March 2009

FORMER WASTE CONTROL SITE, BELLEVUE, WA

Stakeholder Update Meeting Briefing Document

Submitted to:
Department of Environment and Conservation
Level 4, The Atrium
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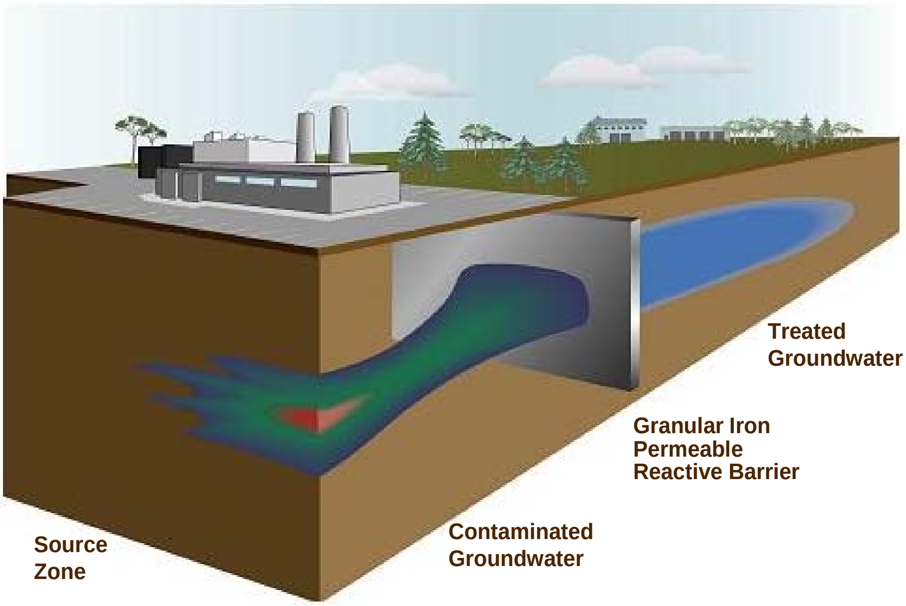
PERTH WA 6000



REPORT

Report Number: 087643011 049 R Rev0

Distribution:

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FIGURES

FIGURES WITHIN TEXT

1.0 INTRODUCTION

A waste chemical/oil recycling and waste treatment facility operated at the former Waste Control Site between 1987 and 2001. The location of the site is shown on Figure 1. In February 2001, a large fire broke out, which destroyed the treatment and recycling plant, and a stockpile of drummed waste chemicals. The fire-fighting operation involved considerable volumes of water, which flowed across the site, prior to flowing onto adjoining properties (primarily Lot 2). Post-fire clean-up of the site and surrounding affected areas was undertaken. However, investigations of the site and surrounds have identified longer term issues of soil and groundwater contamination.

The Department of Environment and Conservation (DEC) has retained Golder Associates Pty Ltd (Golder) to investigate soil and groundwater contamination, assess potential risks and develop remedial plans to address contamination associated with the former Waste Control facility (the site) in Bellevue, WA.

For the purpose of investigation, the site and surrounds have been separated into five regions (Figure 1). These include the site/Lot 2, the Hanson Property, the Southwest Industrial Area, the Damplands and the Surrounding Residences. The latter are predominantly to the north and hydraulically up gradient of the site and are not affected by groundwater impacts.

For discussion purposes, the Bellevue site has also been divided into on-site and off-site areas. These definitions do not correspond with the formal property boundaries of the site. Rather, on-site refers to the former Waste Control site and also encompasses impacted areas on the land immediately adjacent. The impacts consist of a mixture of hydrocarbons, solvents and other facility-related chemicals in the soil and in the groundwater below the ground surface. Separate to this, and located approximately 100 m southwest, is an area of off-site impact. The off-site area is currently defined by soil and groundwater impacted by chlorinated solvents (primarily trichloroethene or TCE). Although it contains some of the same chemicals as the on-site impacts, the off-site groundwater plume has different chemical composition and is distinct from the on-site plume. Further discussion is provided later in this document.

2.0 OBJECTIVES

This document provides background information and explanations of technical information for the Bellevue Community Consultation Committee (BCCC) and other stakeholders in preparation for a project update meeting to be held April 1, 2009. The meeting objective will be to update stakeholders on recent progress and to outline the remediation approaches, concepts and technologies that are proposed for clean-up of soil and groundwater at the former Waste Control Site.

Site investigation results, the health and environmental risk assessment, and potential remedial options have been discussed previously in workshops with the BCCC and other stakeholders.

3.0 PROGRESS REPORT

During 2008, substantial advancements have been made towards remediation of the site, through investigations to address outstanding “data gap” issues and in the selection of remedial approaches to address impacts to soil and groundwater. The following activities were completed in 2008 and the first quarter of 2009:

- Detailed compilation (in two volumes) of previous work on the on-site and off-site impacts for submission and review by the appointed Contaminated Sites Auditor.
- Additional drilling and expansion of the groundwater monitoring well network to further delineate the off-site impacts and identify the source of the separate off-site plume.
- Identification of a new off-site source and evaluation of potential health risks from soil vapours in that area.
- Completion of groundwater monitoring programs in autumn and spring to ensure that health and environmental risks remain appropriately managed.

- Development of a database and three-dimensional geographic information system (GIS) to allow better planning of remediation work.
- Update of human health risk assessment, risk based criteria and ecological screening levels to ensure that clean up objectives are based on the most recent toxicology information available.
- Development of the On-site remediation program including:
  - analysis of remedial options;
  - technical panel workshop to review and select remedial options;
  - laboratory testing of soil treatment; and
  - field injection trials for remediation design purposes.
- Off-site Remedial Program including:
  - technical panel workshop to review and select remedial options;
  - laboratory testing of groundwater treatment technology; and
  - detailed delineation of groundwater and soil in the area of a proposed permeable reactive barrier (PRB) remediation system.

4.0 REVIEW OF RISK FRAMEWORK

A human health and ecological risk assessment (HHERA) was completed in 2006 following input from stakeholder consultation in Workshops No. 2 and 3. The HHERA was updated in 2008 to ensure that risk based screening criteria (RBC) for soil and groundwater were based on the latest available toxicology data and regulatory reference values. The RBC are used to assess soil and groundwater sampling results and ultimately are used to establish clean up objectives for the site. The overall approach and framework behind the HHERA has not been changed.

A full discussion of the risk assessment outcomes was provided in the HERRA and Workshop No.3, and is beyond the scope of the current document. However, the following section outlines areas where soil and groundwater quality currently exceeds RBC.

5.0 2009 CONTAMINANT DISTRIBUTION

5.1 Groundwater

The current distribution of groundwater contaminants with concentrations exceeding RBC is represented in Figure 2. The interpretation is based on data collected throughout 2008 and through to January 2009. A similar illustration was presented at Workshop No.4 based on 2006 and older data. Some changes have been identified as a result of continued monitoring and the further investigations works undertaken in 2008.

Consistent with previous interpretations, there are two plumes of impacted groundwater. These are:

1) The “on-site plume”: extending south-east from beneath the site into Lot 2 is a plume of mixed contaminant types, predominantly hydrocarbons and chlorinated solvents.

2) The “off-site plume: extending south from Stanley St to the north side of the Damplands is a groundwater plume of trichloroethene only.

In 2006, the off-site plume was referred to as a detached chlorinated solvents plume and was thought to be a “pulse” of older contamination originating from the former Waste Control Site. However, the results of investigations in 2008 have indicated that this is not the case, and that the off-site plume originates from a local source near the east end of Stanley St. and that its composition is almost exclusively TCE.

Detailed soil vapour investigations near the east end of Stanley St. have identified a local source zone of contaminated soils in the north-east corner of the cul-de-sac. TCE was the only contaminant identified in the soil vapour, which is consistent with the underlying groundwater plume. In this area the watertable is approximately 12 m below ground surface and there is thick zone of unsaturated soils above. Further drilling is being conducted to determine the extent of the off-site source area for remediation planning.

The shape and composition on-site plume of mixed hydrocarbons and chlorinated solvents has changed since 2006. The distribution of hydrocarbons in groundwater has reduced and no longer extends to monitoring wells located south of the site (i.e. on Oliver St). However, the plume does extend in south-westerly direction beneath Lot 2, where it comprises a mixture of predominantly chlorinated solvents. This change can be explained by the fact that hydrocarbons generally have lower mobility and are naturally degraded more quickly in the groundwater than the chlorinated solvents.

5.2 Soil Contaminants (On-site)

In November 2008, Fugro of Germany was contracted to conduct a detailed investigations of the former Waste Control Site using a Rapid Optical Screening Tool (ROST) and a Membrane Interface Probe (MIP). This level of investigation was considered necessary to provide the detail necessary to conduct an in situ (in place) remediation program. These are high-tech tools attach to a standard geotechnical cone penetrometer (CPT) rig, which is normally used to investigate sites for ground engineering construction requirements. The ROST uses a laser to identify the presence of any hydrocarbons in the soil by causing them to fluoresce. The MIP is able to collect and analyse minute gas samples from the soil and was primarily used to identify the presence of chlorinate solvents (for example, PCE and TCE).

Where previously it was thought that there was widespread soil contamination beneath the site, the results of these surveys indicate that the main source is concentrated within a relatively small (20 m x 25 m) area located in the north half of the former Waste Control site (Figure 3). A smaller area of shallow soil contamination (10 m x 12 m) lies immediately to the south-west. The total volume of soil contamination is now estimated at less than 2000 m^3.

The ROST and MIP have also improved the understanding of the complex soil layering (stratigraphy) beneath the site (Figure 2). The soil profile above the water table has been characterised as:

- An unsaturated upper sand (from ground surface to between 4 and 6 m below ground surface (bgs).
- A middle sandy clay unit (6 to 10 m bgs), which comprises a complex series of beds that range in texture from a nearly pure clay to a clayey sand. Perched groundwater zones exist within the middle sandy clay unit. (This middle unit includes the clay layer previously defined investigations by URS).
- A lower sand (10+ m bgs). The watertable lies at approximately 10 m below ground near the top of the lower sand unit.

Most of the soil contamination is shallow and exists within the upper sand; however in some places it has penetrated into and even through the middle sandy clay unit and extends into the lower sand. Less than 20% of the mass has reached the lower unit where it contacts the water table. Hence, there remains substantial opportunity to prevent future impacts through on-site source removal or source control measures.

5.3 Risk Management

Although concentrations of chemicals exceed their respective RBC in soil and groundwater, there are no current risks to human health or the environment. These risks are managed through controls and site conditions that eliminate possible exposure pathways. For example:

- memorials preclude the use of borewater for irrigation or drinking water prevent direct human exposure to groundwater contamination;

- risks from vapour inhalation are mitigated by the fact that there are no buildings or enclosed structures over the areas of groundwater contamination; and,
- groundwater contamination does not extend to the Helena River nor does it discharge to surface, so there are no environmental (ecological) risks.

6.0 SITE REMEDIATION

6.1 Overall Remediation Strategy

Based on the results of the site investigations, monitoring and risk assessment an overall remediation strategy has been developed, which integrates three individual programs. Although the individual investigation and subsequent remediation programs are individually complex, the overall remediation strategy is straightforward. It consists of three main elements:

1) Cut-off and in ground ("*in situ*") treatment of the groundwater plume;
2) Removal or treatment of the contaminated soil source area beneath the former Waste Control Site; and
3) Removal or treatment of the newly identified off-site source area near the end of Stanley Street.

Computer modelling has been used to assess how the combination of these three elements will address soil and groundwater contamination and to define requirements for management of human health and ecological risks during the remediation process. The model was used to evaluate and compare future outcomes in two situations:

- If no remediation undertaken; and
- Implementation of the remediation strategy. This consisted of installation of a permeable reactive barrier (PRB) at the end of 2009 followed by 99% removal of both on- and off-site sources at the end of 2010.

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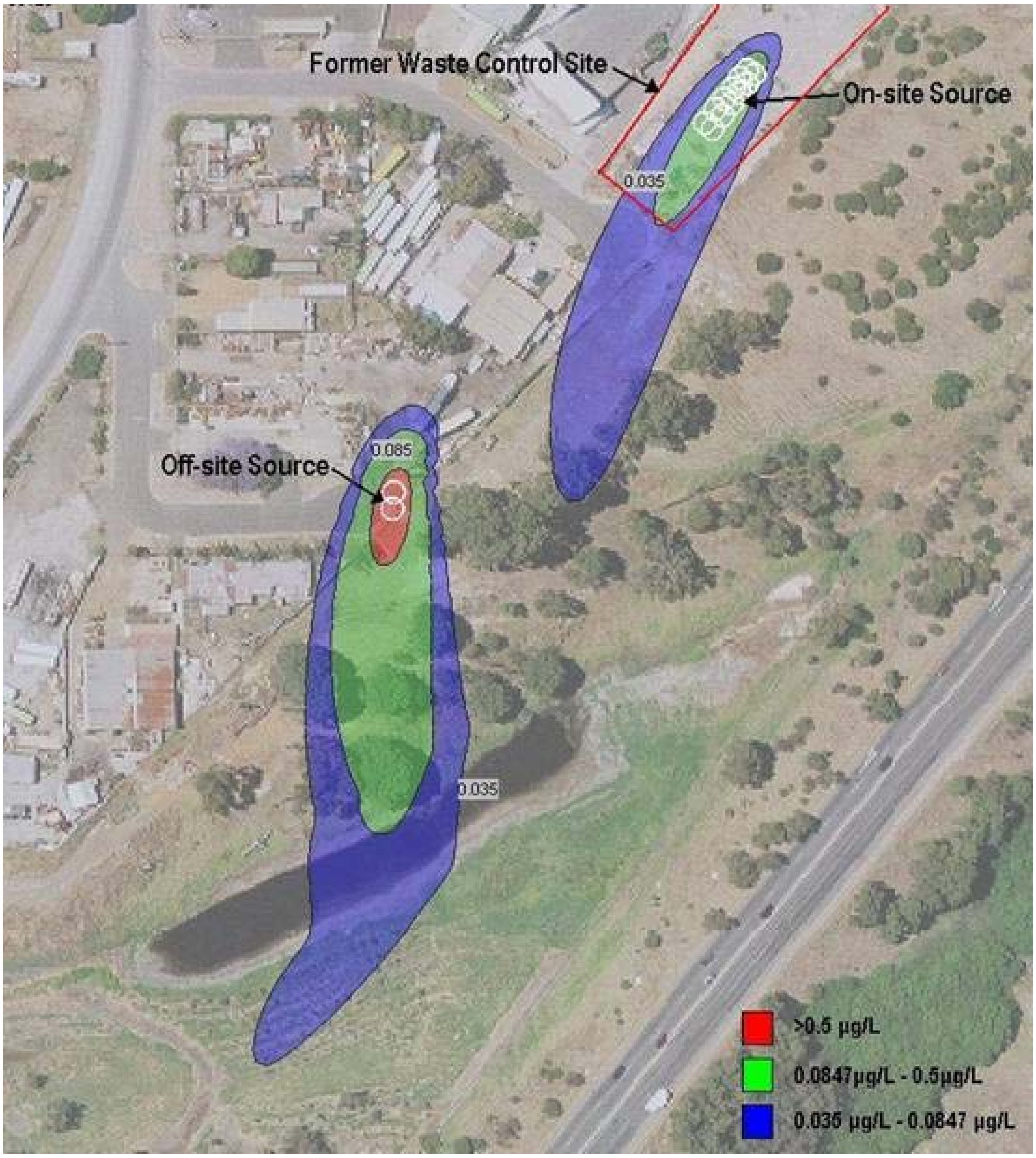

Figure A: Modelled Concentration of TCE in Groundwater by 2028 if No Remediation is Undertaken

Figure A presents the modelled distribution of TCE concentrations in groundwater by 2028, if no remedial actions are undertaken at the site. The simulation indicates that even if no remediation is undertaken, the groundwater plume is unlikely to reach the Helena River by 2028. Nonetheless, the front edge of the TCE plume will continue to advance towards the river and contaminants could eventually reach the Helena River

Figure B shows the simulated distribution of TCE concentrations in groundwater in 2015 after the remedial strategy is implemented. The PRB prevents any further advance of the groundwater plume towards the Helena River. Existing impacts already down gradient of the PRB dissipate within 3 years following PRB installation. The modelling simulations also indicate the remaining TCE impacts will attenuate below RBC by 2024 following removal of the sources in 2010.

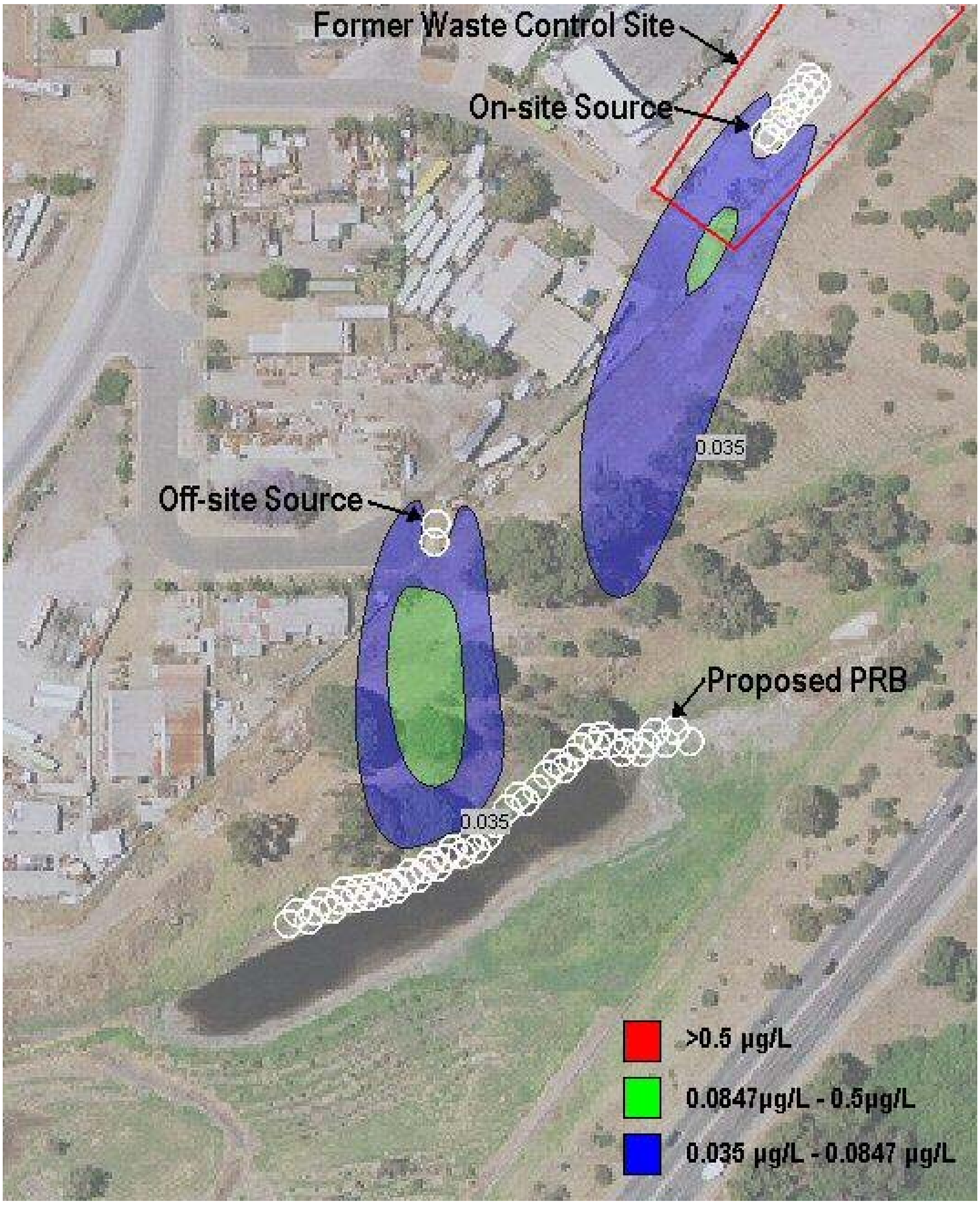

Figure B: TCE Concentrations in Groundwater by 2015 After Implementation of Remediation Strategy

The modelling demonstrates the overall remediation strategy of source removal and PRB installation would successfully address groundwater contamination. However, because contaminant concentrations in groundwater are not expected to decrease below RBC until 2024, ongoing monitoring and risk management controls would need to remain in place until RBC are achieved. Additionally, this result indicates that the PRB would need to be designed to last at least 15 years.

6.2 Downgradient Plume Management (PRB)

A permeable reactive barrier (PRB) has been proposed as the preferred option to arrest the groundwater plume hydraulically down gradient of the former Waste Control Site. The PRB would consist of a flow through wall or 'curtain' of reactive material that would remove contaminants as groundwater naturally flows through the wall.

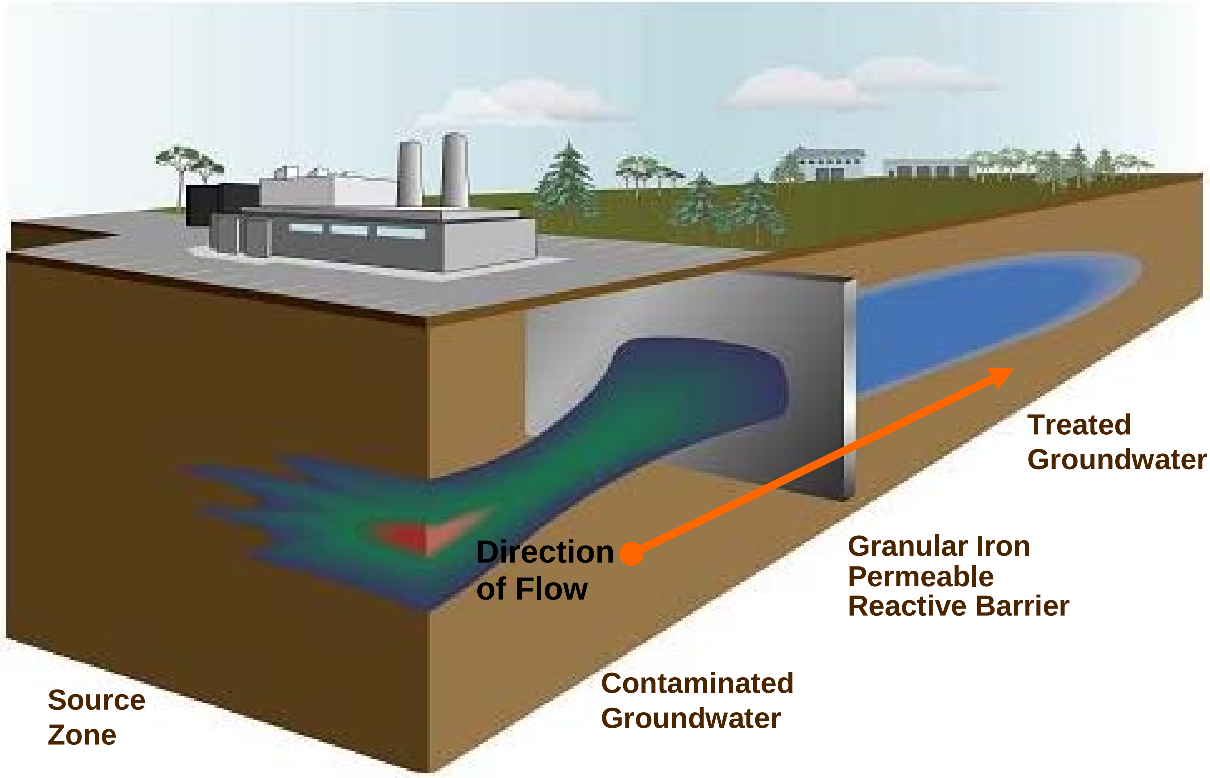

Figure C: Permeable Reactive Barrier (PRB) Concept, Diagram Courtesy of EnviroMetals

A PRB is a passive technology in that it requires no pumping or active removal of groundwater. However, it is also an active technology in that reactive material within the PRB does treat contaminants by creating geochemical conditions favourable for contaminant degradation.

The proposed PRB would be situated at the north end of the Damplands at the base of the escarpment (Figure 5). This is the preferred PRB location for several reasons:

1) Here the groundwater is shallow, within a metre below ground surface, making installation of a PRB technically feasible. In the upland areas closer to the former Waste Control Site, depth to groundwater typically exceeds 10 m, which make PRB installation impractical.

2) Groundwater contamination is naturally focused into a single relatively narrow plume in this area. Therefore the length of the PRB is manageable.

3) The location is up gradient of the Helena River, hence the PRB will prevent groundwater contamination from reaching the aquatic ecosystem.

4) The land is open, available and accessible for construction.

5) Construction in this location would minimise disruption to neighbouring residents and businesses.

Treatment will be accomplished through the use of granular “zero valent” iron (ZVI). The use of granular iron for treatment of halogenated (chlorinated and brominated) organic compounds such as TCE is now a well established technology. The first commercial application of a granular iron PRB was in California in 1994 and it continues to successfully treat groundwater to this day. For the Bellevue project, Golder has teamed up with EnviroMetals who hold the international patents and have successfully implemented it at over 150 sites worldwide (including the original California site). EnviroMetals has undertaken laboratory tests on groundwater from the site using two different commercially available granular iron products to demonstrate feasibility and determine treatment rates. The tests showed that the either granular iron product would be capable of treating the contaminated groundwater to below RBC within 4 to 9 hours of contact time.

Selection of a PRB approach was decided by consensus during a technical review panel workshop held 8 August, 2008. The panel comprised contaminated sites experts from CSIRO, Landcorp, DEC, CSIRO, ENSR Australia Pty Ltd (the appointed Contaminated Site Auditor) and Golder. Eight options in total were considered including groundwater pump and treat and chemical injection treatments. However, all were considered less favourable by important measures including their expected effectiveness, potential for community disruption and overall cost. Specific advantages of the PRB technology are:

- proven effectiveness at treating the types of contaminants found at the site;
- well suited to the groundwater and geologic conditions at the selected location;
- no harmful byproducts are generated as all intermediate compounds are also degraded within the PRB;
- minimal community disruption during construction (accessible public lands) and over the longer term as there are no maintenance requirements, no noise and virtually no surface infrastructure;
- there are no ongoing energy requirements or emissions unlike many active remedial technologies that require power generators and/or treatment of off-gases. This means a PRB is environmentally sustainable as it is virtually free of greenhouse gas emissions or release of other air pollutants; and
- there are no mechanical systems (e.g. pumps) hence there are no ongoing maintenance requirements (ongoing monitoring of performance however would be part of the remediation plan).

6.3 On-site Remediation Approach

6.3.1 Remedial Options Analysis

Selection and design of an on-site remediation approach is ongoing. To date, a review of potential options has been conducted and a shortlist of preferred technologies has been generated. The preferred technology *in situ* chemical oxidation (ISCO) has been evaluated in both the lab and field with mixed success.

A technical review panel workshop for on-site remediation options was held on 22 February 2008. The workshop identified fourteen potential remedial options, of which five were considered to have sufficient merit to warrant more detailed evaluation. Following the workshop, Golder prepared a detailed remedial options analysis report which evaluated the five “short-listed “options:

- *in situ* stabilisation;
- *in situ* treatment through chemical oxidation (ISCO);
- soil vapour extraction and/or air sparging;
- *in situ* thermal treatment (electrical resistance heating and/or steam injection); and
- excavation and off-site disposal (potential in combination with some of the preceding options).

Feedback from the BCCC Workshop No.4 indicated a preference for remedial options that minimised disruption to the community from traffic, dust, air emissions or noise. Additionally, guidance was taken from the WA Environmental Protection Authority (EPA) Bulletin 17 which provides a hierarchy for remediation approaches. In general, processes that address contaminants on-site are preferred over off-site solutions and process that treat or destroy contaminants are preferred over those that involve containment or disposal.

Each option was evaluated according to five main criteria: technical merit, effectiveness, time requirements, sustainability and cost. Potential impacts to the community were directly considered under the sustainability scoring as this included assessment of the potential for disruption, pollution and noise as well as economic and environmental considerations.

The evaluation identified and prioritised three main options for further evaluation. *In situ* (in ground) chemical oxidation (ISCO) was given the highest priority for further evaluation based on its probable success at dealing with contaminants and the ability to conduct the work with minimal disturbance or disruption to the community and local businesses. Soil vapour extraction was also considered a potentially feasible option that would be suitable for much of the site but would probably be limited in its ability to address contaminants in low permeability soils (clays). *In situ* stabilisation was given third priority; it provides perhaps the most robust solution in terms of its ability to address the entire site. However, since this approach safely contains contaminants rather than treats them, it was given a lower priority for further evaluation.

6.3.2 Testing of Preferred Remedial Option (ISCO)

Testing of the preferred remediation option (ISCO) was undertaken both in laboratory and field trials.

In September 2008, contaminated soil core samples were collected from the site and sent to Aquifer Solutions in Berkley California for laboratory scale testing of different chemical oxidant treatments. Test results were completed in January 2009.

The laboratory tests have identified suitable oxidant chemicals, the dosage and time requirements. Successful treatment of site contaminants was demonstrated using both gaseous oxidants (ozone) and liquid oxidants (potassium persulfate). Both oxidants were capable of reducing contaminant levels in soil below RBC levels within 7 to 8 days of application.

In February 2009, Golder performed injection tests at the site using both an inert gas mixture (air and helium) and clean water to assess the effectiveness of injection methods for delivery of oxidants. Field test results demonstrated that gaseous oxidants could be quickly delivered and distributed within the lower sand unit. However, for the middle sandy clay unit, which hosts a significant portion of the contaminant mass, the results demonstrated that neither gas nor liquid injections were feasible. The low permeability and high moisture content of the clayey soils did not allow significant flow rates for either the inert gases or the liquid injection.

The ISCO testing results have provided a mixed outcome. It is clear that oxidation treatment can successfully destroy site contaminants, however delivery of the oxidants cannot be achieved through injection. Other potential options for oxidant delivery including direct mixing either *in situ* or ex-situ, and/or controlled floods may be considered. At the same time the other “short-listed” options must be re-evaluated.

6.3.3 Detailed On-site Delineation of Soil Contaminants

The review process for on-site remedial options identified that a more detailed and up to date understanding of the distribution of contaminants in the soils beneath the site would be required in order to properly evaluate and implement specific remedial options. As outlined in Section 5.0, the combination of ROST and MIP surveys has provided detailed information on the location and distribution of the contaminants in the soil beneath the former Waste Control Site. This detailed information allows for a more accurate evaluation of different remediation technologies by providing a better basis for planning, design and costing.

6.4 Off-site Remediation Approach

An outcome of additional drilling in March 2008 was the identification of a previously suspected but unidentified off-site source area. New monitoring wells within the Southwest Industrial Area and Damplands provided improved definition of the off-site TCE plume and indicated there was a source area near the south end of Lot 2 and/or Stanley Street cul-de-sac.

A series of soil vapour investigations has since been completed in the area of interest to locate the source zone of the off-site TCE plume. An area of elevated TCE soil vapours was identified in the grassed area (verge) off the northeast corner of the Stanley St cul-de-sac (Figure 2). The presence of TCE as the only contaminant in the soil vapour was consistent with the underlying groundwater plume. Additional work is ongoing in March 2009 to identify the extents of this source area and the volume of soil that may require remediation.

Remediation of the off-site source zone is a key component of the previously described remediation strategy. The identification and delineation of the off-site source will provide the necessary information on which to plan a remediation approach. It is quite likely that the remediation approach used for the on-site source area may also be applicable to the off-site source area given the similar (but not identical) nature of the soil contamination. Concurrent programs to address both on-site and off-site sources would allow economies of scale to be realised and reduce implementation times.

The recent soil vapour investigations around the off-site source area also included an assessment for vapour intrusion into buildings. The results demonstrated that areas of high TCE vapour in soil do not extend beneath any existing buildings. Indoor air quality testing results did not identify TCE or other facility-related chemicals above detectable levels. These results confirm the results of the risk assessment which indicated that there is no current risk to building occupants. This finding in turn supports the proposed use of PRB in the Damplands as an appropriate approach to groundwater remediation.

6.5 Monitoring and Ongoing Risk Management

Worldwide experience over the least 20 years has shown that remediation of soil and groundwater (in particular) is a long term process. The remediation concept outlined for the Bellevue site is based on the premise that there are no current risks to human health or the environment and that any such risks can be reasonably managed into the future, while remediation is occurring. Ongoing monitoring of site conditions, groundwater, surface water, air and soil will be required to ensure that risks continued to be managed into the future.

Additionally, remediation plans will include a requirement for performance monitoring of any implemented solutions to demonstrate that they are performing to design and meeting the objectives. Performance monitoring results will allow adjustments to be made or contingency actions to be implemented as necessary to prevent unacceptable risks to human health or the environment.

7.0 CLOSURE

This report is intended as a briefing document for the BCCC meeting on April 1, 2009. It is intended to summarise and explain the ongoing technical work in and around the former Waste Control Site. For more complete information, the reader is referred to the various technical reports and documents on file with Department of Environment and Conservation (DEC). Questions should be directed to Janet MacMillan at the DEC (6467-5353) or any of the undersigned at 9213-7600

Report Signature Page

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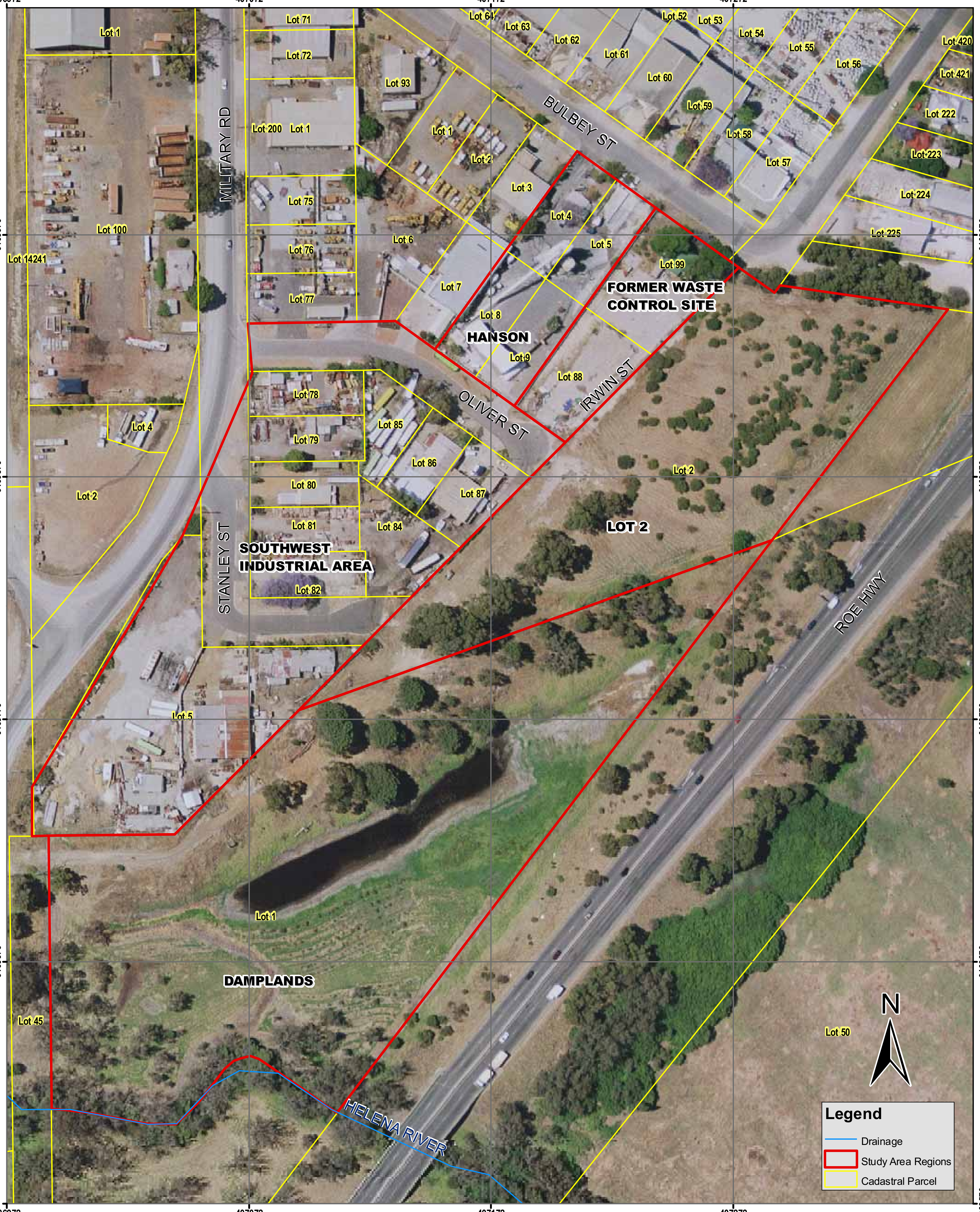

0 10 20 40 60 80 100 m

A3 SCALE 1:1,500

Datum GDA94, Projection MGA94, Zone 50

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Former Waste Control Site, Bellevue

SITE PLAN AND STUDY AREA REGIONS

PROJECT 087643011 049 R REV0
DATE JUNE 2008
DRAWN JOR
APPROVED MLB

Figure 1

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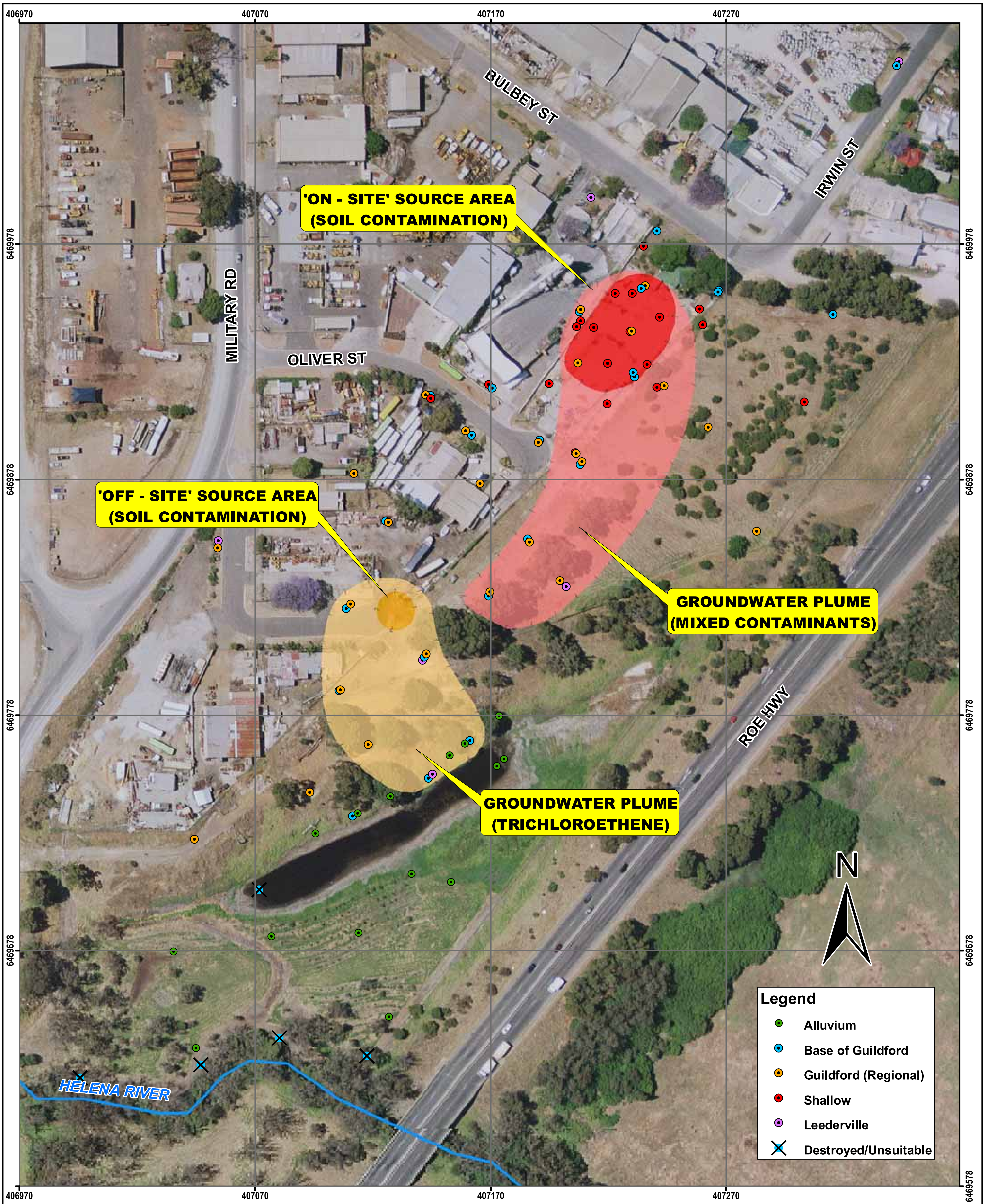

Datum GDA94, Projection MGA94, Zone 50

0 10 20 40 60 80 m

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Conceptualised Soil and Groundwater Contamination 2008 - 2009

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Figure 2

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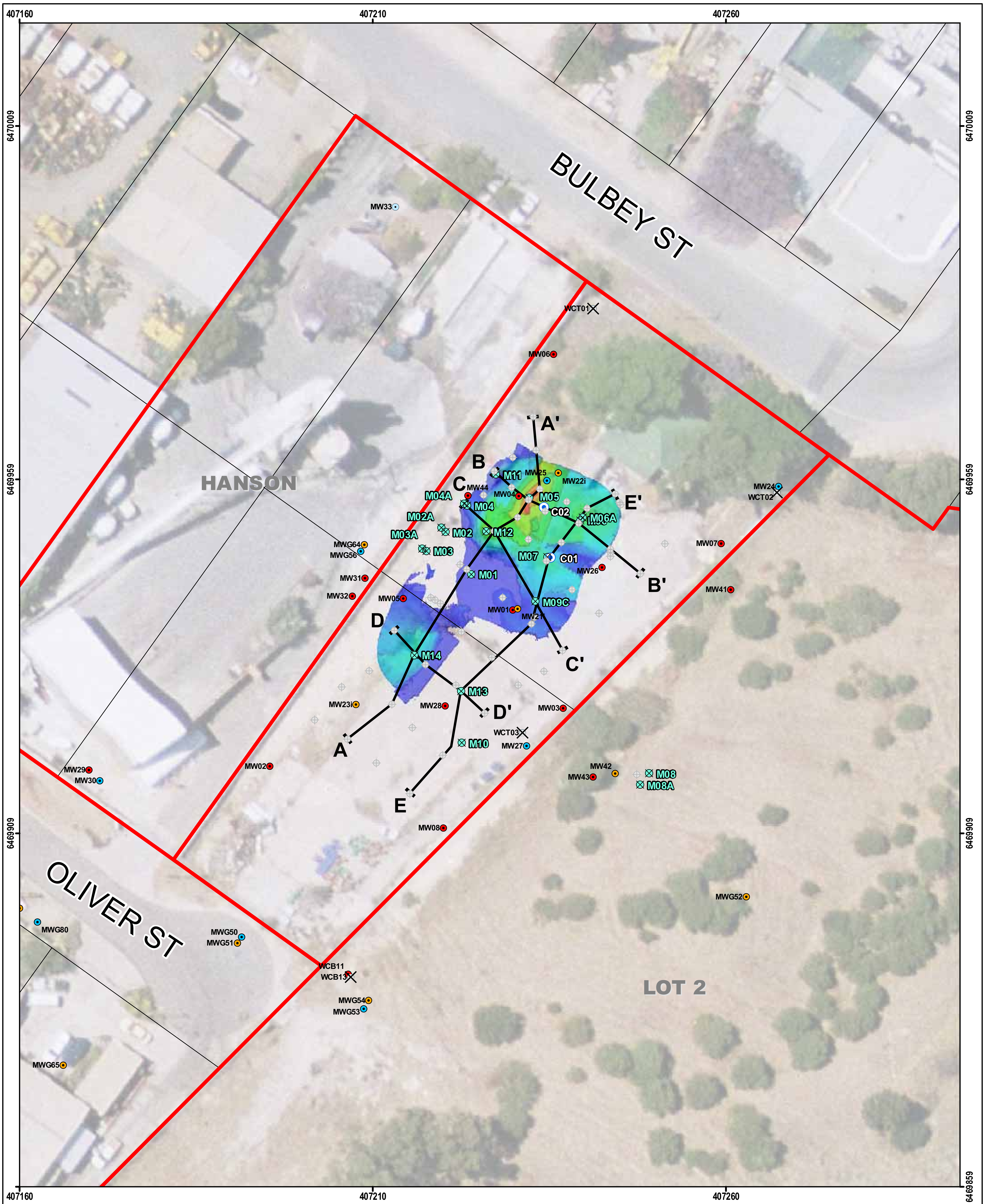

0 3.75 7.5 15 22.5 30 m

A3 SCALE 1:500

Datum GDA94, Projection MGA94, Zone 50

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Wells

AQUIFER TYPE

- Base of Guildford
- Guildford (Regional)
- Shallow
- Decomissioned or Destroyed

TEST LOCATION

- MIPS
- ROST
- Core Hole
- Cross-section Location
- Site Boundaries
- Cadastre

Relative Degree of Impact (MIP Response)

Low Impact 0.1 0.2 0.5 1 2 3 5 High Impact

Former Waste Control Site, Bellevue

AREA OF SOIL IMPACT DEFINED BY MEMBRANE INTERFACE PROBE (MIP)

CLIENT	Department of Environment and Conservation
PROJECT	087643011 049 R REV0
DATE	MAR 2009
DRAWN	JOR
APPROVED	SR

Figure 3

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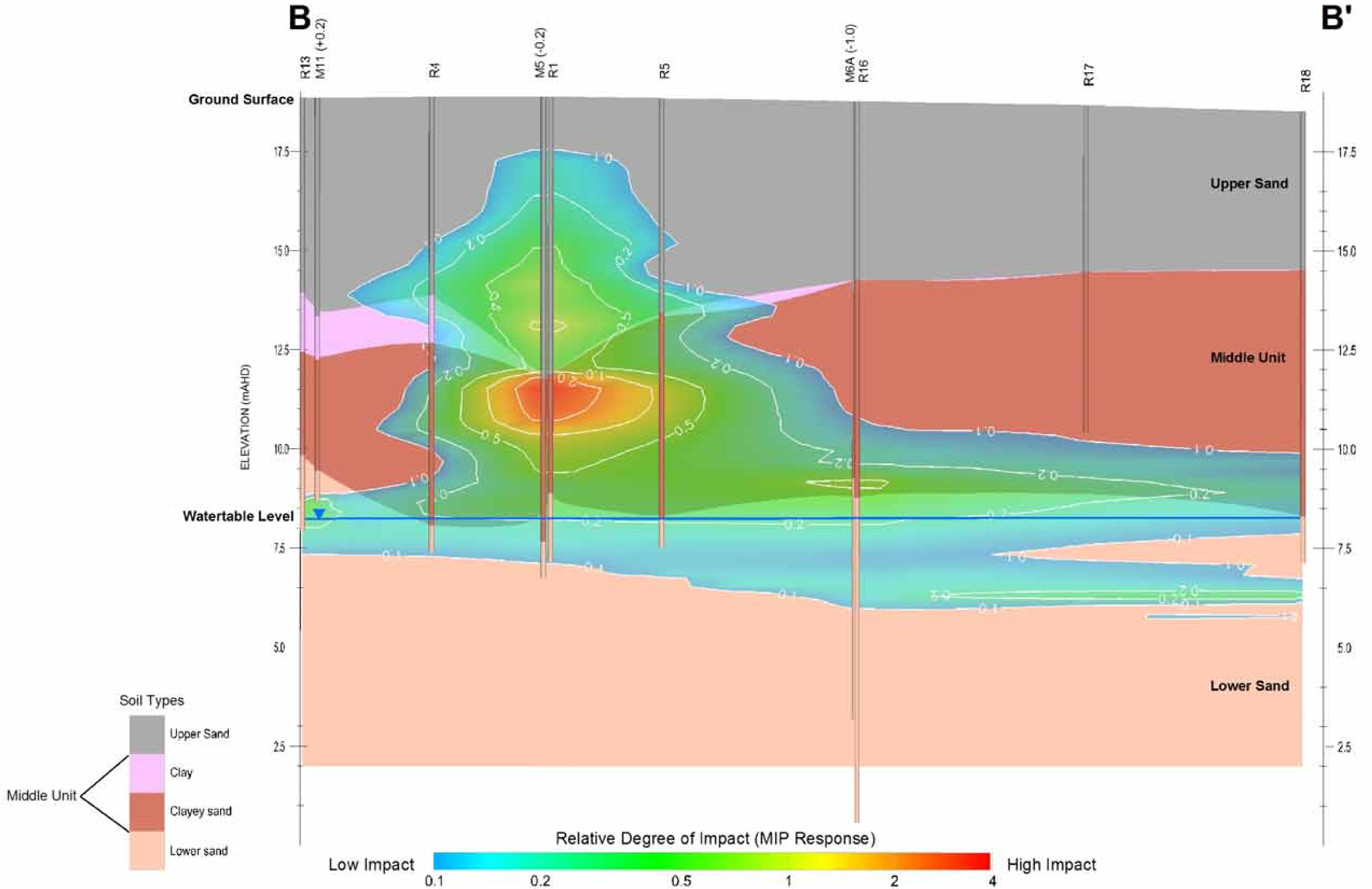

Inferred Ground Water Level (May 2008)

Note:
Test Locations M05, M11 and M6A are not located on the section line
(+1.0) indicates distance of Test location to the section line

CLIENT: Department of Environment and Conservation			PROJECT: Former Waste Control Site, Bellevue	
DRAWN: SR	DATE: JAN 2009		TITLE: SOIL STRATIGRAPHY AND AREAS OF IMPACT DEFINED BY MEMBRANE INTERFACE PROBE (MIP)	
CHECKED: MB	DATE: JAN 2009			
SCALE: H NTS	V 1:100	A3	PROJECT No: 087643011 049 R REV0	FIGURE No: 4

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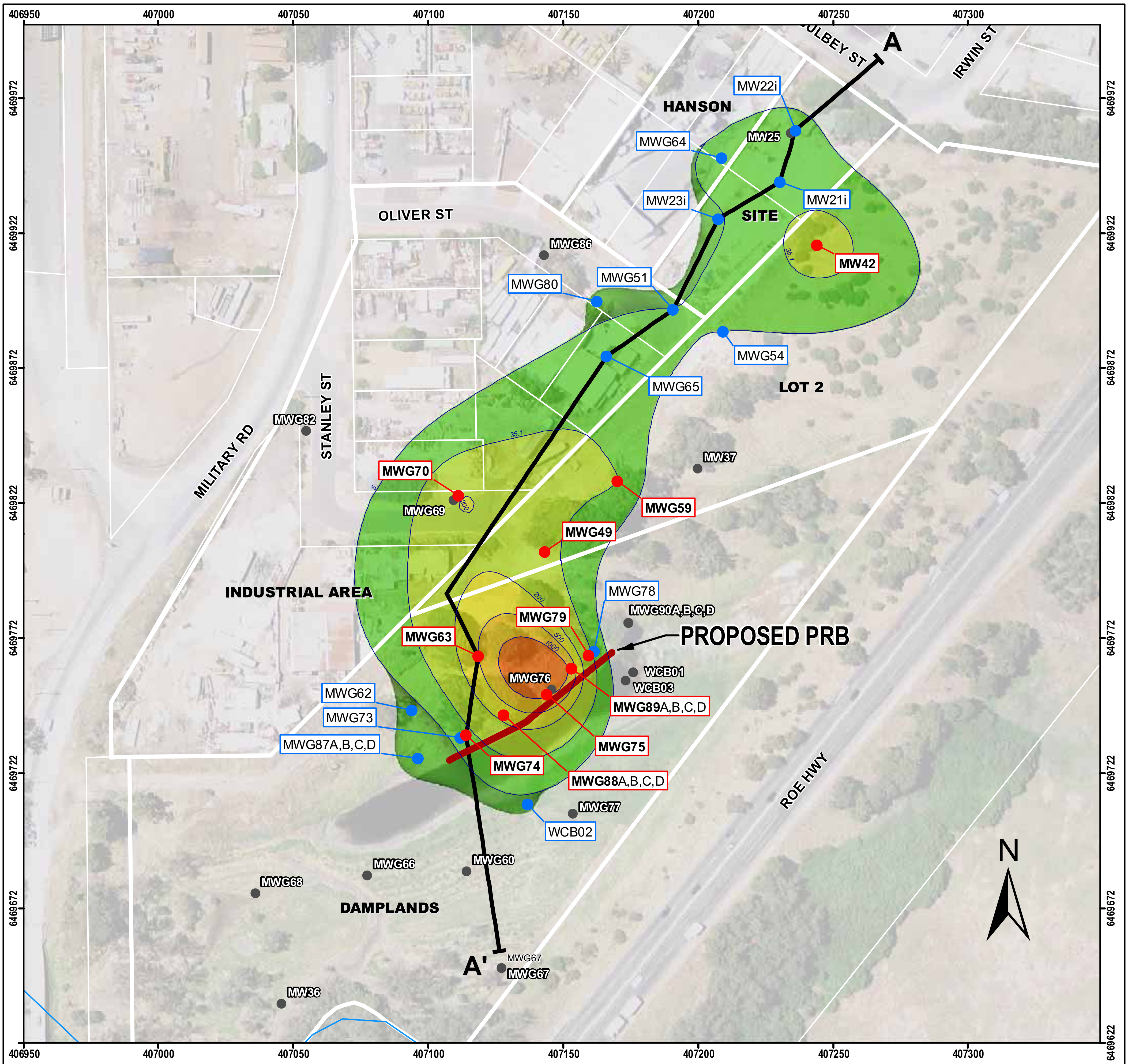

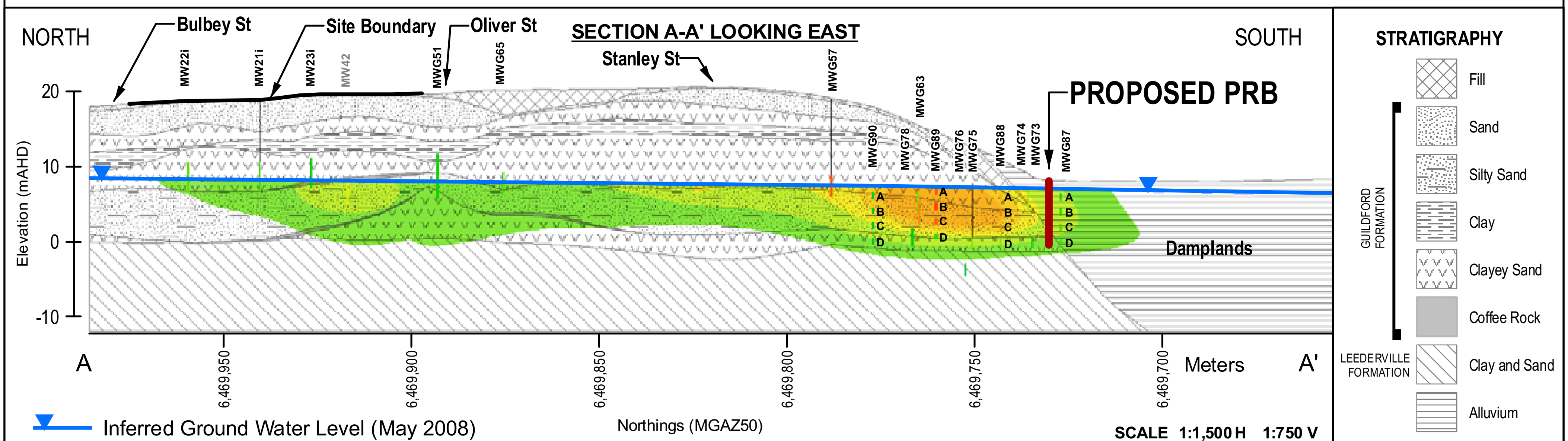

0 15 30 60 90 m

A3 SCALE 1:1,500

Datum GDA94, Projection MGA94, Zone 50

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TCE Groundwater Concentration (μg/L)

5 35.1 200 500 1000

TCE Concentrations - 2008 and 2009 (μg/L)

- > 35.1(Exceeds Risk-based Criteria)
- < 35.1(Below Risk-based Criteria)
- nd (not detected)
- TCE Concentration contour(μg/L)

- Cross Section Location
- Drainage
- Site Boundaries
- Cadastre

NOTE:
This is one possible interpretation based on three dimensional interpolation using EVS. Multiple interpretations are possible

Former Waste Control Site, Bellevue

LOCATION OF PROPOSED PRB IN DAMPLANDS

PROJECT	087643011 049 R REV0
DATE	Mar 2009
DRAWN	SR
APPROVED	MB

Figure 5

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At Golder Associates we strive to be the most respected global group of companies specialising in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organisational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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