land investigation phases.

4. Proposal Description

The NZ Transport Agency (NZTA) seeks to improve access for people and freight to and from the south of Christchurch via State highway 1 (SH1) to the Christchurch City centre and Lyttelton Port by constructing, operating and maintaining the Christchurch Southern Corridor. The Government has identified the Christchurch motorway projects, including the Christchurch Southern Corridor, as a road of national significance (RoNS).

The proposal forms part of the Christchurch Southern Corridor and is made up of two sections: Main South Road Four Laning (MSRFL) involves the widening and upgrading of Main South Road (MSR), also referred to as SH1, to provide for a four-lane median separated expressway; and the construction of the Christchurch Southern Motorway Stage 2 (CSM2) as a four-lane median separated motorway. The proposed construction, operation and maintenance of MSRFL and CSM2, together with ancillary local road improvements, are referred to hereafter as 'the Project'.

4.1 MSRFL

Main South Road will be increased in width to four lanes from its intersection with Park Lane north of Rolleston, for approximately 4.5 km to the connection with CSM2 at Robinsons Road. MSRFL will be an expressway consisting of two lanes in each direction, a median with barrier separating oncoming traffic, and sealed shoulders. An interchange at Weedons Road will provide full access on and off the expressway. MSFRL will connect with CSM2 via an interchange near Robinsons Road, and SH1 will continue on its current alignment towards Templeton.

Rear access for properties fronting the western side of MSRFL will be provided via a new road running parallel to the immediate east of the Main Trunk rail corridor from Weedons Ross Road to just north of Curraghs Road. For properties fronting the eastern side of MSRFL, rear access is to be provided via an extension of Berketts Drive and private rights of way.

The full length of MSRFL is located within the Selwyn District.

4.2 CSM2

CSM2 will extend from its link with SH1 / MSRFL at Robinsons Road for approximately 8.4 km to link with Christchurch Southern Motorway Stage 1(CSM1, currently under construction) at Halswell Junction Road. The road will be constructed to a motorway standard comprising four lanes, with two lanes in each direction, with a median and barrier to separate oncoming traffic and provide for safety[6]. Access to CSM2 will be limited to an interchange at Shands Road, and a half-interchange with eastward facing ramps at Halswell Junction Road. At four places along the motorway, underpasses (local road over the motorway) will be used to enable connectivity for local roads, and at Robinsons / Curraghs Roads, an overpass (local road under the motorway) will be provided. CSM2 will largely be constructed at grade,

[6] CSM2 will not become a motorway until the Governor-General declares it to be a motorway upon request from the NZTA under section 71 of the Government Roading Powers Act 1989 (GRPA). However, for the purposes of this report, the term "motorway" may be used to describe the CSM2 section of the Project.

with a number of underpasses where elevated structures provide for intersecting roads to pass above the proposed alignment.

CSM2 crosses the Selwyn District and Christchurch City Council boundary at Marshs Road, with approximately 6 km of the CSM2 section within the Selwyn District and the remaining 2.4 km within the Christchurch City limits.

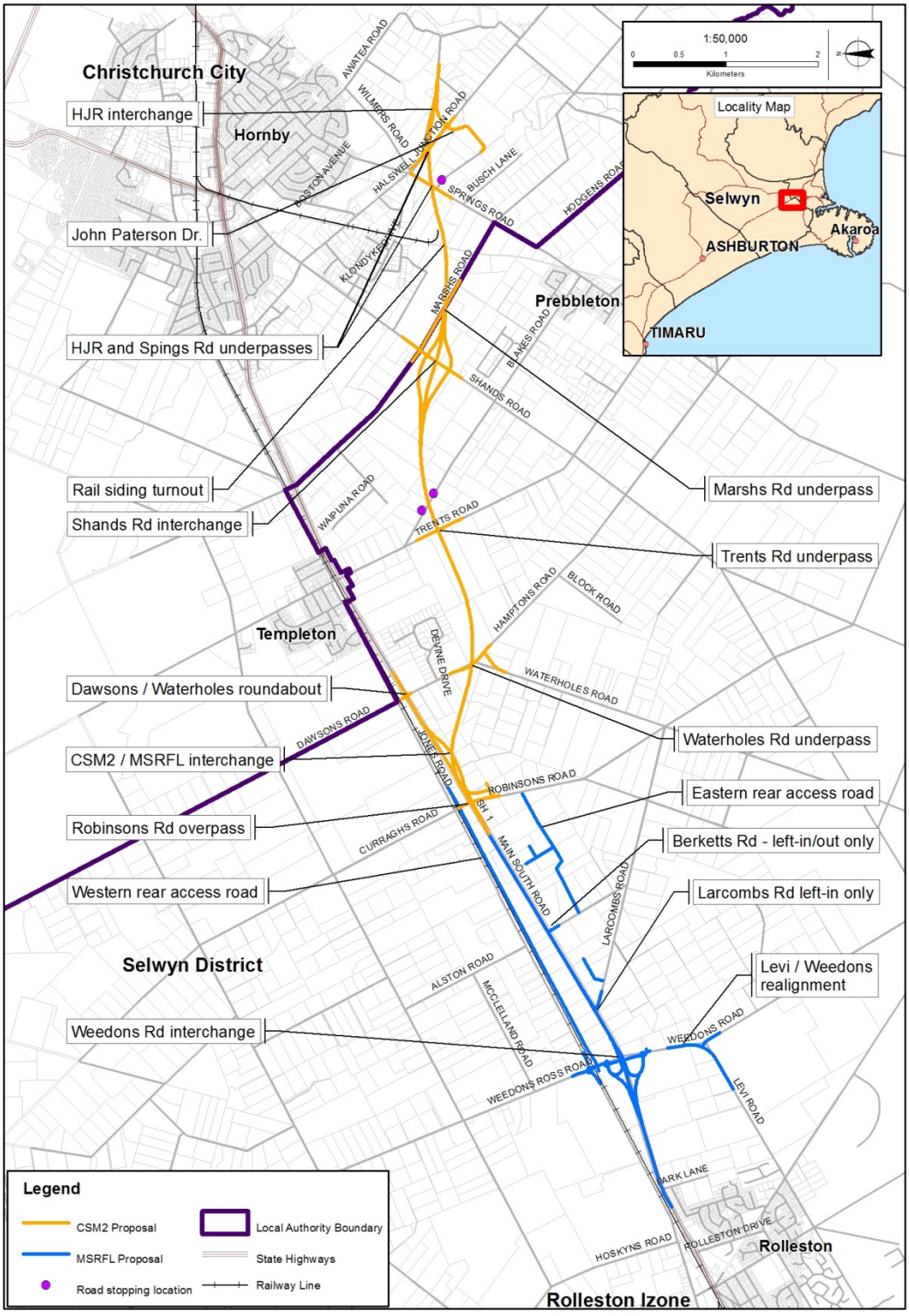
4.3 Key design features

The key design features and changes to the existing road network (from south to north) proposed are:

- a new full grade separated partial cloverleaf interchange at Weedons Road;
- a new roundabout at Weedons Ross / Jones Road;
- a realignment and intersection upgrade at Weedons / Levi Road;
- a new local road running to the immediate east of the rail corridor, to the west of Main South Road, between Weedons Ross Road and Curraghs Road;
- alterations and partial closure of Larcombs Road intersection with Main South Road to left in only;
- alterations to Berketts Road intersection with Main South Road to left in and left out only;
- a new accessway running to the east of Main South Road, between Berketts Road and Robinsons Road;
- an overpass at Robinsons and Curraghs Roads (the local roads will link under the motorway);
- construction of a grade separated y-junction (interchange) with Main South Road near Robinsons Road;
- a link road connecting SH1 with Robinsons Road;
- a short new access road north of Curraghs Road, adjacent to the rail line;
- a new roundabout at SH1 / Dawsons Road / Waterholes Road;
- an underpass at Waterholes Road (the local road will pass over the motorway);
- an underpass at Trents Road (the local road will pass over the motorway);
- the closure of Blakes Road and conversion to two cul-de-sacs where it is severed by CSM2;
- a new full grade separated diamond interchange at Shands Road;
- an underpass at Marshs Road (the local road will pass over the motorway);
- providing a new walking and cycling path linking the Little River Rail Trail at Marshs Road to the shared use path being constructed as part of CSM1;
- an underpass at Springs Road (the local road will pass over the motorway);
- a new grade separated half interchange at Halswell Junction Road with east facing on and off ramps linking Halswell Junction Road to CSM1; and
- closure of John Paterson Drive at Springs Road and eastern extension of John Paterson Drive to connect with the CSM1 off-ramp via Halswell Junction Road roundabout (east of CSM2).

The proposed alignment is illustrated in Figure 1 and encompasses the MSRFL and CSM2 alignments between Rolleston and Halswell Junction Road.

Figure 1 Proposal location map



5. Site History

This section is based upon the GHD (April 2011) Preliminary Assessment report.

5.1 CSM2 Past and Present Land Uses

The area proposed for the CSM2 development requires the construction of a new road corridor to connect the end of the MSRFL project to the Christchurch Southern Motorway. The land intersected by the CSM2 road corridor is primarily light grazing and non-intensive cropping land. The area is well-known for breeding and training racehorses and a number of horse training tracks can be seen on the aerial photo (Figure A3, Appendix A) of the area. A number of lifestyle blocks are located on or near the CSM2 corridor. An orchard is located at 2/1103 Main South Road. A former orchard is located approximately 200 m south of the proposed route at the eastern corner of Shands Road and Blakes Road. This site is now subdivided and forms the Aberdeen residential Subdivision. The eastern end of the CSM2 corridor intersects the former Southbridge Branch railway line.

The underlying gravels in the area have been subject to localised extraction for construction purposes, although records of locations and volumes extracted were not readily available. Based on landforms and discussions with local people, a gravel quarry existed adjacent to Springs Road, approximately 200 m north of the proposed alignment. According to Environment Canterbury records, a backfilled gravel pit is located on the junction of Main South Road and Curraghs Road.

A number of closed landfills are located near the Springs Road / Halswell Junction Road intersection; these sites are all located at least 250 m to the alignment. Investigations at these sites have reported groundwater levels in the range of 4 – 6 m below ground level with the groundwater gradient to the southeast. The reported groundwater quality does not show any indication of leachate contamination[7].

5.2 MSRFL Past and Present Land Uses

Main South Road is one of the original major roads connecting Christchurch with outlying settlements to the southwest. The land surrounding the MSRFL corridor is predominantly rural land used primarily for cropping and livestock grazing (sheep and horses). There are a number of small commercial operations primarily on the southern side of Main South Road including a plant nursery, knitwear retailer, furniture maker and a chicken processing factory. The buildings relating to these operations are set back from Main South Road.

The land use has involved rural activities since the original establishment of settlements in the area in the late 1800s and early 1900s. Larger land blocks have been divided into smaller blocks over time, and the establishment of smaller lifestyle sections has occurred in recent years.

[7] NTC 224 Ground Water Monitoring Report 10. Pattle Delamore Partners Limited, July 2010.

The Main South Road is currently a single carriageway with grassed verges on both sides for much of the route. Traffic volumes have grown steadily with the development of the region, resulting in the proposal to four-lane part of Main South Road.

6. Site Condition and Surrounding Environment

A limited walkover of the proposed route was undertaken on 14 July 2010 and again, on 14 February 2011. As land access agreements were not in place, the walkover route was restricted to locations where the proposed alignment intersected public roads.

6.1 Site Walkover (CSM2)

The area is generally flat with no significant undulations or depressions observed, with the exception of the land parcel between the rail line and Springs Road near the eastern terminus of the alignment. Based upon information provided by Environment Canterbury this site has reportedly been subject to uncontrolled land filling. This may be related to the development of the large industrial buildings backing on to the property and/or historic gravel extraction in the area. No significant or obvious indications of settlement were observed at the Springs Road Quarry or at any other location along the route.

Land use appeared to predominantly comprise rural residential/lifestyle and agricultural farmland. However occasional orchards were observed and other land uses may be present. Approximately east of Shands Road the land use changes, with industrial units becoming common. Large established trees commonly form shelterbelts across the route.

Overhead power lines were observed running parallel to the majority of roads and one large high voltage power pylon line crosses the CSM2 route to the immediate south of Marshs Road and the intersection of the CSM2 alignment. Buried services are likely to run within the road verge with connections running to private properties. Telecommunications boxes were observed at numerous locations.

No significant water ways or overland flow paths were noted during the site visits. Shallow (approx. 1 m deep) stock water races were observed adjacent to the roads and these features intersect the proposed route.

6.1.1 Springs Road Quarry

The former quarry comprised an area of approximately 7 ha and appeared to have been used as an informal storage/dumping area for a number of years. The CSM2 alignment passes through the southern corner of the site, however the filled area of the site is located approximately 100 m from the alignment at it nearest point. The inferred extent of the filled area was identified from review of historic aerial photographs[8]. This shows that filling primarily occurred in the southern portion of the site.

A compound was constructed in the central part of the former quarry, and is currently leased as a general storage area for heavy vehicles, machinery and timber. The compound comprised an area of approximately 0.6 ha.

[8] Springs Road Quarry Aerial Photo Review, GHD Limited, 10 September 2012.

Outside of the compound area, a number of mounds of soil, concrete pipes, drums, large oil tanks and construction waste were observed, during the site visit. One of the large oil tanks was noted to have been opened and was leaking a tar-like substance directly onto the ground. Some photographs of the former quarry are presented in Figures 2 – 5.

The New Zealand Gazette notice shows that the site was originally owned by the Ministry of Works and according to information provided by council waste materials have been disposed of in pits across the site for over 30 years. The locations of the pits are unknown. GHD undertook an investigation of the Springs Road Quarry site to assess soil conditions in April 2012. Near-surface samples were collected adjacent to areas of potential contamination including the leaking tar-like substance from the large tanks, burnt chemical containers, mounds of soils, timber storage area and general rubbish disposal areas. The results of this investigation and soil sampling along the balance of the alignment are summarised in this report.

Figure 2 Photograph of Compound Area Looking West (30 June 2011)

Figure 3 Photograph of Abandoned Tanks (30 June 2011)

Figure 4 Photograph of Discarded Containers (30 June 2011)

Figure 5 Photograph of Timber Storage in Compound (30 June 2011)

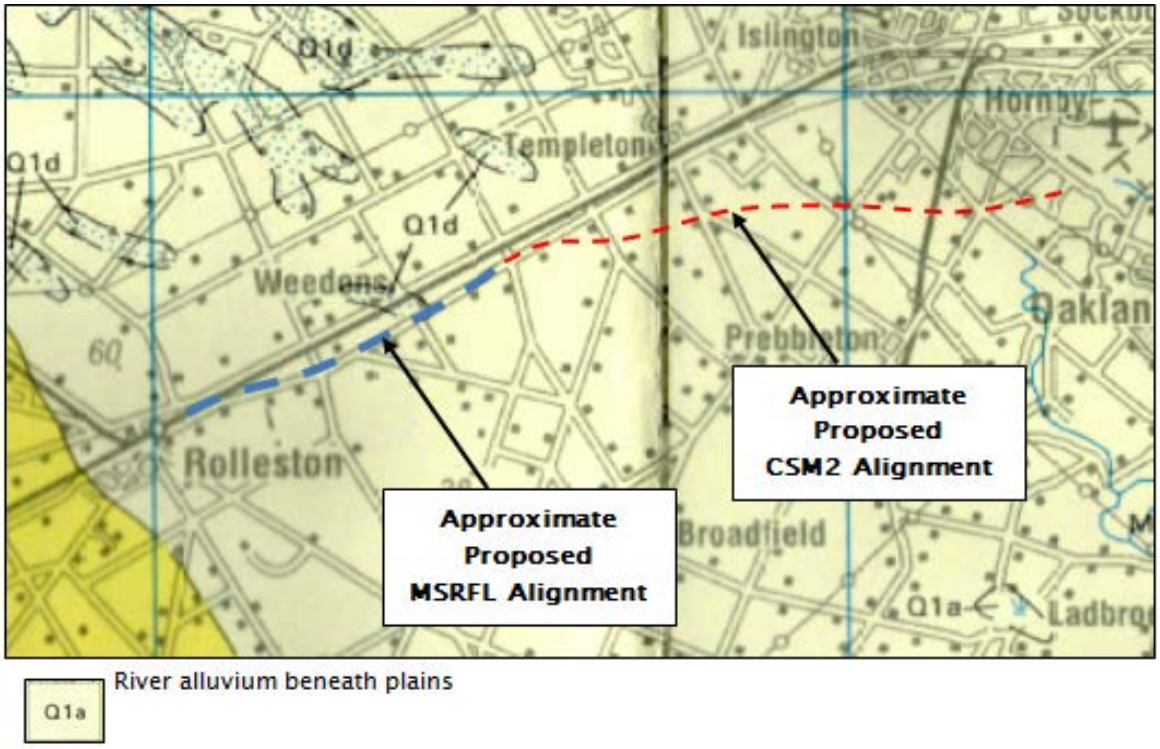
6.2 Site Walkover (MSRFL)

The MSRFL is predominantly bordered by agricultural land use. Established trees typically form shelterbelts either side of the existing Main South Road. Overhead power lines run adjacent to the road. Topography is typically flat. No significant overland flowpaths, signs of settlement, signs of filling or waterways (apart from irrigation races) were observed during the walkover.

7. Geology and Hydrogeology

The geological assessment[9] developed a ground model during the investigation of the Project. An extract from the published geological mapping is presented as Figure 6.

Figure 6 Extract from the Published Geological Mapping[10]



The general topography for the site is characterised by flat alluvial plains (Q1a). The alluvial material has been subdivided into alluvial sand and silt of historic river flood channels and underlying alluvial gravel and sand (and silt overbank deposits), both of the Yaldhurst Member of the Springston Formation. These have been laid by alluvial processes over the past 10,000 years and consist of shallow low plasticity silts and clays, intermixed with fine sands. These soils are typically overlain by 0.1 – 0.3 m of topsoil and generally extend to a depth of between 0.1 to 2.2 m below ground level, map unit Q1d also extends to the MSRFL alignment near Weedons, as shown in Figure 6. The soil type comprises stabilised river or beach sand dunes.

A simplified soil profile has been adopted for the purposes of developing geotechnical parameters and design philosophies. The profiles adopted are generally described as:

- Top Soil:
- Sandy Silt:

[9] Christchurch Southern Motorway Stage 2 and Main South Road Four Laning: Assessment of Environmental Effects Technical Report 11 Geotechnical Engineering and Geo-hazard, GHD March 2012.

[10] Geology of the Christchurch Area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 16. 2008.

- Sandy Gravel: and
- Silty Sandy Gravel.

The groundwater of the alluvial gravels of the Canterbury Plains typically extend within shallow (<20 m depth) unconfined aquifers with hydraulic connection to any nearby surface water courses. Groundwater yields tend to vary laterally over short distances indicating that more permeable gravel horizons heavily influence the groundwater flow. Groundwater movement below the plains and the Project site is generally downward and towards the coast. Shallow groundwater levels vary seasonally and respond to winter recharge and summer irrigation use. Connectivity of surface waters with shallow groundwater increases the vulnerability of groundwater to contamination.

8. Site Characterisation

The Preliminary Site Investigation identified a number of potentially contaminated sites within the study area, based on past or current land uses. These sites are summarised in Table 1 overleaf. The sampling and analysis plan was developed for investigating these sites (Section 9 below). A figure is included in Appendix A showing the site locations.

The "potential to impact" the project was assessed prior to the site investigations as a relative, subjective ranking based upon the nature of the activity. Agricultural and horticultural activities were ranked as relatively low risk because the pesticides used in spray operations are applied in a broad-acre, diffuse manner, and the resultant soil concentrations are generally low. By contrast, the potential risk posed from contaminants at the landfill timber treatment sites were categorized as moderate to high.

Table 1 Potential Sources of Contamination

Site ID	Description	Route	Potential Primary Contaminants of Concern[11]	Extent of site within the alignment	Potential to impact
NA	Majority of CSM2 and MSRFL – Agricultural Land (Greenfield Soils)	MSRFL/ CSM2	Arsenic, lead, copper, cadmium[12] and organochlorine pesticides including DDT	Whole site potentially	Low
1	Larcombs Vineyard	MSRFL	Arsenic, lead, copper, and organochlorine pesticides	Not Affected[13]	Low
2	Evergreen Garden Centre and Southern Woods Nursery	MSRFL	Arsenic, lead, copper, and organochlorine pesticides	Northern boundary	Low
3	North east corner of Main South Road and Curraghs Road (Former Landfill)	MSRFL	Heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs), petroleum hydrocarbons, Pentachlorophenol (PCP) and asbestos.	Not Affected	Low/ Moderate
4	Former Applefields Orchards	CSM2	Arsenic, lead, copper, and organochlorine pesticides	Not affected	Low
5	Former Southbridge Branch Railway Line	CSM2	Heavy metals, PAHs, creosote and herbicides	Partially Intersects	Moderate
6	Former Quarry (Springs Road)	CSM2	Heavy metals, hydrocarbons including PAHs, petroleum hydrocarbons, PCP and asbestos	Partially intersects	Moderate/ High
7	McVicars Site – Timber Treatment (Halswell Junction Road)	CSM2	Arsenic, copper, chromium, boron, PCP (dioxins and furans as impurities in PCP)	Southern boundary	Moderate/ High

[11] Based upon the contaminants identified for the HAIL activity; refer appendix C of the Ministry for the Environment Users Guide for the NES (April 2012).

[12] Cadmium is trace element associated with some forms of superphosphate fertiliser application, commonly used for pastoral agriculture in New Zealand.

[13] Refer Table 2.

9. Sampling and Analysis Plan

9.1 Data Quality Objectives

The purpose of the sampling and analysis plan was to investigate and provide information on the following aspects of the land:

1. The degree to which contamination may have arisen from current or historic land uses (refer Table 1);
2. The potential for contamination to pose a risk to the environment (migration to land, surface water or groundwater);
3. The potential for contamination to pose a risk to construction workers (human health risks); and
4. Indicative cost for disposal of any contaminated soil as a result of the Project.

9.1.1 Sampling and Investigation Plan

The sampling and investigation plan was based on investigating the areas identified in the Preliminary Site Investigation (GHD, April 2011) and summarised in Table 1.

Some of the areas identified in the Preliminary Site Investigation were not investigated, primarily due to more detailed information being available on the proposed route, resulting in lesser impact on some of the potentially contaminated sites. Areas that were excluded from the field investigation programme are summarised in Table 2 below.

Sampling locations, as listed in Table 3 below, were selected on a judgmental basis, with three targeted sites where HAIL activities were identified (horticulture, quarrying and railway) and non HAIL greenfield sites.

Table 2: Areas Excluded from Site Investigation

Site ID	Description	Justification for exclusion
1	Larcombs Vineyard	Widening of Main South Road is primarily on the opposite side to the vineyard. The extent of the construction zone does not include the vineyard site.
2	Evergreen Garden Centre and Southern Woods Nursery	As site visit revealed little potential for contamination. No evidence of widespread spraying because plants were contained in pots. Glass houses located well away from the alignment.
3	North east corner of Main South Road and Curraghs Road (Former Landfill)	This site is recorded on the ECan Listed Land Use Register (LLUR) as a landfill site (site no. 3789). ECan records a geotechnical investigation for the construction of an office, workshop and display facility in 2009. This investigation reported refuse buried in the western and southern side of a backfilled 50 m^2 pit. There is no record of remedial action on the ECan files. While the eastern part of the site may lie close to or within the CSM2 designation, the reported area of refuse is located outside of this area.
7	McVicars Site – Timber Treatment (Halswell Junction Road)	Works in this location are part of CSM Stage 1 and not part of the Project.

Table 3 below shows the sampling plan, sample identification and analytical suite undertaken for each area. The sample locations are provided in Figures A1 – A3, Appendix A to this report.

Table 3 Proposed Sampling Plan

Site ID	Description	Sample IDs	Analytical Suite
'Greenfield Soils'	Rural/agricultural land throughout CSM2 and MSRFL	BG01 to BG15 (15 samples)	OCPs, HMs
4	Former Applefields Orchard	AS01 to AS03 (3 samples)	OCPs, HMs
5	Former Southbridge Branch Railway Line	RW01 to RW05 (5 samples)	PAHs, AH, HMs
6	Former Quarry (Springs Road)	Q1 to Q9 (including 6A and 6B) (10 samples)	PAHs, HMs

Notes:

Greenfield soils – relates to sites with no known use, apart from agricultural land use, based upon information reviewed during the Preliminary Site Investigation, April 2011.

OCPs – Organochlorine Pesticide Screen

HMs – Heavy Metals Screen (Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Zinc)

PAHs –Polynuclear aromatic Hydrocarbons

AH – Acid Herbicides

9.2 Field Investigation Methodology

The field investigation was carried out between 30 June and 4 July 2011. Sampling was carried out by an Environmental Scientist using a hand auger to collect soil samples to a maximum depth of 0.8 metres below ground level. Most of the samples were collected from <0.2m depth, because the pesticides related contaminants would be derived from surface application. Likewise, the railway derived contaminants would be expected to be encountered in shallow soil. Several deeper samples were taken at the Quarry site where evidence of fill was encountered in test pits up to 2.5 m depth. A total of thirty three sites were sampled, including three blind duplicate samples for quality assurance purposes. The locations of the samples and depths are presented in Appendix A to this report.

Soils were logged and any indicators (visual and olfactory indicators) of contamination were noted. Sample locations were selected based on proximity to potential contamination sources and limitations on site (access, obstructions and underground services). Where locations were on private property, approval directly from the landowner for access was gained before undertaking the fieldwork.

Soil samples were transferred to laboratory supplied sample jars using disposable gloves and stainless steel tools. All samples were collected and recorded in accordance with standard GHD Contaminated

Sites Procedures and the Ministry for the Environment Contaminated Land Management Guidelines[14] (CLMG, MfE, 2011).

A sample register is provided In Appendix B to this report.

9.3 Field Quality Control and Assurance

All fieldwork was conducted in general accordance with GHD's Standard Field Operating Procedures and the Guidelines prepared by the Ministry for the Environment[15]. These procedures ensure all environmental samples are collected by a set of uniform and systematic methods, as required by GHD's Quality Assurance System. Key requirements of these procedures are listed below:

- Decontamination procedures – washing (in detergent) and removing soil from exposed surfaces of equipment between each sample to avoid cross-contamination and rinsing with distilled water;
- Disposable latex gloves were changed between each sample and dedicated sampling containers provided by Hill Laboratories were used;
- Sample identification procedures – Samples were immediately transferred to sealed sample containers of appropriate composition and preservation for the requested analysis. Every sample container was clearly labelled with a unique identifier as well as the location, depth and date. The samples were transferred to a 'chilly-bin' with ice packs for sample preservation and delivered to Hill Laboratories on the following day;
- Chain of Custody information requirements – a chain of custody form was completed and forwarded to Hill Laboratories for each batch of samples.

Duplicate samples – to measure the uncertainty in the data from sampling, handling and laboratory errors, one duplicate sample was collected for every ten samples taken. The duplicate samples were given separate identifications and were sent to the laboratory as a 'blind duplicate' i.e. the laboratory did not know which sample was duplicated. In total three duplicate samples were collected. The results of the duplicate analysis are presented in Table 13 in Section 10.3 of this report, together with the relative percentage difference (RPD) calculation.

9.4 Basis for Soil Assessment Criteria

9.4.1 NRRP

When the natural background contaminant soil concentration is exceeded, the Canterbury NRRP considers that the extent and severity of risk to human health and the environment from contaminated land should be assessed with reference to the appropriate national guideline, national environmental standard or national policy statement. The NRRP does not set soil contaminant concentrations, but Environment Canterbury has advised that it accepts the numerical standards for contaminants in soil

[14] Site Investigation and Analysis of Soils. Contaminated Land Management Guidelines No. 5, Ministry for the Environment 2011.

[15] Ibid

to protect human health set by the Soil NES as compliance with the contaminated land rules of the NRRP[16].

9.4.2 Soil NES

The Soil NES establishes applicable risk based standards for contaminants in soil for the protection of human health ($SCS_{(health)}$) for 12 priority contaminants for five typical land use scenarios (rural residential, residential, high density residential, recreational and commercial/industrial).

For the purposes of this assessment, the "Rural Residential" standard has been adopted, as the alignment passes through a rural environment. The "Rural Residential" land use scenario is also considered to provide a reasonable surrogate for construction workers that may be involved in the road construction as dermal contact, ingestion and inhalation assumptions are likely to be comparable to a "rural residential" land use scenario.

Where relevant, the "Industrial" land use has been applied for measured contaminant concentrations in soil for a number of sites adjacent to the alignment where the land use is comparable to an industrial land use scenario. For contaminants that are not priority contaminants the Soil NES mandates that either a site-specific soil guideline value can be derived (Regulation 7 (4) (a)), or a guideline value can be chosen from national and international literature in accordance with *the Contaminated Land Management Guidelines No. 2 – Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011)* (CLMG No.2) (Regulation 7 (4) (b)).

Nickel and Zinc

As there are no acceptance criteria included in the Soil NES or in other New Zealand risk based acceptance criteria for nickel and zinc, for the purposes of this assessment, the Australia NEPC 1999[17] criteria for residential land use have been adopted. Application of these criteria is considered to provide a reasonable assessment of risk for the proposed land use changes and associated risks to human health, in the context of the Project.

9.4.3 Assessment of Environmental Risk

As there are no applicable New Zealand, risk based, ecological or environmental soil acceptance criteria for contaminated land, for the purposes of this assessment, the United States Environmental Protection Authority (USEPA) Ecological Screening Levels (Eco SSL) have been adopted[18]. The Eco SSL criteria for a range of priority soil contaminants were promulgated by USEPA in 2005 and additional criteria were issued in 2007. Although ecological receptors are likely to differ in the United States of America, application of these criteria is considered to provide a reasonable assessment of risk to ecological receptors along the CSM2 and MSRFL alignment. The USEPA Eco SSL criteria derived for total DDT (0.093 mg/kg for birdlife and 0.021 mg/kg for mammals) were less than the published

[16] Teleconference between Peter Nelson and Brett Mongillo, ECan 14/05/2012.

[17] National Environment Protection – Assessment of Site Contamination, 1999: National Environmental Protection Council. Soil Investigation Levels, Residential 10% product consumption.

[18] USEPA (2005) Guidance for Developing Ecological Soil Screening Levels. OSWER Directive 9285.7-55. United States Environmental Protection Agency Office of Solid Waste and Emergency Response. November 2003; revised 205. Note: additional EcoSSIs were released by USEPA in 2007 for contaminants including DDT and PAHs.

background criteria (see below). The PAH Eco SSL for soil investigation (18 mg/kg) was adopted but the derived value for mammalian protection (1.1 mg/kg) was ignored on the basis that there are no native mammal species in New Zealand.

9.4.4 Background Concentrations of Trace Elements and DDT Isomers

The results obtained in this investigation were also compared with naturally occurring background concentrations of trace elements in the major Canterbury soil groups, as recorded on the Environment Canterbury Online GIS[19]. The results were compared with Trace Elements Level 2 data for the 'Recent Regional' group which covers the location of CSM2 and MSRFL. Background concentrations of trace elements in soil represent natural concentrations of elements in the soil from the weathering of various mineral deposits, geothermal sources and sea spray or inundation. The background soil concentrations for the 'Recent Regional' group are presented in Table 4.

Table 4 Background Soil Metal Concentrations (Recent Regional)

Contaminant	Arsenic	Cadmium	Copper	Chromium	Nickel	Lead	Zinc
Concentration (mg/kg)	12.6	0.19	20.3	22.7	20.7	41	93.9

A study of background organo-chlorine pesticide concentrations in Christchurch was conducted by the Ministry for the Environment in 1998[20]. Pesticides used in the past included the organo-chlorine pesticide DDT, which is a very persistent chemical. DDT and its breakdown products and metabolites, DDE and DDD are extremely hydrophobic, strongly sorbed by organic material in soil and are bio-accumulative. The term 'total DDT' is often used to refer to the sum of all DDT related compound (DDT, DDE and DDD) concentrations in a sample.

As part of that study, six soil samples, representative of background concentrations, were taken in Christchurch by the Ministry for the Environment. The background soil concentrations of DDT are presented in Table 5. These background concentrations have been used to assess concentrations of DDT (and related breakdown products) in soil samples from this investigation.

Table 5 Background Soil Concentrations of DDT (mg/kg)

	4,4'-DDE	2,4'-DDT	4,4'-DDT	Total DDT
min	0.11900	0.01030	0.07880	0.21
max	0.46900	0.03970	0.34000	0.85
mean	0.23000	0.02350	0.17200	0.43

[19] Background concentrations of selected trace elements in Canterbury soils. Environment Canterbury 2007.

[20] OCP Concentrations in Christchurch. Ambient concentrations of selected organochlorine in soils, Organochlorine Programme, Ministry for the Environment. December 1998. Simon J Buckland, Howard K Ellis, Ray T Salter.

9.4.5 USEPA Eco SSLs

As discussed above, the USEPA Eco SSLs have been adopted for this assessment, in accordance with the hierarchy of environmental guideline application prescribed by the Ministry for the Environment. The Eco SSLs "can be used to identify contaminants of potential concern in soils requiring further evaluation in a baseline ecological risk assessment". They "are not designed to be used as clean-up levels and EPA emphasizes that it is inappropriate to adopt or modify these Eco SSKs as clean-up standards".

The Eco SSLs apply to sites were terrestrial receptors may be exposed directly or indirectly to contaminated soil. The criteria apply to soils with pH 4 – 8.5 and organic matter <10%, which include soils within the project alignment. The Eco SSLs are not intended to apply to situations such as wetland soils or soils that are regularly flooded (i.e. sediments).

10. Results

10.1 Soil Description

The investigation was focussed on near-surface soils (generally less than 0.2 m below ground level) to assess contaminants arising from pastoral or horticultural land use. Contaminants associated with these types of land uses along the alignments typically occur in near surface soils. The top soils encountered were generally consistent dark brown sandy silt with fine to coarse rounded gravel. The soil was noted to be lighter in colour in areas of raised or disturbed ground particularly around the former Springs Road Quarry.

The soils encountered during the investigation were consistent with the description of soils given in Technical Report 11, Geotechnical Engineering and Geo-hazard Report.

10.2 Analytical Results

The contaminants of concern and their potential locations are listed in Table 3 above. The results of the laboratory testing for these contaminants are summarised in Tables 6 below. The analytical reports are presented in Appendix C to this report.

10.2.1 Greenfield Soils

Soil samples from the near-surface were obtained at regular intervals along the proposed CSM2 and MSRFL routes. A total of ten (10) samples were collected within the alignment of CSM2 and five (5) samples were collected within the MSRFL alignment. Most of the samples were collected in paddocks used for cropping or light stock grazing as these land uses are considered typical for the alignment. A photograph of a typical sampling location is shown in Figure 7. No indicators of contamination were noted at the sampling locations or in the samples collected.

Figure 7 Photograph of Typical Greenfield Soil Sampling Location

The results of the analytical testing are compared with the published background concentrations for trace elements and DDT for soils in Canterbury, the Soil NES site-specific soil contaminant standard ($SCSs_{(health)}$), rural residential land use and the NEPC guidelines for, residential land use in Table 6.

The measured concentrations of all trace elements were below the $SCSs_{(health)}$ of the Soil NES. Concentrations of arsenic, chromium, copper and nickel were below published background concentrations in the samples analysed. The cadmium concentration, 0.2 mg/kg, marginally exceeded the published background concentration of 0.19 mg/kg, but was below the $SCSs_{(health)}$ of the Soil NES. Cadmium is a common impurity of agricultural fertiliser, and as such, is commonly found in the rural environment. All of the measured trace element concentrations were below the respective ecological screening criteria.

Three samples (sample IDs BG11, BG12 and BG15), taken from the road verge on the northern side of Main South Road exceeded the published background concentration of lead (100 % greater) and zinc (<10% greater), however all of the measured soil concentrations were below the Rural Residential $SCSs_{(health)}$ of the Soil NES and the ecological screening criteria.

The results of testing for selected organochlorine pesticides (OCP) are presented in Table 6.

DDD, DDE and DDT were detected in these samples at concentrations less than the reported background levels. All other pesticides analysed were below laboratory detection limits. All of the measured soil concentrations were below published background concentrations and the Rural Residential $SCSs_{(health)}$ of the Soil NES.

Table 6 Trace Elements in Greenfield Soil Samples

	No. Samples	Min	Max	Mean	Published Background Concentration	NES $SCSs_{(health)}$ (Rural Residential 25% produce)	NEPC[21], Human Health Residential <10% Produce Consumption	US EPA Eco-SSLs Ecological Receptors[22]	No. Exceeding Guideline Values
Arsenic	15	2	8	3.9	12.6	17		37	0
Cadmium	15	<0.1	0.2	0.12	0.19	0.8		29	0
Chromium	15	12	19	14	22.7	$290^{Cr\ VI}$		BL	0
Copper	15	3	17	8.5	20.3	NL		61	0
Lead	15	12.3	98	28.1	41	160		BL	0
Nickel	15	8	16	10.3	20.7		600	60	0
Zinc	15	43	102	67.5	93.9		7000	190	0

*BG – Background

NL = Not Limiting

BL = below published background concentrations

[21] Assessment of Site Contamination. Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater, 1999: Australian National Environmental Protection Council.

[22] Ecological Screening Levels 2005: United States Environmental Protection Authority.

Table 7 Selected OCPs in Greenfield Soil Samples

	No. Samples	Min	Max	Mean	Published Background Concentration	NES SCSs(health) Rural Residential 25% produce	US EPA Eco-SSLs Ecological Receptors	No. Exceeding Guideline Values
4,4'-DDE	15	<0.01	0.21	0.04	0.23	n/a	n/a	0
2,4'-DDT	15	<0.01	0.017	0.01	0.02	n/a	n/a	0
4,4'-DDT	15	<0.01	0.041	0.01	0.17	n/a	n/a	0
Total DDT	15	<0.03	0.268	0.06	0.42	45	n/a	0

n/a – not available

BL Below published background concentrations

10.2.2 Former Applefields Orchard (Aberdeen Subdivision)

Three soil samples (AS01 to AS03) were collected from near-surface depths on the north-west boundary of the Aberdeen Subdivision adjacent to Shands Road. The location of the soil samples was based on the planned area of ground disturbance required to construct the Shands Road underpass. The samples were analysed for trace elements and organochlorine (OC) pesticides. The results of the trace element analysis are provided in Table 8. The results for OC pesticides are not tabulated because no OC pesticides were detected.

Table 8 Former Applefields Orchard (Aberdeen Subdivision) Summary of Soil Sample Concentrations (mg/kg) for Trace Elements

	No. Samples	Min	Max	Mean	Published Back Ground Concentration	NES $SCSs_{(health)}$ Rural Residential	NEPC[23], Human Health Residential <10% Produce Consumption	US EPA Eco-SSLs Ecological Receptors[24]	No. Exceeding Guideline Value
Arsenic	3	5	5	5	12.6	17		37	0
Cadmium	3	<0.1	<0.1	0.12	0.19	0.8		29	0
Chromium	3	16	17	14	22.7	290Cr VI		BL	0
Copper	3	9	12	8.5	20.3	NL		61	0
Lead	3	32	35	28.1	41	160		BL	0
Nickel	3	13	14	10.3	20.7		600	60	0
Zinc	3	57	137	67.5	93.9		7000	190	0

*BG – Background

1 NES Soil Contaminant Standard for health, priority inorganic substances

BL = Below published background concentrations

[23] Assessment of Site Contamination. Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater, 1999: Australian National Environmental Protection Council.

[24] Ecological Screening Levels 2005: United States Environmental Protection Authority.

The results of the trace element analysis show that all results except one were below published background concentrations. The soil concentration of zinc (137 mg/kg) at one location (AS02) exceeded the published background concentration 93.9 mg/kg. All of the measured trace element concentrations (including Zinc) were less than the Rural Residential $SCS_{s(health)}$ of the Soil NES and the ecological screening criteria.

Soil samples were analysed for a range of 25 organochlorine pesticides. The results of testing for all analysed OCPs were below laboratory detection limits. As such, all of the measured pesticide concentrations were less than the relevant guideline criteria.

10.2.3 Former Southbridge Branch Railway Line

A total of five samples were collected along the alignment of the former Southbridge Branch Railway Line. It is understood that the line is still used occasionally for manoeuvring goods wagons associated with the line towards Hornby. A photograph of the former Southbridge Branch railway line is presented in Figure 8.

Figure 8 Photograph of former Southbridge Branch Railway Line looking South (1 July 2011)

The samples were analysed for heavy metals, PAH and acid herbicides. The results are summarised in Tables 9 and 10.

Table 9 Former Southbridge Branch Railway Soil Sample Concentrations (mg/kg) for Trace Elements

	RW01	RW02	RW03	RW04	RW05	Published BG* Concentration	NES SCSs(health)		US EPA Eco-SSLs[25]	No. Exceeding Guideline Values
							Rural Residential	Industrial (Unpaved)	Ecological Receptors	
Arsenic	6	5	7	5	63	12.6	17	70	37	1 (Eco)
Cadmium	0.25	0.12	< 0.10	0.11	0.58	0.19	0.8	1,300	29	0
Chromium	15	17	15	14	44	22.7	290$^{Cr\ VI}$	6,300$^{Cr\ VI}$	BL	0
Copper	28	14	28	24	67	20.3	NL	NL	61	1 (Eco)
Lead	51	28	51	38	400	41	160	3,300[1]	BL	1
Nickel	12	13	12	12	18	20.7		7000[26,]	60	0
Zinc	141	97	49	53	320	93.9			190	0

NL – no limit

*BG – Background

BL = Below published background concentrations

[25] Ecological Screening Levels 2005: United States Environmental Protection Authority.

[26] Assessment of Site Contamination. Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater, 1999: Australian National Environmental Protection Council.

Samples collected at locations RW01 – RW04 contained trace element concentrations below or less than 50% greater than the regional background concentrations (only two of these locations intersect the CSM2 alignment – RW02 and RW03). All soil metal concentrations were less than the Rural Residential $SCSs_{(health)}$ of the Soil NES. At location RW05 the heavy metal concentrations were significantly elevated above the regional background concentrations. The arsenic soil concentration exceeded the Rural Residential $SCSs_{(health)}$ of the Soil NES concentration, but not the Industrial concentration.

The Soil NES provides a soil contaminant standard for health ($SCSs_{(health)}$) for the combined toxicity of carcinogenic polycyclic aromatic hydrocarbons (PAH) relative to benzo(a)pyrene. This is called benzo(a)pyrene toxic equivalence (BaP TEQ). The PAH results, expressed as BaP TEQ are summarised in Table 10.

Table 10 Former Southbridge Branch Railway Soil Sample Concentrations (mg/kg) for BaP TEQ

No. Samples	Min	Max	Mean	$SCS_{(health)}$ Rural Residential	SCS (Health Industrial)	US EPA PAH Eco SSL (Soil Invertebrates)	No. Exceeding Guideline Values
5	0.0744	0.1138	0.08774	6	35	18	0

Although PAH compounds were detected, the BaP TEQ concentrations was less than the SCSs(health) of the Soil NES for residential land and less than the adopted ecological screening value (Eco SSL)

Samples were screened for a range of 22 herbicides. All samples were below laboratory detection limits for the herbicides analysed.

10.2.4 Former Quarry on Springs Road

A total of ten (10) samples were collected from the former quarry/gravel pit off Springs Road. It should be noted that the site is largely located south of the CSM2 alignment. All of the sample locations described herein were located south of the CSM2 alignment in an area of the site where filling had been known to occur, and therefore considered to have an increased likelihood of the presence of soil contamination Samples were collected at near-surface depths from the base of the former quarry and from mounded material adjacent to the quarry.

The results of the analysis of trace elements are presented in Table 11.

Table 11 Former Quarry Soil Sample Concentrations (mg/kg) for Trace Elements

	No. Samples	Min	Max	Mean	Published BG* Concentration	NES SCSs(health)		NEPC[27], Human Health	US EPA Eco-SSLs[28]	No. Exceeding Guideline Values
						Rural Residential	Industrial (Unpaved)	Residential <10% Produce Consumption	Ecological Receptors	
Arsenic	10	4	12	5.7	12.6	17	70		37	0
Cadmium	10	<0.1	0.26	0.12	0.19	0.8	1,300		29	0
Chromium	10	14	21	16.3	22.7	290Cr VI	6,300 Cr VI		BL	0
Copper	10	9	55	18.2	20.3	NL	NL		61	0
Lead	10	19.4	138	113.6	41	160	3,300		BL	0
Nickel	10	11	19	13.8	20.7			600	60	0
Zinc	10	57	450	129.7	93.9			7000	190	0

NL – no limit

*BG – Background

BL – Below published background concentrations

[27] Assessment of Site Contamination. Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater, 1999: Australian National Environmental Protection Council.

[28] Ecological Screening Levels 2005: United States Environmental Protection Authority.

The concentrations of trace elements in soils collected from four locations, Q2 – Q4 and Q9 were less than the soil background concentrations and below the Rural Residential $SCSs_{(health)}$. The soils at the remaining locations contained concentrations of some heavy metals that exceeded the background concentrations. None of these heavy metal soil concentrations exceeded the Rural Residential $SCSs_{(health)}$ of the Soil NES. All of these locations were located south of the CSM2 alignment.

Samples collected from the former quarry were also analysed for PAH compounds. The results, expressed as BaP TEQ, are summarised in in Table 12.

Table 12 Former Quarry Soil Sample Concentrations (mg/kg) for BAP TEQ

Site	4,4'-DDE	2,4'-DDT
Q1		0.0733
Q2		0.2002
Q3		0.1863
Q4		0.1861
Q5		0.1428
Q6A		13.528
Q6B		0.4728
Q7		7.658
Q8		9.76
Q9		0.0723
SCSs(health)	Rural residential	6
	Industrial	35
US EPA	Eco-SSL for PAHs (Soil Invertebrate protection)	18

None of the soil samples had PAH concentrations that exceeded the USEPA criteria for ecological protection.

Three soil samples, collected at Q6A, Q7 and Q8, contained BaP TEQ concentrations exceeding the Rural Residential, but not the Industrial, $SCSs_{(health)}$ of the Soil NES. The highest exceedence, in sample Q6A, was collected from the base of a stockpile of fill material deposited on the site. The fill material was observed as light brown sandy silt with occasional gravel. The source of the fill material is unknown.

10.3 QA/QC Data Evaluation

A total of thirty three (33) samples were collected and analysed as part of this investigation. Blind duplicate samples were collected at a ratio of 1 in 10 samples. Three samples were sent to the laboratory as blind duplicates to assess the variability in results and uncertainty.

The results of the duplicate analysis were compared and the relative percentage difference (RPD) was calculated. Generally, variability (RPD) of less than 30 % is considered acceptable. The results of the duplicate analysis and calculated RPD are given in Table 13.

Table 13 Relative Percentage Difference Calculations

Sample ID	BG9	QA3	RPD	Q9	QA1	RPD	AS2	QA2	RPD
Units	mg/kg	mg/kg	%	mg/kg	mg/kg	%	mg/kg	mg/kg	%
Arsenic	3	3	0	5	4	14	5	4	14
Cadmium	0.1	0.15	29	0.1	0.1	0	0.1	0.12	13
Chromium (Total)	13	13	0	15	14	5	17	17	0
Copper	10	11	6	9	8	8	9	9	0
Lead	14.3	14.4	0	19.4	15.2	16	34	31	6
Nickel	9	8	8	13	12	5	14	13	5
Zinc	60	61	1	57	50	9	137	116	11

The RPD calculations show that all duplicate test results were within the acceptable range (< 30%).

11. Site Characterisation

Based on the findings of this investigation, for the majority of the route of the Project, concentrations of contaminants in soil are comparable to published background soil concentrations and most are less than the Rural Residential $SCSs_{(health)}$ criteria provided in the Soil NES. Land disturbances in these areas are unlikely to result in any significant risk of adverse effects to human health (in the context of a Rural Residential land use scenario) or the environment, as concentrations were generally below regional background concentrations within the Project alignments.

Apart from greenfield locations, a number of specific areas were identified as being potentially contaminated based on past or current land use. Parts of the selected study areas lie outside of the proposed designation boundaries (see Appendix A) of the Project. The specific areas that we investigated are discussed in the following sections.

11.1 Greenfield Sampling

Most of the land use within the route of the proposed CSM2 is flat, low-intensity grazing, cropping and 'lifestyle blocks'. There were no indicators of contamination noted in the soils collected during the investigation and there were no potential sources of contamination observed. No sheep dip sites were identified from the review of aerial photographs or site walkovers. Ten (10) samples were collected along the proposed route of the CSM2 and, of the parameters analysed, none contained contaminant concentrations above the Rural Residential $SCSs_{(health)}$ of the Soil NES. The concentrations of trace elements in soil samples were generally consistent with published background concentrations. Organochlorine pesticides soil concentrations were also generally lower than published background concentrations and less than the Rural Residential $SCSs_{(health)}$ of the Soil NES.

Measured concentrations also complied with the adopted ecological acceptance criteria.

11.2 Road Verge

Five (5) soil samples were collected along the northern verge of MRSFL between Robinsons Road and Rolleston. Again, no indicators of contamination were noted in the soils collected and no potential sources of contamination were observed. Of the parameters analysed in the soil samples, none contained contaminant concentrations above the Rural Residential $SCSs_{(health)}$ of the Soil NES. The concentrations of trace elements in soils were generally consistent with published background concentrations and concentrations of organochlorine pesticides were less than published background concentrations and the Rural Residential $SCSs_{(health)}$ of the Soil NES.

Measured concentrations also complied with the adopted ecological acceptance criteria.

11.3 Former Applefields Orchard (Aberdeen Subdivision)

Full grade-separated interchange at Shands Road will be constructed just south of Marshs Road. At this interchange it is proposed to construct an underpass so that Shands Road can pass over the Christchurch Southern Motorway adjacent to the former Applefields Orchard which has been

redeveloped as a subdivision (Aberdeen Subdivision). Aberdeen Subdivision is located on the eastern corner of Shands Road and Blakes Road. Three (3) soil samples were collected on the southeast side of the road verge and, of the parameters analysed, the results revealed no concentrations of contaminants above background concentrations and the Rural Residential $SCSs_{(health)}$ of the Soil NES. Concentrations of organochlorine pesticides were below laboratory detection limits and the Rural Residential $SCSs_{(health)}$ of the Soil NES.

Measured concentrations also complied with the adopted ecological acceptance criteria.

11.4 Southbridge Branch Railway

The route of the CSM2 will intersect the Southbridge Branch railway line which runs in a roughly north-south direction from Hornby towards Prebbleton. It is proposed to realign the railway siding to curve eastwards on the northern side of the proposed motorway. The railway line was in generally good repair with wooden sleepers and coarse gravel (ballast) between the rails. The immediate verges were grass covered and overgrown.

Soil samples collected at locations RW01 – RW04 contained heavy metals at concentration below regional background concentrations or exceeding regional background concentrations by no more than 50%. The trace element concentrations were less than the Rural Residential $SCSs_{(health)}$ of the Soil NES.

At location RW05, the heavy metal concentrations were significantly elevated above the regional background concentrations. The arsenic and lead concentrations exceeded the Rural Residential, but not the industrial, $SCSs_{(health)}$ of the Soil NES. The BaP concentrations did not exceed the $SCSs_{(health)}$ for rural residential or industrial land use, and also did not exceed the adopted Eco SSL for PAHs. The concentrations of arsenic and copper in the sample form RW05 exceeded the adopted ecological acceptance criteria. However, RW05 is located outside of the CSM2 proposed designation area and no works relating to the motorway construction is required for this area.

11.5 Former Quarry on Springs Road

The alignment of the CSM2 is adjacent to the south of a former quarry on Springs Road. From a review of historical aerial photographs and site visits, this site has been used as an informal storage/dumping area for a range of materials including tanks, timber, mounded soil, concrete pipes, tyres and construction waste. Five of the soil samples collected,(Q1 – Q4 and Q9) contained low concentrations of heavy metals similar to the soil background concentrations and low concentrations of BAP TEQ which were less than the $SCSs_{(health)}$ of the Soil NES. Three of the remaining five soil samples (collected at Q6A, Q7 and Q8)l contained BAP TEQ concentrations that exceeded the Rural Residential, but not the Industrial, $SCSs_{(health)}$ of the Soil NES.

Three large disused stationary tanks were located in the western half of the site near Q4. One of the tanks was noted to be leaking a tar-like substance from the outlet pipe, whilst another had its ends removed and a tar-like substance had been spilt directly on the ground surface (Figure 9). A soil sample, Q4, collected adjacent to the tanks contained low concentrations of heavy metals similar to the soil background concentrations and low concentration of PAH. None of the contaminant soil concentrations at this location exceed the Rural Residential $SCSs_{(health)}$ of the Soil NES.

Timber and sawn firewood were stored in a separated compound at the site. There was no apparent evidence that the timber was treated. A soil sample, Q8 taken from soils in the area where timber was stored contained low concentrations of heavy metals similar to the soil background concentrations and less than the Rural Residential $SCS_{(health)}$ of the Soil NES. The concentration of BAP TEQ in soil at this location exceeded the Rural Residential but not the Industrial $SCS_{(health)}$ of the Soil NES.

No suspected asbestos-containing materials (ACM) were observed on or in the surface soils, and therefore no analytical testing of samples was completed for asbestos. No oil staining was noted, and therefore no testing was completed for Total Petroleum Hydrocarbons.

Figure 9 Tar-substance spilt from tank (30 June 2011)

12. Risks, Effects and Mitigation

12.1 Risk Register

A register outlining the risk assessment of the contamination results is provided in Table 14. From this assessment, it is concluded that while contaminant concentrations in soils at locations QA5, Q6A, Q7 Q8 at the Springs Road quarry site, and RW05 at the Southbridge railway line significantly exceed the soil background concentrations they do not exceed the relevant $SCSs_{(health)}$ of the Soil NES. The relevant sections of the Soil NES relating to ground disturbances are:

- Regulation 8(3) permits ground disturbance at a HAIL site to $25m^3/500m^2$, i.e only to small scale ground disturbance.
- If the ground disturbance exceeds $25m^3/500m^2$ under Regulation 9(1) it becomes a controlled activity and a resource consent is required.
- If the $SCSs_{(health)}$ of the Soil NES are exceeded, ground disturbance becomes a restricted discretionary activity under Regulation 10 and remediation is required.

The locations of QA5, Q6A, Q7 Q8, and RW05 where elevated soil contaminant concentrations were identified lie outside of the CSM2 designation and will not be disturbed during construction of CSM2 or MSRFL. A discretionary activity consent and remediation under the Soil NES is therefore not required.

The potential environmental effects from contaminated soil were also evaluated by comparing the soil results with international based guidelines criteria (the USEPA Ecological Soil Screening levels; Eco SSLs). The EcoSSLs were derived to protect ecological receptors such as plants, soil invertebrates and wildlife (birds and mammals) that commonly come into contact with soil or ingest biota that live in or on soil[29].

The construction phase of the CSM2 will be subject to adherence to a Construction Environmental Management Plan (CEMP, discussed in more detail in Section 12.5 below). The CEMP documents procedures that include the management of discovered contamination during ground disturbance works associated with the CSM2 and MSRFL construction. It is considered that the CEMP (if appropriately implemented and adhered to) will effectively control any risks associated with the contaminants measured along the alignment.

[29] USEPA (2005) Guidance for Developing Ecological Soil Screening Levels. OSWER Directive 9285.7-55. United States Environmental Protection Agency Office of Solid Waste and Emergency Response. November 2003; revised 205. Note: additional EcoSSIs were released by USEPA in 2007 for contaminants including DDT and PAHs.

Table 14 Tier 1 Risk Assessment of Compliance with the Soil NES and NRRP

Area	HAIL	Contaminants	Location	Compliance (NES and NRRP)		Mitigation	
				Background	$SCSs_{(health)}$	Remedial	Procedural
Greenfield	A10: Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds	Agrichemicals: heavy metals, organochlorine pesticides	BG01 – 15	Mostly	yes	none required	Compliance with CEMP
Applefields	A10: Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds	Agrichemicals: heavy metals, organochlorine pesticides	AS 01 – 03	Mostly	yes	none required	Compliance with CEMP
Southbridge Rail Line	F6: Railway yards including goods-handling yards, workshops, refuelling facilities or maintenance areas	Hydrocarbons, heavy metals	RW 01 – 04	yes	yes	none required	Compliance with CEMP
			RW05	no	yes (industrial)	None required: Location RW05 is located outside of the designation boundaries.	Compliance with CEMP
Springs Road Quarry	G5: Waste disposal to land (excluding where biosolids have been used as soil conditioners)	Hydrocarbons, heavy metals	Q1– 4 & Q9	yes	yes	none required	Compliance with CEMP
			Q6A, Q7 & Q8	no	Yes (industrial)	None required: Locations are located outside of the designation boundary.	Compliance with CEMP
			Q5	no	yes		
			Q6B	no	yes		

12.2 Effects

Contaminated soils outside of the designated alignment were encountered at the former Southbridge Branch Rail Line and former gravel pit north of the alignment near Springs Road. The north east corner of Main South Road and Curraghs Road is recorded on the ECan Listed Land Use Register (LLUR) as a landfill site (site no. 3789). ECan records a geotechnical investigation for the construction of an office, workshop and display facility in 2009. This investigation reported refuse buried in the western and southern side of a backfilled 50 m^2 pit. There is no record of remedial action on the ECan files.

Whilst the likelihood of presence of contaminated ground is considered to be minimal, contingency planning is required in the event of contamination being discovered during construction, particularly adjacent to the Springs Road quarry site and at the Curraghs Road landfill site.

12.3 Risk to workers

As mentioned in section 9.4.2 of this report, the Soil NES does not provide standards for protection of maintenance and excavation workers. Therefore, for the purposes of this assessment, the Rural Residential land use standard was considered to provide a reasonable surrogate based upon typical exposure scenarios.

Based upon the measured soil contaminant concentrations and comparisons with the Rural Residential soil contamination standards, it is considered that the risk to the health of workers involved in the construction of the Project is likely to be minimal. No special precautions are considered necessary. Workers should follow normal hygiene practices including washing hands prior to eating, drinking and smoking.

12.4 Risk to Environment

The risk of adverse environmental effects arising from contaminated land is considered to be minimal as measured contaminant concentrations in soil within the designation of the Project alignment are generally consistent with background concentrations.

Furthermore measured concentrations along both the Project alignments were compliant with the adopted US EPA risk based ecological acceptance criteria. With the exception of one sample from the former Southbridge Branch Railway that falls outside the proposed alignment and will not be subject to earthworks for the Project. Comparison of the results with the USEPA Eco SSLs indicate that the soil conditions assessed pose no unacceptable risks to terrestrial biota including plant life, birds and soil invertebrates. Although some trace elements and organic pesticide residues were detected in the soils tested, most of the impacted soil will be managed as topsoil during the construction programme. As such, this topsoil will be isolated and stockpiled with sediment and erosion control measures in place to protect surface water and groundwater.

12.5 Construction Environmental Management Plan

There is no formal NZTA guidance on managing contamination during construction of highway projects. It is understood that a National Contamination Management Plan is being prepared by the NZTA, and if available at the time of construction, any such Plan should be complied with. In the absence of NZTA national guidance, the regional guidance for the NZTA Auckland *region (Transit New Zealand, Contamination Management Plan, Capital Works and Minor Projects (Auckland Regional Council Area), October 2008)* is likely to be of value as it contains guidance to minimise the release of contaminants into the environment

A draft Construction Environmental Management Plan (CEMP) has been prepared (Volume 4 of the AEE documentation) for this Project. This CEMP details the minimum expectations and actions that are to be taken to protect the environment during the construction phase. The plan provides the framework, methods and tools for how environmental effects of the Project should be managed, remedied or mitigated during construction, in order to meet resource consent and designation conditions, relevant legislation and the NZTA's environmental objectives. It includes contingency action in the event that contaminated land is discovered during construction.

Contamination management under the CEMP is designed to be in accordance with the following documents:

- The NZTA's Environmental Policy Manual, First edition, Amendment 1, Effective from 1 September 2010;
- Environmental Plan, Transit New Zealand, Version 2, 2008, Section 2.7; and
- Standard Professional Services Guideline PSG/13 – Social and Environmental Management, Version 3, March 2011.

All personnel are required to understand and implement the requirements of this CEMP. The contaminant discovery section of the draft CEMP is reproduced below.

12.6 Contaminant Discovery

Signs of land contamination include, but are not limited to:

- Deposited inorganic wastes (e.g car bodies, construction debris, drums etc);
- Soil mounds or excavations that do not match the natural contour of the land;
- Underground storage tanks;
- Deposited organic wastes (e.g. trees, vegetation, household wastes);
- Unnatural staining of soil or pooled water;
- Unusual odours;
- Unstable ground;
- Gas bubbles in pooled water;
- Coloured or bleached soils;
- Hydrocarbon staining and odours;
- General refuse; and

- Fibrous material (i.e. potentially asbestos).

The NZTA or its supplier[30] is required to actively monitor for these indicators during excavation. If contamination indicators are not observed, work may continue.

12.7 Response

If any of the above indicators are observed the NZTA or its supplier shall:

- Cease all work within a 20m radius and make the work safe;
- If possible, contain any contaminant dispersion and shut off/divert any water flow; and
- Advise the NZTA's Construction Manager;

The NZTA or its supplier shall assess the site. If the potential for contamination is assessed as low risk, work may recommence. If the assessment concludes that confirmation of contamination is required, the NZTA or its supplier shall:

- Control the site: install temporary fencing, silt traps and bunding as required around the exclusion zone;
- Small volumes of excavated soil shall be contained in covered skips to control leachate formation from rainfall;
- If this is not possible, larger volumes should be covered and bunded to manage stormwater runoff;
- Dispose of any pooled rainwater to a treatment facility. It must not be discharged as stormwater;
- Direct the collection of appropriate samples for laboratory analyses following procedures recommended in the Soil NES and the Contaminated Land Rules of the Canterbury NRRP;
- Arrange the analysis of soil samples by an IANZ accredited laboratory;
- Assess the results against the permitted activity $SCS_{(health)}$ of the Soil NES and the Contaminated Land Rules of the Canterbury NRRP;
- When the soil contaminant levels are within the permitted activity soil criteria, advise the Construction Manger that work may proceed and that the soil may remain on site within the zone from which it originated;
- Advise the Construction Manger that such soils are not cleanfill and can only be disposed off site at managed fills consented to receive them;
- Advise the Construction Manger that if the soil contaminant levels on site exceed the permitted activity soil criteria, ECan must be advised in writing and that a consent will be required for work to proceed. Selwyn district Council may also need to be engaged with if contaminated concentrations exceed the relevant Soil NES. This outcome will delay the continuation of site works;
- Where friable asbestos containing materials are identified in the soil matrix, all works (including the excavation and disposal of affected materials) shall be undertaken in accordance with the Health and Safety in Employment (Asbestos) Regulations 1998, and the Department of Labour Guidelines for the Management and Removal of Asbestos (Revised) 1999; and

[30] Supplier means construction contractor or environmental consultant.

- Health and safety measures appropriate to the identified contaminants shall be implemented during any investigations.

12.8 Disposal

Soils and related materials requiring disposal that arise from the construction excavations, may be contaminant free, contain contaminants within the permitted range for land use, or require contaminant management. The following procedures shall be followed for the disposal of excess soils arising from construction.

For soils that meet the $SCS_{(health)}$ of the Soil NES:

- If no contamination indicators are observed, excess soils may be relocated within the zone from which they originated. They are not to be relocated into other zones;
- If contamination indicators are observed, the soils must be characterised by chemical analyses and assessed against the Soil Contaminant Criteria of the Soil NES;
- Such soils must be contained, e.g. in a covered steel bin until they have been characterised. They must not be stockpiled in the open;
- If the soils are characterised as cleanfill, they may be used as such and relocated in any zone of the alignment, or disposed off site as cleanfill;
- If soils are not characterised as cleanfill but contaminant levels are within the permitted activity criteria, they may be relocated within the zone from which they originated. They are not to be relocated into other zones;
- The contractor is responsible for the suitability of areas for final disposal and shall involve the NZTA Manager if necessary;
- Excavated soils shall not be relocated in zone within 50 m of a water body; and
- Soils containing contaminants below the Rural Residential Soil NES that cannot be relocated within the zone but are not characterised as cleanfill must be disposed of at a disposal site consented to accept them. These soils cannot be disposed of at other industrial land use sites;

These are permitted activities and do not require resource consents.

Soils exceeding the permitted activity criteria require the NZTA to determine which of the following actions will proceed:

- Remediation, removal, and management of the contaminated soil and validation of the remediation. Approval from the NZTA or its supplier(an environmental consultant) is required prior to removal of contamination from the site. Disposal shall be at a managed fill consented to accept the soil. Treatment may be required to meet the acceptance criteria.
- Where such material is to be encapsulated or contained on site, the encapsulation or containment shall be undertaken under the direction of the NZTA or its supplier(an environmental consultant) who shall maintain a record of the location, extent and nature of the material and include this information in an environmental monitoring report to ECan.
- These options are controlled activities and require resource consents under the Soil NES.

13. Conclusions and Recommendations

The purpose of investigation and report was to:

1. Assess the likelihood of adverse effects of soil contaminants on human health and the environment;
2. Assess potential risk to construction workers (human health risks) posed by soil contamination; and
3. Outline any contaminant mitigation methods likely to be required.

A total of thirty-three (33) soil samples were collected from near-surface depths and analysed for a range of contaminants based on past or current land uses. The results were assessed against relevant NES standards and background concentrations. As a result of the investigation, the following conclusions can be drawn:

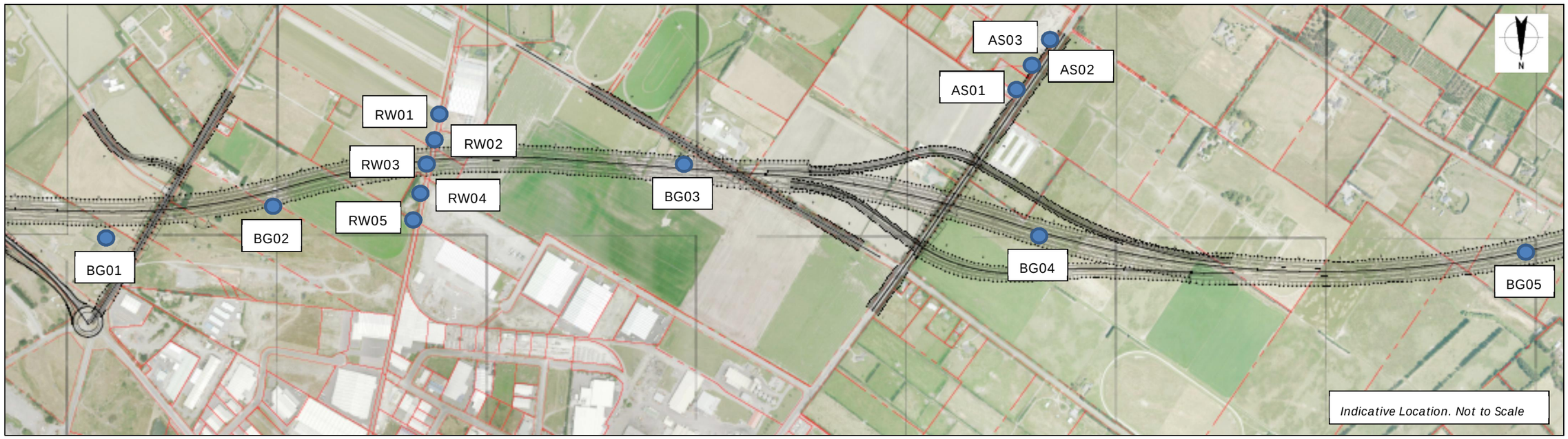
- Concentrations of contaminants in all soil samples collected within the designation boundaries for the Project were less than the Rural Residential $SCS_{(health)}$ of the Soil NES;
- A Tier 1 Risk Assessment (Table 14) of the investigation results demonstrates that contamination arising from historic land use activities along the CSM2 and MSRFL designated route is not likely to have a measurable effect on human health or the environment;
- No significant water ways or water bodies are present in the vicinity of the CSM2 and MSRFL route, and therefore impacts to surface water are considered unlikely.
- As several locations along the CSM2 and MSRFL routes are identified as HAIL sites (Table 14), Regulation 9 of Soil NES identifies soil disturbance as a controlled activity subject to the results of a soil investigation identifying that the soil contamination does not exceed the applicable standard (the $SCS_{(health)}$) of Regulation 7,, as has been identified by this investigation; Therefore, soil disturbance for the CSM2 and MSRFL routes is considered a controlled activity under the Soil NES, and consent will need to be sought.
- As a controlled activity, the activity must be managed under a site management plan, monitored and reported on, including the transport, disposal and tracking of materials taken away in the course of the activity. The Construction Environmental Management Plan will address these aspects, along with contamination discovery;
- Measured soil contaminant concentrations along the CSM2 and MSRFL alignment are not likely to have an effect on construction workers health;
- Excess soils arising from construction are likely to be acceptable as cleanfill, however further testing may be required by the disposal facility.
- No mitigation is required unless contaminated land is discovered in the ground disturbance activities of the construction phase. If contaminated land is discovered, the contingency action for mitigation provided in Section 12.7 of this report and in the draft CEMP must be followed.

Appendix A
Investigation Location Plans

1. Whole Route (Figures A1 – A3) showing approximate alignment for CSM2 and MSRFL. Note north faces down.

2. Springfield Railway and Springs Road Quarry sample locations overlaid on final designation plan sheets 11 and 12.

Figure A1 Investigation Locations (CSM2)



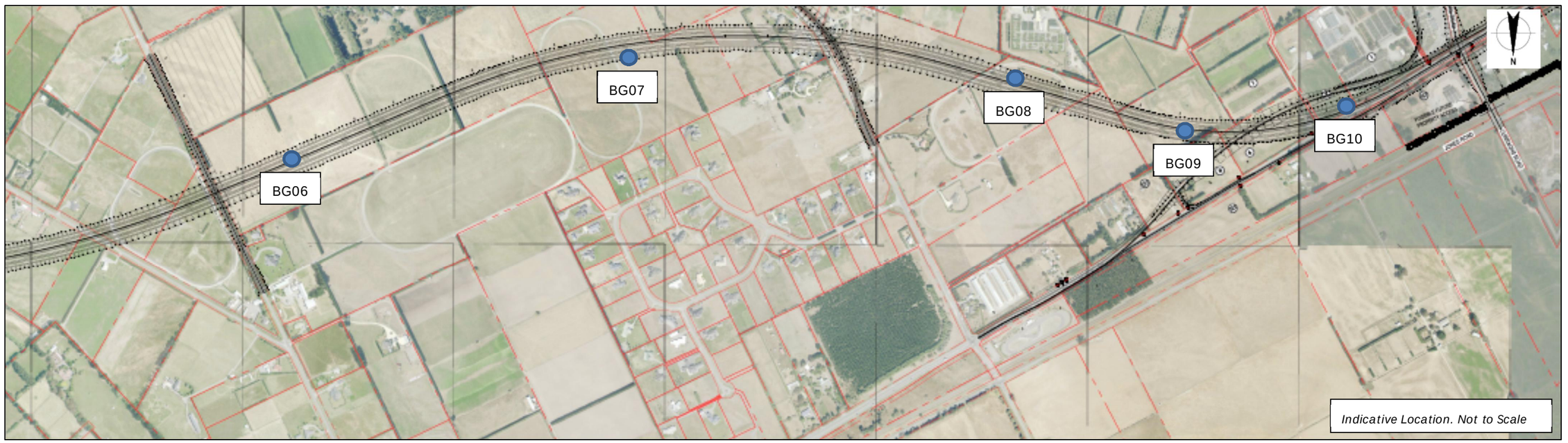
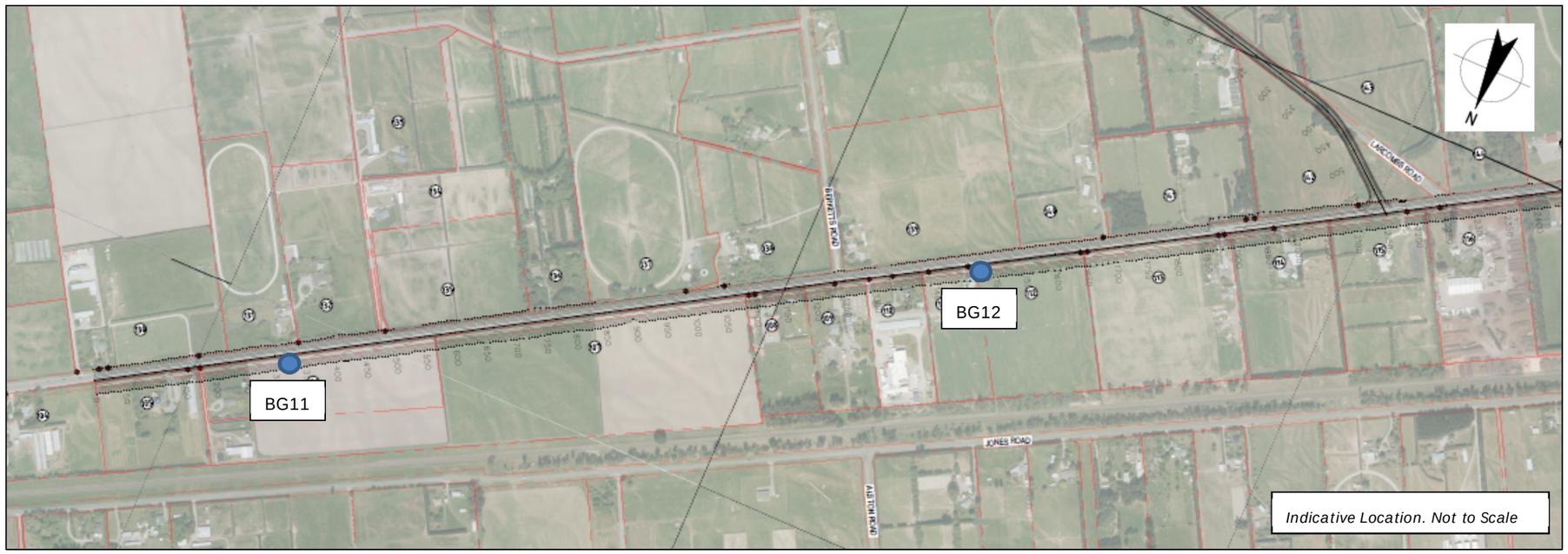


Figure A2 Investigation Locations (MSRFL)



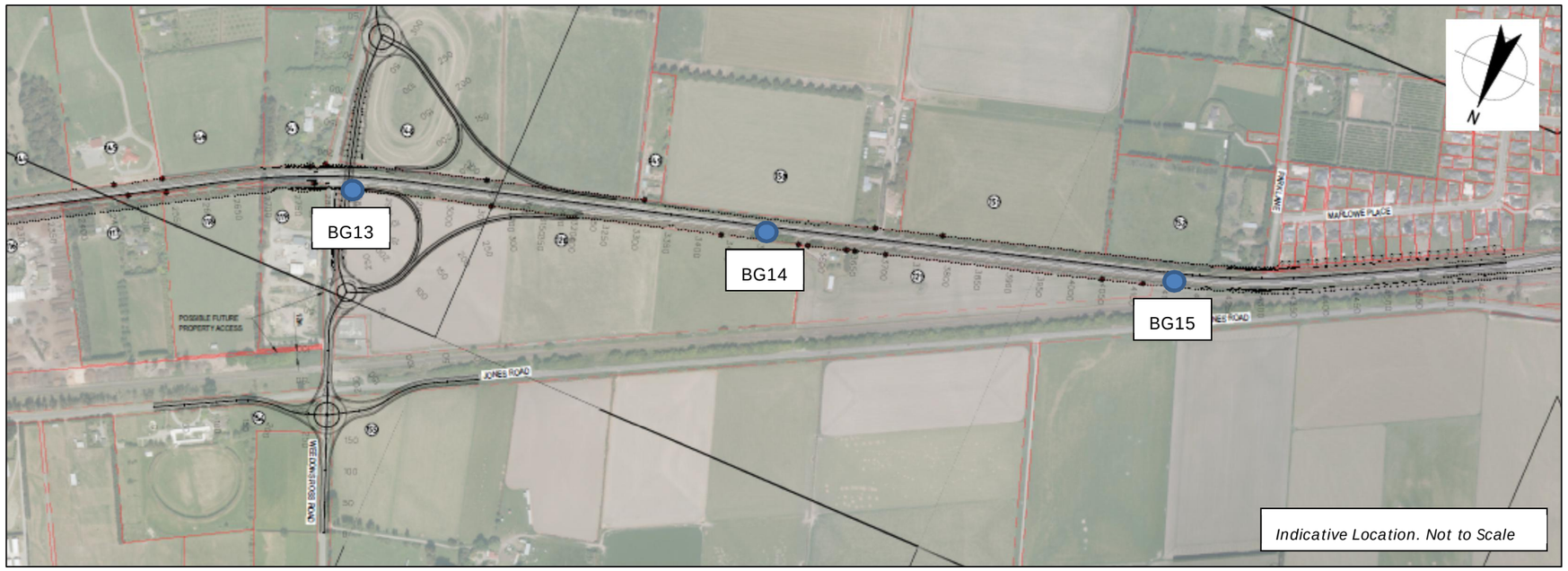
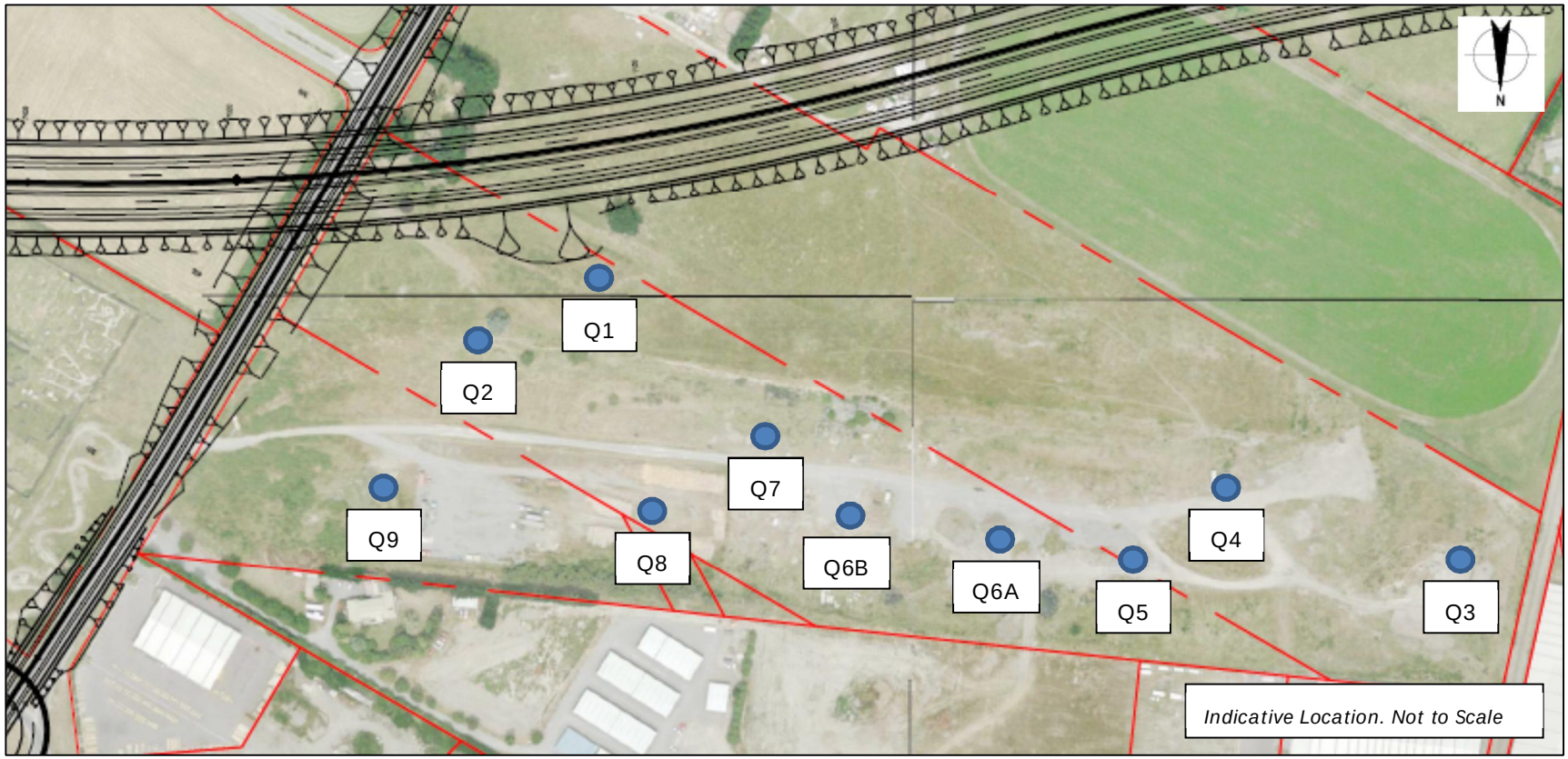
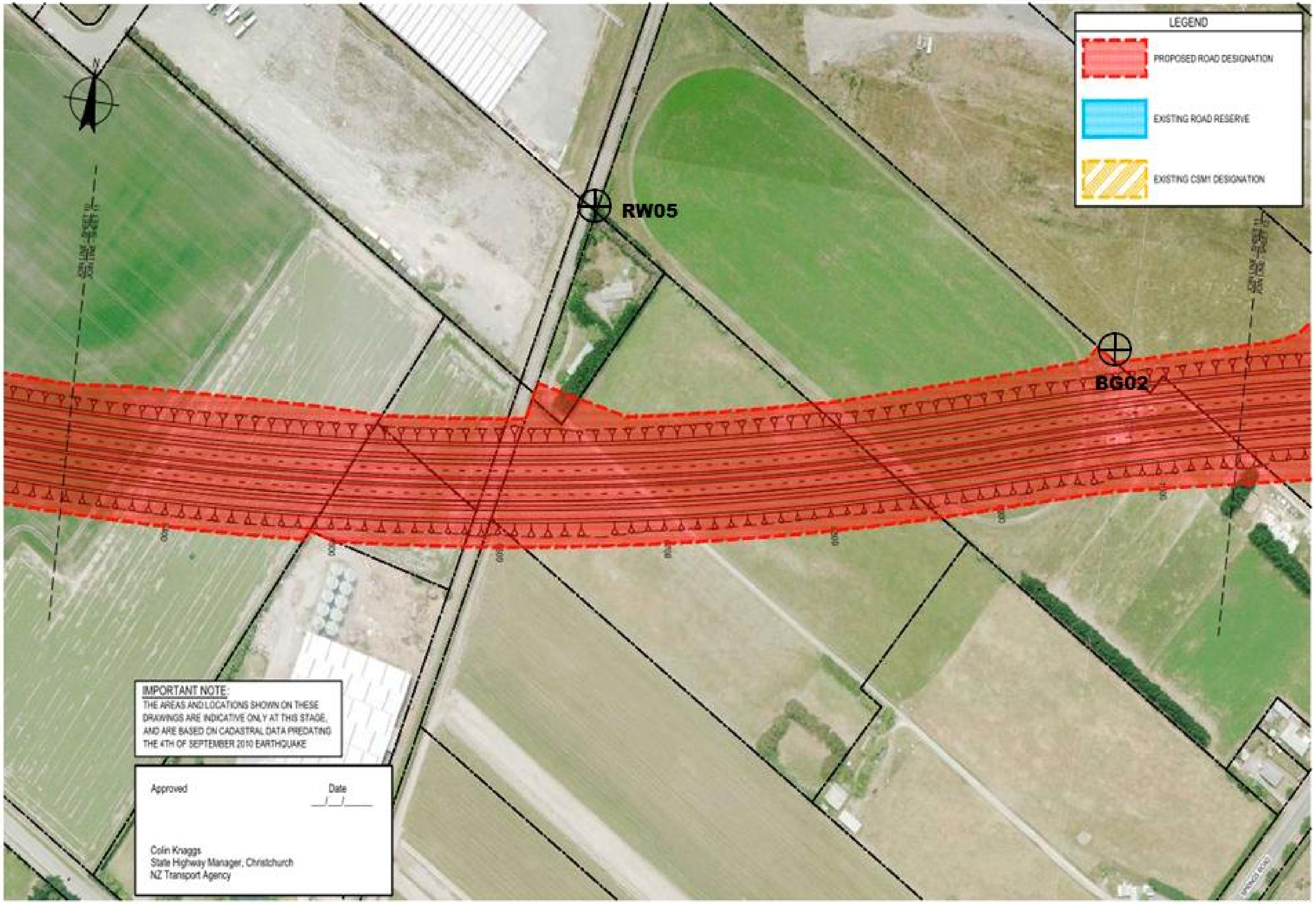


Figure A3 Investigation Locations (Former Quarry)





IMPORTANT NOTE:
THE AREAS AND LOCATIONS SHOWN ON THESE DRAWINGS ARE INDICATIVE ONLY AT THIS STAGE, AND ARE BASED ON CADASTRAL DATA PREDATING THE 4TH OF SEPTEMBER 2010 EARTHQUAKE

Approved

Date
__/__/____

Colin Knaggs
State Highway Manager, Christchurch
NZ Transport Agency

FOR INFORMATION

No	Revision	Drawn	Checked	Approved	Date
B	FOR INFORMATION	CMG	DGA	CG	31.05.12
A	FOR INFORMATION	CMcG	DGA	CG	14.10.11

NZ TRANSPORT AGENCY
WAKA KOTAHI

GHD

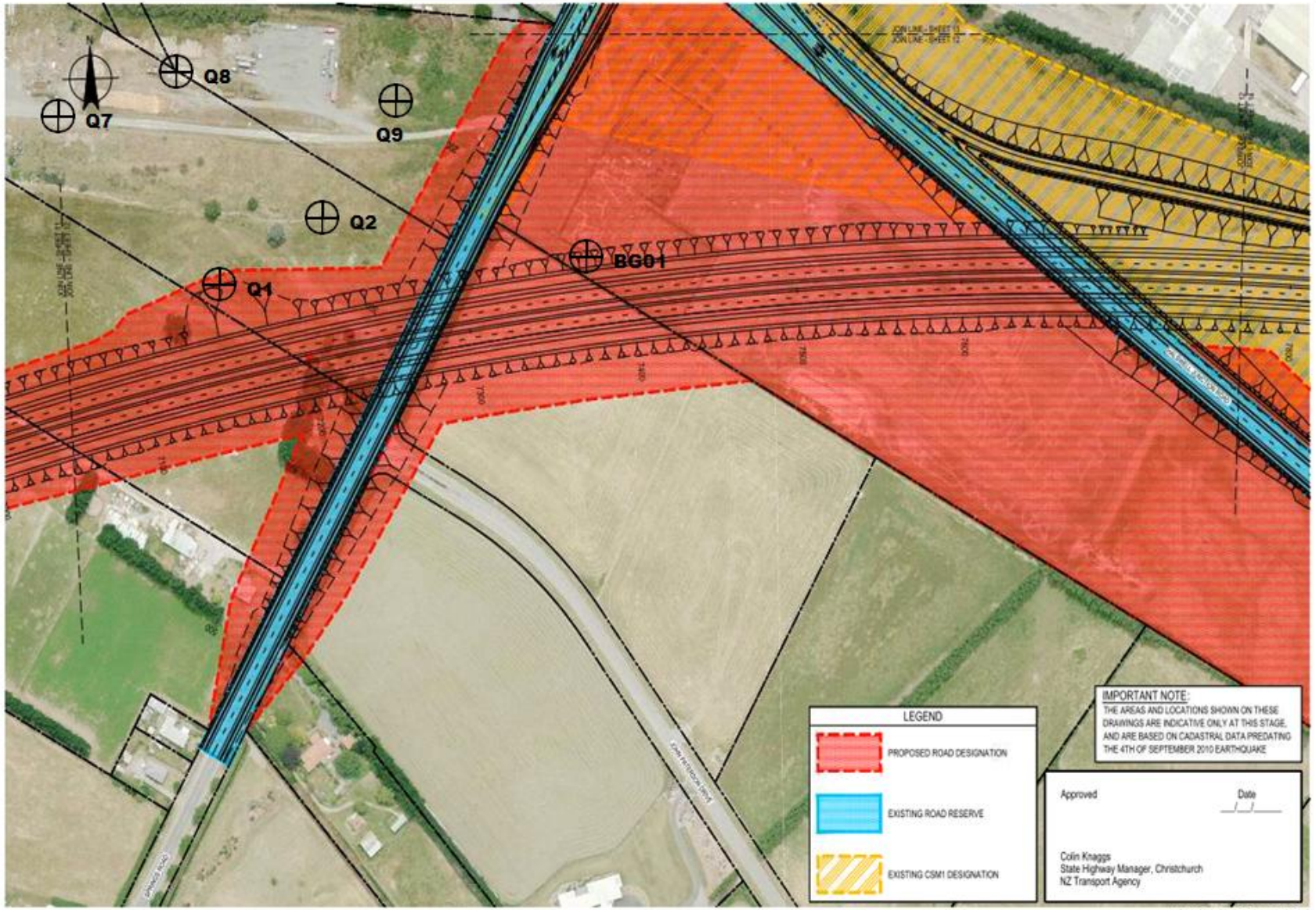
Beca

DO NOT SCALE

Drawn CMcG
Designed JAS
Drafting Check JAS
Design Check DGA
Approved CHRIS GREGORY
Date 17.10.11
A1 Scale
A3 Scale 1:2000

Client NEW ZEALAND TRANSPORT AGENCY
Project SH1 REGION 11 RP350/3.92 TO RP365/2.11
CHRISTCHURCH SOUTHERN MOTORWAY 2
Title DESIGNATIONT PLAN - SHEET 11 OF 17

Drawing No: 62236-B-C1011
Rev: B



FOR INFORMATION

No	Revision	Drawn	Checked	Approved	Date
B	FOR INFORMATION	CMD	OGA	CG	21.05.12
A	FOR INFORMATION	DMcG	OGA	CG	14.10.11

NZ TRANSPORT AGENCY
WAKA KOTAHI

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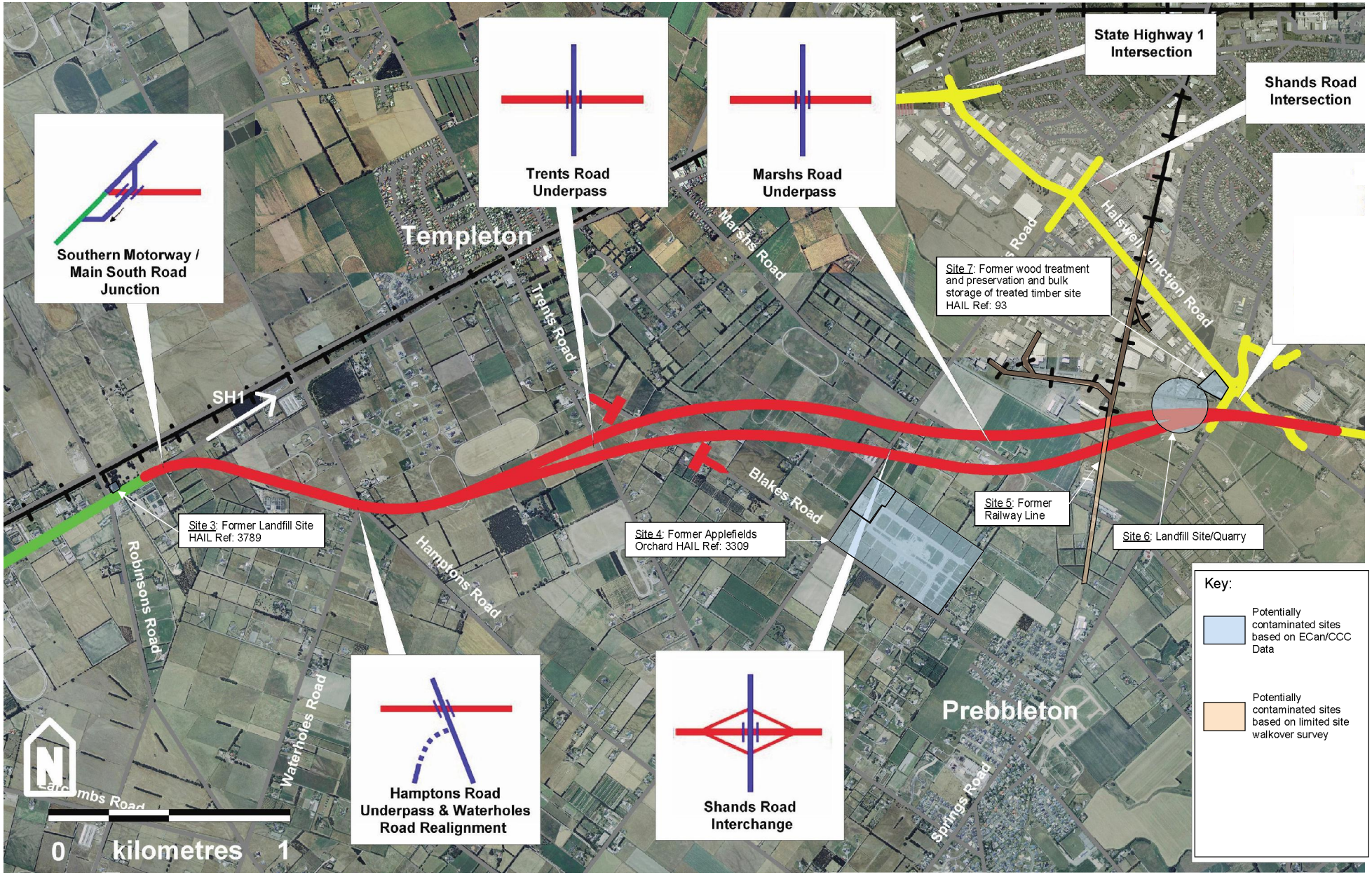
Drawn: DMcG	Designed: JAS
Drafting Check: JAS	Design Check: DGA
Approved: CHRIS GREGORY	
Date: 17.10.11	
A1 Scale:	This Drawing must not be used for construction unless signed as Approved
A3 Scale: 1:2000	

Client: NEW ZEALAND TRANSPORT AGENCY
Project: SH1 REGION 11 RP350/3.92 TO RP365/2.11 CHRISTCHURCH SOUTHERN MOTORWAY STAGE 2
Title: DESIGNATION PLAN - SHEET 12 OF 17

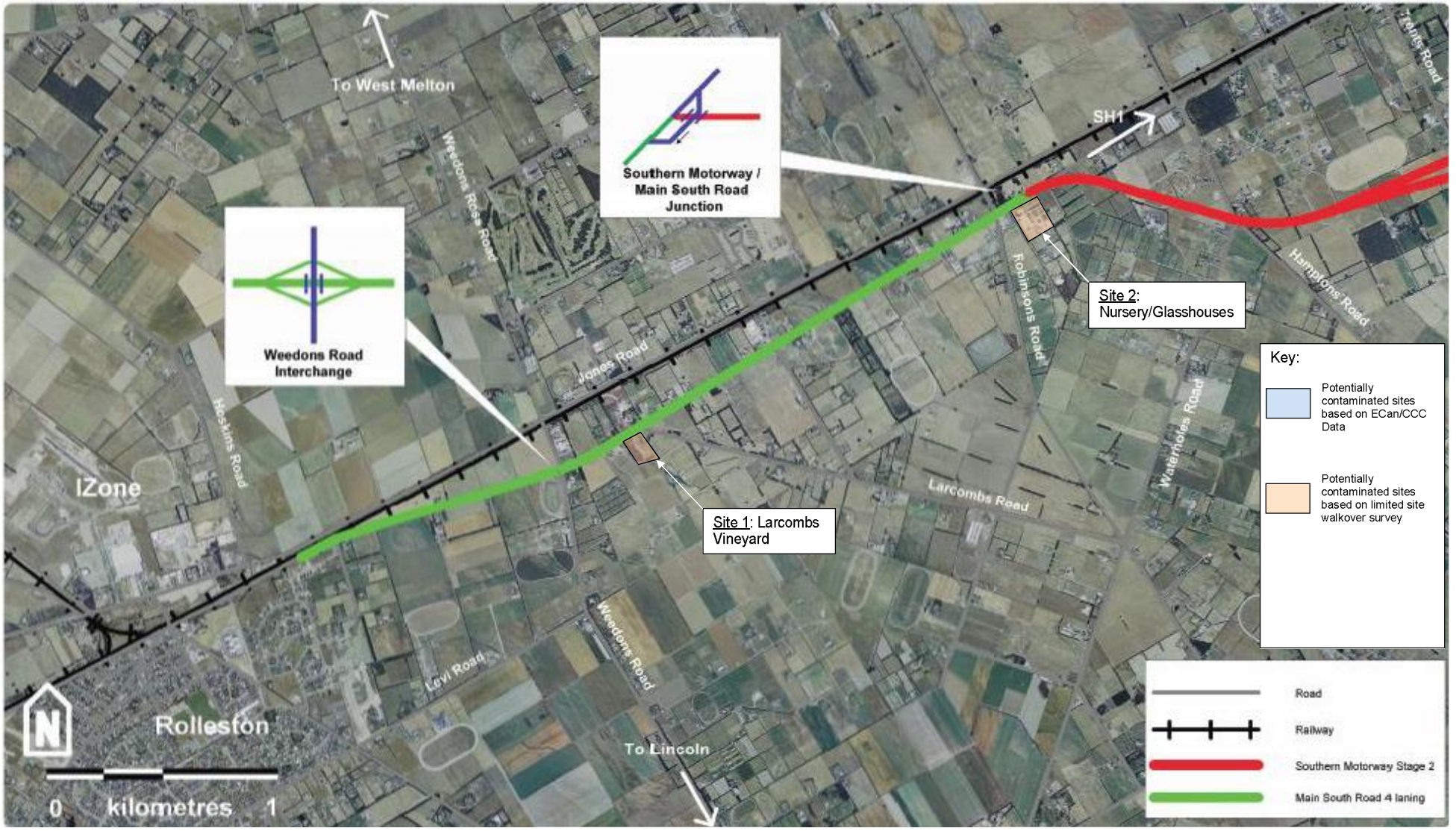
Drawing No: 62236-B-C1012 Rev: B

Figure A1 - CSM2 Potentially Contaminated Sites



Note: Extents are approximate based on limited site walkover information and ECan LLUR files

Figure A2 – MSRFL Potentially Contaminated Sites



Note: Extents are approximate based on limited site walkover information and ECan LLUR files

Appendix B:
Sample Register

MSRFL/CSM2 - Contamination Investigation

Sample Schedule

Jul-11

ID	Date	Location	Depth	Description	Analysis	Comments
BG01	30/06/2011	West of Springs Road, open field, paintballing	0.2	Dk brown sandy SILT	HMs, OCPs	
BG02	1/07/2011	Open field, Edge of NZTA land	0.2	Dk brown sandy SILT	HMs, OCPs	
BG03	30/06/2011	Onion field, Marshs Road	0.2	Dk brown sandy SILT	HMs, OCPs	
BG04	4/07/2011	Horse paddock, Shands Road	0.2	Dk brown sandy SILT	HMs, OCPs	
BG05	1/07/2011	Horse paddock, Blakess Road	0.2	Dk brown sandy SILT	HMs, OCPs	
BG06	1/07/2011	Open paddock, Trents Road	0.2	Dk brown sandy SILT	HMs, OCPs	
BG07	1/07/2011	Horse paddock, Hamptons Road	0.2	Dk brown sandy SILT	HMs, OCPs	
BG08	1/07/2011	Horse paddock, trotting ring (Kim Property)	0.2	Dk brown sandy SILT	HMs, OCPs	
BG09	4/07/2011	Pony paddock, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	
BG10	4/07/2011	Pony paddock, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	
BG11	4/07/2011	Road verge, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	
BG12	4/07/2011	Road verge, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	
BG13	4/07/2011	Road verge, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	
BG14	4/07/2011	Road verge, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	
BG15	4/07/2011	Road verge, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	
Q1	30/06/2011	Quarry, top of mound	0.4	Lt brown sandy SILT. Occ gr	HMs, PAHs	
Q2	30/06/2011	Quarry, lower mound	0.4	Lt brown sandy SILT. Occ gr	HMs, PAHs	
Q3	30/06/2011	Quarry, close to railway	0.8	Lt brown sandy SILT. Occ gr	HMs, PAHs	0.5m silt
Q4	30/06/2011	Quarry, close to tar tanks	0.3	Dk brown gravelly sandy SILT	HMs, PAHs	Spilt tar on ground
Q5	30/06/2011	Quarry, close to disposed containers/burnt area	0.3	Dk brown gravelly sandy SILT	HMs, PAHs	
Q6A	30/06/2011	Quarry, fill material in stockpile	0.5	Lt brown sandy SILT. Occ gr	HMs, PAHs	
Q6B	30/06/2011	Quarry, near concrete pipes	0.3	Dk brown gravelly sandy SILT	HMs, PAHs	
Q7	30/06/2011	Quarry, flat area outside compound (grass)	0.2	Dk brown gravelly sandy SILT	HMs, PAHs	
Q8	30/06/2011	Quarry, inside compound, timber storage area	0.3	Grey sandy SILT	HMs, PAHs	Woodchips/shavings GL to 0.3
Q9	30/06/2011	Quarry, raised area close to Springs Road	0.2	Lt brown sandy SILT. Occ gr	HMs, PAHs	
RW1	1/07/2011	Railway, centreline	0.4	Dk brown slightly si, sa GRAVEL	HMs, PAHs, AH	
RW2	1/07/2011	Railway, centreline	0.4	Dk brown slightly si, sa GRAVEL	HMs, PAHs, AH	
RW3	1/07/2011	Railway, centreline	0.4	Dk brown slightly si, sa GRAVEL	HMs, PAHs, AH	
RW4	1/07/2011	Railway, verge	0.3	Dk brown sl sa, gr SILT	HMs, PAHs, AH	
RW5	1/07/2011	Railway, verge	0.3	Dk brown sl sa, gr SILT	HMs, PAHs, AH	
AS1	4/07/2011	Shands Road, Aberdeen Subdivision	0.2	Dk brown sandy SILT	HMs, OCPs	Nearest Marshs Rd
AS2	4/07/2011	Shands Road, Aberdeen Subdivision	0.2	Dk brown sandy SILT	HMs, OCPs	Middle
AS3	4/07/2011	Shands Road, Aberdeen Subdivision	0.2	Dk brown sandy SILT	HMs, OCPs	Furthest
QA1	30/06/2011	Quarry, raised area close to Springs Road	0.2	Lt brown sandy SILT. Occ gr	HMs, PAHs	Duplicate of Q9
QA2	4/07/2011	Shands Road, Aberdeen Subdivision	0.2	Dk brown sandy SILT	HMs, OCPs	Duplicate of AS2
QA3	4/07/2011	Pony paddock, MSR	0.2	Dk brown sandy SILT	HMs, OCPs	Duplicate of BG9

Appendix C
Laboratory Results

	CSM2 Alignment										Published Background Concentration	MfE 2012		NEPC	US EPA
GHD Sample ID	BG1 30-Jun-2011	BG2 30-Jun-2011	BG3 30- Jun-2011	BG4 30-Jun-2011	BG5 30-Jun-2011	BG6 30-Jun-2011	BG7 30-Jun-2011	BG8 30-Jun-2011	BG9 30-Jun-2011	BG10 30-Jun-2011					
Lab Sample ID	910570.1	911255.2	910570.2	911255.1	911255.6	911255.7	911255.8	911255.9	911255.2	911255.2					
Sample Depth	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		**NES**	**NES**		
Sample Date	30/06/2011	1/07/2011	30/06/2011	4/07/2011	1/07/2011	1/07/2011	1/07/2011	1/07/2011	4/07/2011	4/07/2011					
Sample Type	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT		**Commercial / Industrial Outdoor Worker**	**Rural residential / lifestyle block 25% produce**	**Human Health Residential <10% Produce Consumption**	**Eco-SSLs Ecological Receptors**
Sample Description	West of Springs Road, open field, paintballing	Open field, Edge of NZTA land	Onion field, Marshs Road	Horse paddock, Shands Road	Horse paddock, Blakess Road	Open paddock, Trents Road	Horse paddock, Hamptons Road	Horse paddock, trotting ring (Kim Property)	Pony paddock, MSR	Pony paddock, MSR					
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analytes															
Heavy Metals															
Arsenic	6	6	3	4	3	3	3	3	3	2	**12.6**	**70**	**17**		**37**
Cadmium	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.14	**0.19**	**1300**	**0.8**		**29**
Chromium (Total)	16	19	12	16	13	13	12	14	13	13	**22.7**	**6300 (VI)**	**290**		**BL**
Copper	10	10	6	8	5	5	3	4	10	14	**20.3**	**NL**	**NL**		**61**
Lead	23	23	15.3	17.4	14.7	14.3	12.3	14.8	14.3	19.3	**41**	**3300**	**160**		**120**
Nickel	13	16	9	13	8	10	8	9	9	9	**20.7**			**600**	**60**
Zinc	71	87	52	62	59	54	43	51	60	72	**93.9**			**7000**	**190**
Organochlorine Pesticides															
Aldrin	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
alpha-BHC	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
beta-BHC	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
delta-BHC	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
gamma-BHC (Lindane)	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
cis-Chlordane	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
trans-Chlordane	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Total Chlordane [(cis+trans)*100/42]	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04					
2,4'-DDD	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
4,4'-DDD	0.019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
2,4'-DDE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
4,4'-DDE	0.176	< 0.010	< 0.010	0.021	0.21	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
2,4'-DDT	0.017	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
4,4'-DDT	0.041	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Σ DDT	0.253	< 0.060	< 0.060	0.071	0.071	< 0.060	< 0.060	< 0.060	< 0.060	< 0.060		**1,000**	**45**		
Dieldrin	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endosulfan I	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endosulfan II	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endosulfan sulphate	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endrin	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endrin Aldehyde	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endrin ketone	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Heptachlor	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Heptachlor epoxide	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Hexachlorobenzene	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Methoxychlor	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					

	Former Quarry Samples (Springs Road)											MfE 2012		NEPC	US EPA
GHD Sample ID	Q1 30-Jun-2011	Q2 30-Jun-2011	Q3 30-Jun-2011		Q5 30-Jun-2011	Q6 (A) 30-Jun-2011	Q6 (B) 30-Jun-2011	Q7 30-Jun-2011	Q8 30-Jun-2011	Q9 30-Jun-2011					
Lab Sample ID	910570.3	910570.4	910570.5	910570.6	910570.7	910570.8	910570.9	910570.1	910570.11	910570.12					
Sample Depth	0.4	0.4	0.8	0.3	0.3	0.5	0.3	0.2	0.3	0.2		**NES**	**NES**		
Sample Date	30/06/2011	30/06/2011	30/06/2011	30/06/2011	30/06/2011	30/06/2011	30/06/2011	30/06/2011	30/06/2011	30/06/2011					
Sample Type	Lt brown sandy SILT. Occ gr	Lt brown sandy SILT. Occ gr	Lt brown sandy SILT. Occ gr	Dk brown gravelly sandy SILT	Dk brown gravelly sandy SILT	Lt brown sandy SILT. Occ gr	Dk brown gravelly sandy SILT	Dk brown gravelly sandy SILT	Grey sandy SILT	Lt brown sandy SILT. Occ gr	**Published Background Concentration**	**Commercial / Industrial Outdoor Worker**	**Rural residential / lifestyle block 25% produce**	**Human Health Residential <10% Produce Consumption**	**Eco-SSLs Ecological Receptors**
Sample Description	Quarry, top of mound	Quarry, lower mound	Quarry, close to railway	Quarry, close to tar tanks	Quarry, close to disposed containers/burnt area	Quarry, fill material in stockpile	Quarry, near concrete pipes	Quarry, flat area outside compound (grass)	Quarry, inside compound, timber storage area	Quarry, raised area close to Springs Road					
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analytes															
Heavy Metals															
Arsenic	4	5	4	4	5	6	12	6	6	5	**12.6**	**70**	**17**		**37**
Cadmium	< 0.10	0.12	< 0.10	< 0.10	< 0.10	< 0.10	0.26	0.14	< 0.10	< 0.10	**0.19**	**1300**	**0.8**		**29**
Chromium (Total)	15	17	15	14	21	17	18	16	15	15	**22.7**	**6300 (VI)**	**290**		**BL**
Copper	55	11	11	10	16	14	25	19	12	9	**20.3**	**NL**	**NL**		**61**
Lead	93	32	37	23	46	43	138	60	45	19.4	**41**	**3300**	**160**		**120**
Nickel	14	16	13	11	19	13	12	13	14	13	**20.7**			**600**	**60**
Zinc	116	87	72	76	450	70	191	106	72	57	**93.9**			**7000**	**190**
Polycyclic Aromatic Hydrocarbons															
Acenaphthene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.69	< 0.03	0.14	0.17	< 0.03					
Acenaphthylene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	1.31	0.03	0.34	0.34	< 0.03					
Anthracene	< 0.03	0.04	0.05	< 0.03	< 0.03	5.7	< 0.03	0.89	1.57	< 0.03					
Benzo[a]anthracene	0.03	0.12	0.13	0.1	0.08	10.2	0.24	4.8	7	< 0.03					
Benzo[a]pyrene (BAP)	0.03	0.12	0.11	0.11	0.08	9	0.29	5.1	6.4	0.03					
Benzo[b]fluoranthene + Benzo[j]fluoranthene	0.05	0.19	0.17	0.18	0.13	9.8	0.54	5.8	7.8	0.03					
Benzo[k]fluoranthene	0.02	0.08	0.08	0.08	0.05	4.8	0.21	2.7	3.6	< 0.03					
Chrysene	0.03	0.12	0.13	0.11	0.08	7.8	0.28	3.8	5	< 0.03					
Dibenzo[a,h]anthracene	< 0.03	0.03	0.03	0.03	< 0.03	1.48	0.06	0.88	1.1	< 0.03					
Fluoranthene	0.06	0.21	0.28	0.19	0.16	28	0.32	9.5	14.9	0.06					
Indeno(1,2,3-c,d)pyrene	0.03	0.1	0.07	0.09	0.06	4.9	0.21	3.1	3.7	< 0.03					
Benzo[g,h,i]perylene	0.04	0.12	0.1	0.11	0.08	5.8	0.3	3.7	4.7	< 0.03					
Fluorene	0.03	< 0.03	0.04	< 0.03	< 0.03	3.1	< 0.03	0.25	0.23	< 0.03					
Naphthalene	< 0.13	< 0.14	< 0.14	< 0.13	< 0.14	0.85	< 0.14	0.16	< 0.14	< 0.14					
Phenanthrene	0.07	0.08	0.26	0.12	0.11	29	0.14	4.1	8.3	0.06					
Pyrene	0.08	0.23	0.3	0.23	0.19	28	0.4	9.8	14.4	0.06					
BaP (TEQ)	0.07	0.20	0.19	0.19	0.14	13.53	0.47	7.66	9.76	0.07		**35**	**6**		**NA**

	MSRF Alignment									
GHD Sample ID	BG11 30-Jun-2011	BG12 30-Jun-2011	BG13 30-Jun-2011	BG14 30-Jun-2011	BG15 04-Jul-2011	**Published Background Concentration**	**MfE 2012**		**NEPC**	**US EPA**
Lab Sample ID	911255.15	911255.14	911255.13	911255.12	911255.11					
Sample Depth	0.2	0.2	0.2	0.2	0.2		**NES**	**NES**	**Human Health Residential <10% Produce Consumption**	**Eco-SSLs Ecological Receptors**
Sample Date	4/07/2011	4/07/2011	4/07/2011	4/07/2011	4/07/2011					
Sample Type	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT		**Commercial / Industrial Outdoor Worker**	**Rural residential / lifestyle block 25% produce**		
Sample Description	Northern verge MSR	Northern verge MSR	Northern verge MSR	Northern verge MSR	Northern verge MSR					
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analytes										
Heavy Metals										
Arsenic	8	4	3	5	3	**12.6**	**70**	**17**		**37**
Cadmium	< 0.10	0.2	< 0.10	0.19	0.17	**0.19**	**1300**	**0.8**		**29**
Chromium (Total)	17	15	13	13	12	**22.7**	**6300 (VI)**	**290**		**BL**
Copper	16	17	4	5	10	**20.3**	**NL**	**NL**		**61**
Lead	98	77	16.8	15.8	45	**41**	**3300**	**160**		**120**
Nickel	11	11	9	9	10	**20.7**			**600**	**60**
Zinc	95	96	55	53	102	**93.9**			**7000**	**190**
Polycyclic Aromatic Hydrocarbons										
BaP (TEQ)	-	-	-	-	-		**35**	**6**		**NA**
Organochlorine Pesticides										
Aldrin	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
alpha-BHC	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
beta-BHC	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
delta-BHC	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
gamma-BHC (Lindane)	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
cis-Chlordane	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
trans-Chlordane	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Total Chlordane [(cis+trans)*100/42]	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04					
2,4'-DDD	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
4,4'-DDD	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
2,4'-DDE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
4,4'-DDE	0.075	< 0.010	< 0.010	0.023	< 0.010					
2,4'-DDT	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
4,4'-DDT	0.031	< 0.010	< 0.010	< 0.010	< 0.010		**1,000**	**45**		**NA**
Σ DDT	0.106	< 0.060	< 0.060	0.073	< 0.060					
Dieldrin	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endosulfan I	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endosulfan II	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endosulfan sulphate	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endrin	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endrin Aldehyde	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Endrin ketone	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Heptachlor	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Heptachlor epoxide	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Hexachlorobenzene	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					
Methoxychlor	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010					

	Former Southbridge Branch Railway Samples					Aberdeen Subdivision (Marshs Road)			QA Duplicate Samples			Published Background Concentration	MfE 2012		NEPC	US EPA
GHD Sample ID	RW1 30-Jun-2011	RW2 30-Jun-2011	RW3 30-Jun-2011	RW4 30-Jun-2011	RW5 30-Jun-2011	AS1 04-Jul-2011	AS2 04-Jul-2011	AS3 04-Jul-2011	QA1 30-Jun-2011	QA2 04-Jul-2011	Q4 30-Jun-2011					
Lab Sample ID	911255.1	911255.2	911255.3	911255.4	911255.5	911255.19	911255.2	911255.21	910570.13	911255.22	911255.23					
Sample Depth	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2		NES	NES		
Sample Date	1/07/2011	1/07/2011	1/07/2011	1/07/2011	1/07/2011	4/07/2011	4/07/2011	4/07/2011	30/06/2011	4/07/2011	4/07/2011					
Sample Type	Dk brown slightly si, sa GRAVEL	Dk brown slightly si, sa GRAVEL	Dk brown slightly si, sa GRAVEL	Dk brown sl sa, gr SILT	Dk brown sl sa, gr SILT	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Lt brown sandy SILT. Occ gr	Dk brown sandy SILT	Dk brown sandy SILT		Commercial / Industrial Outdoor Worker	Rural residential / lifestyle block 25% produce	Human Health Residential <10% Produce Consumption	Eco-SSLs Ecological Receptors
Sample Description	Railway, centreline	Railway, centreline	Railway, centreline	Railway, verge	Railway, verge	Shands Road, Aberdeen Subdivision	Shands Road, Aberdeen Subdivision	Shands Road, Aberdeen Subdivision	Quarry, raised area close to Springs Road	Shands Road, Aberdeen Subdivision	Pony paddock, MSR					
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analytes																
Heavy Metals																
Arsenic	6	5	7	5	63	5	5	5	4	4	3	**12.6**	**70**	**17**		**37**
Cadmium	0.25	0.12	< 0.10	0.11	0.58	< 0.10	< 0.10	< 0.10	< 0.10	0.12	0.15	**0.19**	**1300**	**0.8**		**29**
Chromium (Total)	15	17	15	14	44	17	17	16	14	17	13	**22.7**	**6300 (VI)**	**290**		**BL**
Copper	28	14	28	24	67	12	9	10	8	9	11	**20.3**	**NL**	**NL**		**61**
Lead	51	28	51	38	400	32	34	35	15.2	31	14.4	**41**	**3300**	**160**		**120**
Nickel	12	13	12	12	18	14	14	13	12	13	8	**20.7**			**600**	**60**
Zinc	141	97	49	53	320	87	137	93	50	116	61	**93.9**			**7000**	**190**
Polycyclic Aromatic Hydrocarbons																
Acenaphthene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	-	-	-	-	-	-					
Acenaphthylene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	-	-	-	-	-	-					
Anthracene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	-	-	-	-	-	-					
Benzo[a]anthracene	0.04	0.03	0.04	0.06	0.03	-	-	-	-	-	-					
Benzo[a]pyrene (BAP)	0.04	0.03	0.04	0.06	0.03	-	-	-	-	-	-					
Benzo[b]fluoranthene + Benzo[j]fluoranthene	0.07	0.05	0.06	0.09	0.07	-	-	-	-	-	-					
Benzo[k]fluoranthene	0.03	< 0.03	< 0.03	0.04	0.03	-	-	-	-	-	-					
Chrysene	0.06	0.04	0.05	0.08	0.04	-	-	-	-	-	-					
Dibenzo[a,h]anthracene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	-	-	-	-	-	-					
Fluoranthene	0.09	0.07	0.08	0.12	0.07	-	-	-	-	-	-					
Indeno(1,2,3-c,d)pyrene	0.03	< 0.03	0.03	0.04	0.03	-	-	-	-	-	-					
Benzo[g,h,i]perylene	0.05	0.04	0.04	0.06	0.04	-	-	-	-	-	-					
Fluorene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	-	-	-	-	-	-					
Naphthalene	0.18	< 0.15	< 0.12	< 0.12	< 0.12	-	-	-	-	-	-					
Phenanthrene	0.19	0.08	0.1	0.17	0.07	-	-	-	-	-	-					
Pyrene	0.09	0.07	0.09	0.13	0.07	-	-	-	-	-	-					
BaP (TEQ)	0.09	0.07	0.09	0.11	0.08	-	-	-	-	-	-		**35**	**6**		**NA**
Organochlorine Pesticides																
Aldrin	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
alpha-BHC	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
beta-BHC	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
delta-BHC	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
gamma-BHC (Lindane)	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
cis-Chlordane	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
trans-Chlordane	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Total Chlordane [(cis+trans)*100/42]	-	-	-	-	-	< 0.04	< 0.04	< 0.04	-	< 0.04	< 0.04					
2,4'-DDD	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
4,4'-DDD	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
2,4'-DDE	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
4,4'-DDE	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
2,4'-DDT	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
4,4'-DDT	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					**NA**
Σ DDT	-	-	-	-	-	< 0.060	< 0.060	< 0.060	-	<0.060	< 0.060		**1,000**	**45**		
Dieldrin	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Endosulfan I	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Endosulfan II	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Endosulfan sulphate	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Endrin	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Endrin Aldehyde	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Endrin ketone	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Heptachlor	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Heptachlor epoxide	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Hexachlorobenzene	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					
Methoxychlor	-	-	-	-	-	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010					

- denotes not applicable

	Aberdeen Subdivision (Marshs Road) Samples			QA Duplicate Samples			MfE 2012	
GHD Sample ID	AS1 04-Jul-2011	AS2 04-Jul-2011	AS3 04-Jul-2011	QA1 30-Jun-2011	QA2 04-Jul-2011	Q4 30-Jun-2011		
Lab Sample ID	911255.19	911255.2	911255.21	910570.13	911255.22	911255.23		
Sample Depth	0.2	0.2	0.2	0.2	0.2	0.2	**NES**	**NES**
Sample Date	4/07/2011	4/07/2011	4/07/2011	30/06/2011	4/07/2011	4/07/2011		
Sample Type	Dk brown sandy SILT	Dk brown sandy SILT	Dk brown sandy SILT	Lt brown sandy SILT. Occ gr	Dk brown sandy SILT	Dk brown sandy SILT	**Commercial / Industrial Outdoor Worker**	**Rural residential / lifestyle block 25% produce**
Sample Description	Shands Road, Aberdeen Subdivision	Shands Road, Aberdeen Subdivision	Shands Road, Aberdeen Subdivision	Quarry, raised area close to Springs Road	Shands Road, Aberdeen Subdivision	Pony paddock, MSR		
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Analytes								
Organochlorine Pesticides								
Aldrin	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
alpha-BHC	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
beta-BHC	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
delta-BHC	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
gamma-BHC (Lindane)	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
cis-Chlordane	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
trans-Chlordane	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Total Chlordane [(cis+trans)*100/42]	< 0.04	< 0.04	< 0.04	-	< 0.04	< 0.04		
2,4'-DDD	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
4,4'-DDD	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
2,4'-DDE	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
4,4'-DDE	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
2,4'-DDT	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
4,4'-DDT	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Σ DDT	< 0.060	< 0.060	< 0.060	-	<0.060	< 0.060	**1,000**	**45**
Dieldrin	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Endosulfan I	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Endosulfan II	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Endosulfan sulphate	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Endrin	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Endrin Aldehyde	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Endrin ketone	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Heptachlor	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Heptachlor epoxide	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Hexachlorobenzene	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		
Methoxychlor	< 0.010	< 0.010	< 0.010	-	< 0.010	< 0.010		

- denotes not applicable