May 2009

FORMER WASTE CONTROL SITE, BELLEVUE WA

Stakeholder Discussion Document for Workshop No. 5

Submitted to:
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REPORT

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1.0 INTRODUCTION

Waste Control Pty Ltd historically operated a chemical/oil recycling and treatment facility at 1 Bulbey St. /88 Oliver St, in Bellevue, WA, until a fire destroyed the facility in February 2001. The Department of Environment and Conservation (DEC) has engaged Golder Associates Pty Ltd (Golder) to evaluate remedial options and develop risk management plans (including remediation) for the former Waste Control site.

A draft groundwater remediation plan has been developed to address contaminated groundwater down gradient of the former Waste Control Site using a permeable reactive barrier (PRB) system. The draft groundwater remediation plan includes a conceptual design for the PRB system, a preferred construction method and data gaps to be addressed prior to final design and works specification. Following auditor review and approval, a final design and construction plan will be developed, suitable to support a construction tender document.

2.0 OBJECTIVES OF THE FIFTH STAKEHOLDER WORKSHOP

This report is an explanatory document for stakeholders in preparation for Workshop No.5, scheduled for June 17 2009. The objectives of Workshop No.5 are to:

- present the principles of the off-site groundwater remediation plan; and
- to provide an opportunity for stakeholders to discuss any potential issues or concerns arising from the proposed remedial strategy.

It is not necessary for stakeholders to have a detailed knowledge and understanding of the draft groundwater remediation plan prior to the workshop, however, a copy of the draft plan has been provided in case participants may wish to refer to it for further details.

A construction method has been recommended for the PRB system and a preliminary construction plan has been included here to inform discussions at the workshop. The main focus of this workshop will be a discussion of the construction approach (see Appendix A), potential impacts on the community and the environment and steps that can be taken to minimise these concerns.

The off-site groundwater remediation plan has been designed considering the interests and concerns raised by stakeholders at previous workshops. These include:

- Minimising environmental impacts (air emissions, soil disturbance, traffic impacts) and security issues;
- Effective clean up of the site;
- Risk minimised during treatment;
- Stakeholder input and representation; and
- Beneficial use of the site during the remediation process.

3.0 BACKGROUND

Two plumes of groundwater contamination have been identified down gradient of the former Waste Control site (Figure 1). The diagram shows the projected direction of plume movement based on groundwater flow. The first plume, comprising mixed hydrocarbons and halogenated organics, originates from the former Waste Control site and extends approximately 80 m down gradient of the site boundary in a southwest direction. The second plume, comprising only trichloroethene (TCE), originates near the east end of Stanley St and extends approximately 100 m south-southwest to the base of the escarpment at the edge of the Helena River floodplain (“the Damplands”). The two plumes overlap (and mix) near the base of the escarpment.

Potential human health and ecological risks related to the groundwater contaminants were evaluated in a site specific risk assessment (discussed in Workshop No. 3) and risk based criteria (RBC) were developed for the contaminants of concern. These RBC form the basis of the remedial objectives for the groundwater clean-up. The PRB system is being installed to protect the environment (the Helena River aquatic environment) and human health such as the health of adults working in the Damplands and the health of adults and children who may visit the area for recreational activities such as fishing or walking.

Figure 1 illustrates the approximate source area locations and the extent of the associated groundwater plumes where contaminant concentrations exceed the relevant risk based criteria (RBC) based on monitoring data from 2008 and 2009. Low concentrations of mixed hydrocarbon and halogenated organics from the first plume are present in the mixing zone; however their concentrations are 10 to 100 times below the relevant RBC.

4.0 REMEDIATION STRATEGY

The remediation strategy consists of three main elements:

1) Cut-off and in ground ("*in situ*") treatment of the groundwater plume using a PRB;

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.

The groundwater remediation plan addresses the first element of this strategy. Evaluation of source removal options is at an advanced stage and will be covered in a separate remediation plan.

Computer modelling has been used to assess how the combination of these three elements will address soil and groundwater contamination. The results indicated that groundwater contamination is likely to persist for approximately 15 years following source removal. Hence, the PRB system will need to last for at least 15 years.

Further discussion of the modelling can be found in the Stakeholder Update Meeting Briefing Document (1 April 2009) available on the DEC website at: www.dec.wa.gov.au/bellevue

5.0 REMEDIAL OPTIONS SELECTION

A PRB is a subsurface wall or curtain of reactive material that removes contaminants as groundwater flows through the wall (Figure A). The reactive material is incorporated into a permeable matrix that allows groundwater to naturally flow through the PRB under its own gradients. However, because contaminants are treated by the reactive material, it is also a barrier to contaminant migration. A PRB treats contaminants by creating favourable conditions within the barrier for contaminant degradation to take place. A PRB requires no pumping or removal of groundwater.

In this particular application reactive material placed in the PRB will be a mixture of zero valent iron (ZVI) and coarse sand. ZVI has been shown to effectively degrade TCE and other halogenated organic compounds through a process known as reductive dechlorination.

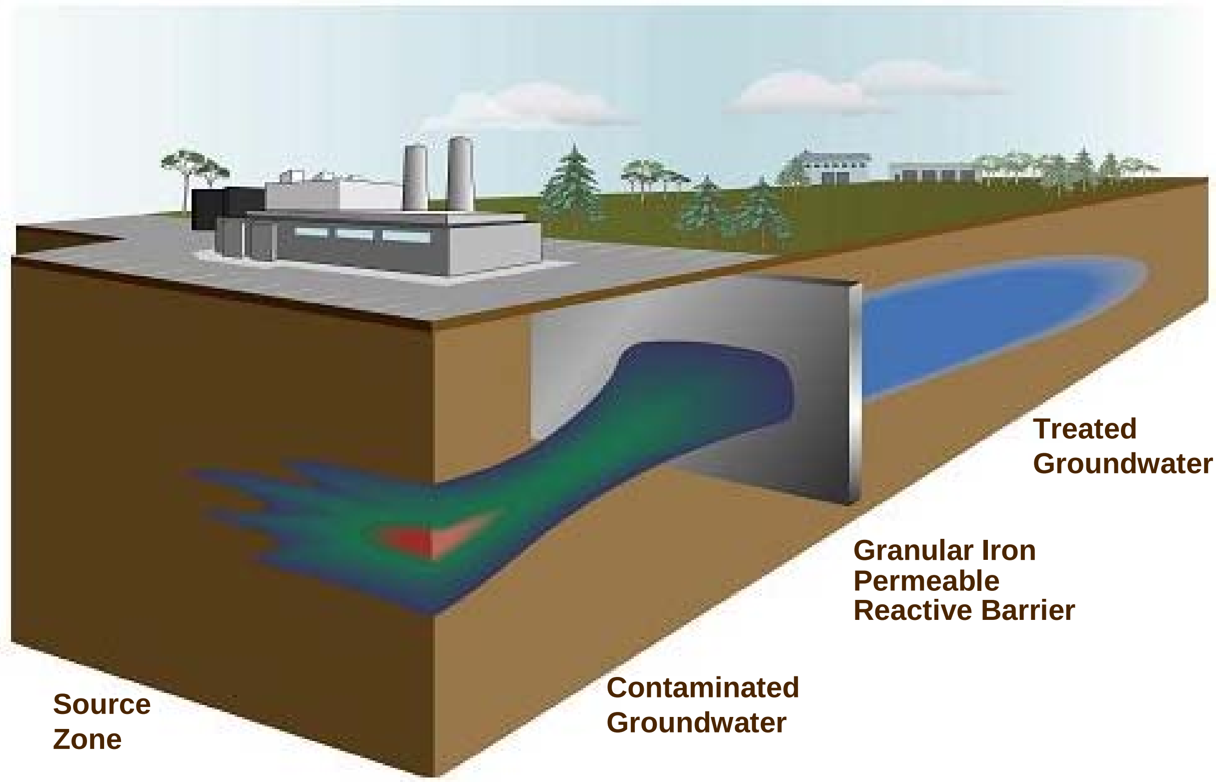

Figure A: Permeable Reactive Barrier (PRB) Concept, courtesy of ETI.

Specific advantages of PRB technology, specifically a zero valent iron or ZVI PRB, for the Bellevue site are:

- proven effectiveness at treating the types of contaminants found at the site;
- well suited to the site groundwater and geologic conditions at the selected location;
- no harmful by-products are produced as all intermediate compounds are degraded within the PRB;
- minimal community disruption during construction (accessible public lands) and over the longer term as there are minimal maintenance requirements, no noise and virtually no surface infrastructure;
- there are no ongoing energy requirements or emissions; and
- minimal maintenance requirements as there are no mechanical components (e.g. pumps). .

The proposed PRB would be situated at the north end of the Damplands at the base of the escarpment (Figure 2). This location is suitable for a PRB for several reasons:

1. The groundwater is shallow, within a metre of the surface, making installation of a PRB feasible. In the upland areas closer to the site, depth to groundwater typically exceeds 10 m making PRB installation impractical.
2. Groundwater contamination is naturally focussed into a single relatively narrow plume in this area.
3. The proposed location is up gradient of the Helena River floodplain; hence the PRB will prevent groundwater contamination from reaching the river.

4. The land is undeveloped and the location is accessible for construction.
5. Construction in this location would minimise disruption to neighbouring businesses and local residents.
6. It is likely that the PRB can be “keyed” into an underlying low permeability unit to prevent possible bypass flow beneath the barrier.

6.0 PRB DESIGN BACKGROUND

A number of evaluation studies have been undertaken to inform the PRB design and detailed site selection. These included:

- Additional site characterisation to understand the distribution of contaminants, groundwater chemistry, geologic conditions and hydraulic conductivity at the proposed PRB site;
- Laboratory “bench scale” testing of commercially available zero valent iron products to evaluate treatment rates and material requirements;
- Review of case studies to understand factors affecting failure and success; and
- Modelling to evaluate hydraulic requirements of the PRB to achieve the required groundwater capture.

A bench-scale treatability study was completed by EnviroMetals Technologies Inc. (ETI) of Waterloo Canada to support the design of the ZVI PRB. The bench-scale testing indicated that:

- ZVI was able to completely degrade TCE without breakthrough of any intermediate breakdown products and that
- nitrate levels, typical of the site groundwater, could severely reduce the longevity of the ZVI PRB via precipitation of mineral coatings (“passivation”) on the ZVI material.

An assessment of the required thickness of ZVI required to treat the groundwater over 15 years was carried out. This indicated that up to 98% of the required ZVI barrier thickness would be required to treat the nitrate. A reduction in nitrate concentrations (denitrification) entering the PRB would greatly reduce the required volume of ZVI and therefore costs.

Denitrification of groundwater using organic carbon mixtures is an established groundwater remediation technique and PRBs containing various organic carbon sources have been demonstrated as an effective denitrification method in a number of documented case studies including sites in Western Australia.

All the literature reviewed highlighted that hydraulic performance was the most significant issue affecting the success or otherwise of ZVI PRBs, that is part of the plume went around or under, rather than through the PRB. Design features discussed in the following section will be incorporated into the proposed Bellevue PRB system to minimise this risk.

7.0 PRB DESIGN

The PRB system will consist of two permeable reactive barriers (PRBs) separated by approximately 1 metre (Figure 3). A deintrification PRB will be constructed immediately up gradient of the primary ZVI PRB.

The PRB system will be located near the base of the Damplands escarpment and will prevent contaminants of concern from entering the adjacent floodplain and the Helena River.

Major design elements are as follows:

- The proposed length of both PRBs is 65 m. This includes an extra 10 m safety factor (Figure 4) to account for changes in groundwater flow direction.
- The ZVI PRB should be constructed with a minimum equivalent thickness of 0.1 m of ZVI, within a sand and iron mixture.

- The denitrification PRB would be constructed with a minimum equivalent thickness of 0.3 m of carbon.
- The hydraulic conductivity of the porous media in both PRBs would be a minimum of five times that of the natural aquifer to ensure funnelling of groundwater flow into the PRB.
- Both PRBs would extend vertically downward to a low permeability unit to minimise the potential for underflow of contaminated groundwater.

Specific testing on locally available carbon source material has been recommended prior to proceeding to a final design for the denitrification PRB. The most commonly used organic carbon source in PRBs is sawdust; this includes several applications by WaterCorp in Western Australia.

Further information can be found in the remediation plan.

8.0 CONCEPTUAL CONSTRUCTION PLAN

8.1 Methods Evaluated

A number of potential construction techniques were reviewed in conjunction with ETI who shared their experience of numerous PRB projects worldwide. Golder has also met with local contractors to discuss possible construction techniques, available equipment and challenges specific to the Damplands site.

Construction in the Damplands will be particularly challenging due to the high water table and the saturated silty sand soils. These soils have low strength and excavation walls will be prone to collapse. Any construction technique must include some means of wall stabilisation to ensure the PRB media can be evenly and consistently distributed within the subsurface and reach the design depth of approximately 9 m below ground surface.

Four potentially suitable techniques for PRB construction were identified and their advantages and disadvantages evaluated.

Despite being the most expensive method, the caisson secant wall technique was identified as the preferred construction method since it is by far the most robust and provides the most controllable means of establishing a continuous permeable reactive barrier with a consistent composition. This method also provides the least risk of unforeseen circumstances arising and, therefore, provides the greatest chance of achieving the project objectives. At least four PRBs have been constructed worldwide using the caisson secant method including a PRB in Hedenstad, Denmark that was 170 m long and 11 m deep.

Figure B: Photos showing PRB construction with secant caisson and filling of caisson with ZVI/sand mixture- courtesy of ETI.

8.2 Construction Plan

The conceptual construction plan (Appendix A) is based upon the caisson construction method. It outlines the major construction stages and an approximate schedule. Potential areas of impact on the community and the environment have been identified and potential mitigation methods proposed.

All construction would need to occur during the summer to early autumn (January to March) when the Damplands are dry and the pond is absent. During this time the site is reasonably accessible to the heavy equipment required for construction. It is anticipated that some site preparation work will be needed to address soft ground conditions.

Figure C: Photo of conditions in Damplands in mid summer, near proposed PRB location.

9.0 MONITORING AND VALIDATION

Monitoring is required to demonstrate that the PRB system is performing as expected and that remediation targets are being met. The proposed monitoring network is shown on Figure 3. The PRB performance monitoring network will comprise wells up gradient, down gradient and within the PRBs.

The monitoring network will be gauged on a quarterly basis for the first 12 months following installation. The monitoring frequency will then be reviewed to reflect the degree of variability observed and the stability of the groundwater chemistry encountered. At each monitoring location measurements and samples collected will include depth to groundwater, general water quality indicators (pH, redox, conductivity etc), nitrate, and volatile organic compounds (VOCs).

The PRB monitoring program will be undertaken in addition to, and will compliment, the existing annual monitoring program conducted for the wider study area around the former Waste Control site.

10.0 CLOSURE

This document provides a summary of the concepts and technical details outlined in the Off-Site Groundwater Remediation Plan and Permeable Reactive Barrier Design document prepared in May 2009 by Golder for DEC.

The groundwater remediation plan will be submitted to the Contaminated Sites Auditor once feedback from Stakeholder Workshop No. 5 (scheduled for 17 June 2009) has been received and incorporated. The final design and construction plan will be developed following auditor approval.

Report Signature Page

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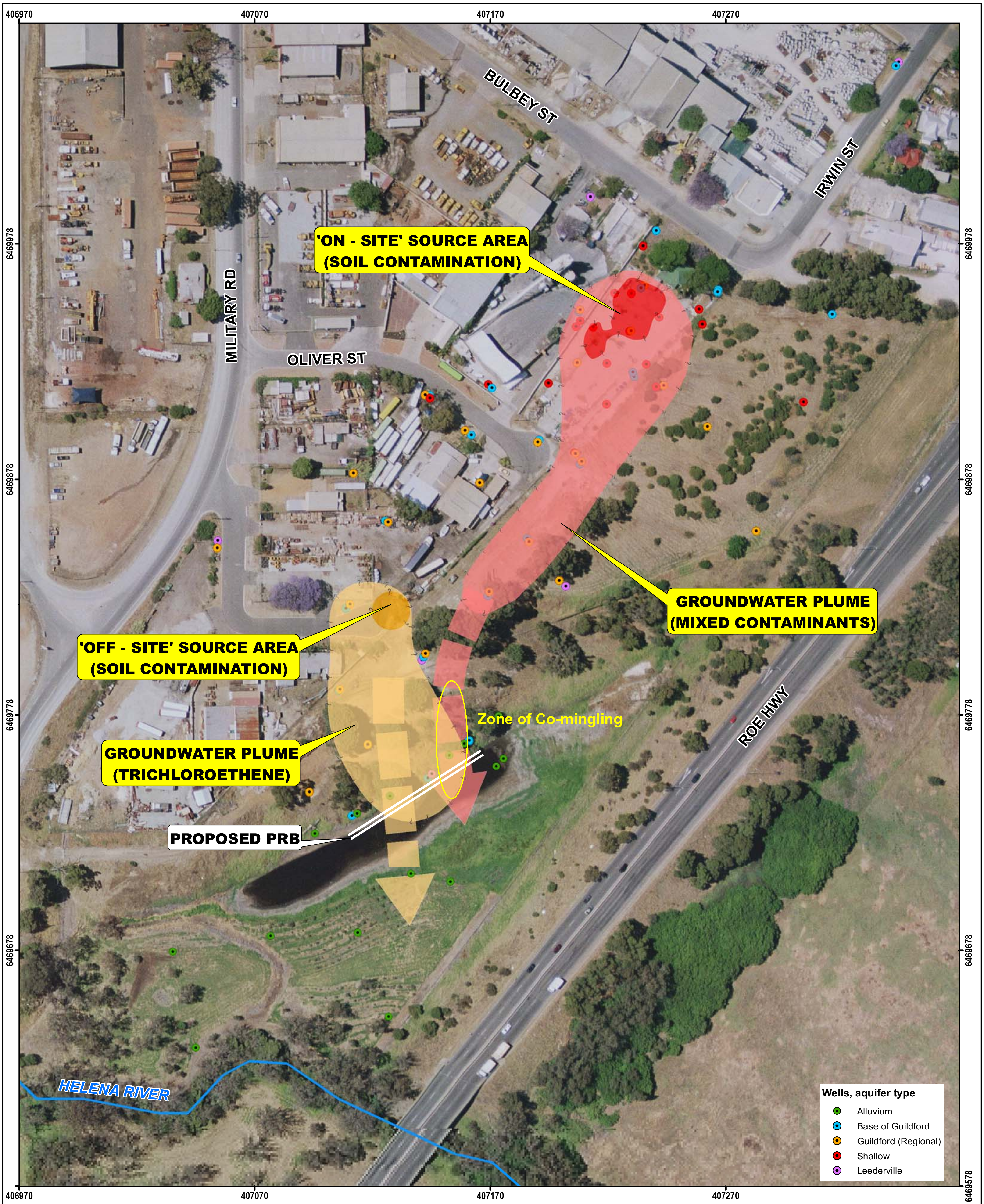

Datum GDA94, Projection MGA94, Zone 50

0 10 20 40 60 80 m

A3 SCALE 1:1,500

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Soil Contamination

- On-site plume migration path
- Off-site plume migration path
- Mixed Contaminant Groundwater Plume
- TCE Groundwater Plume

Former Waste Control Site, Bellevue

Conceptualised Soil and Groundwater Contamination 2008 - 2009

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DATE	MAY 2009
DRAWN	SR
APPROVED	MB

Figure 1

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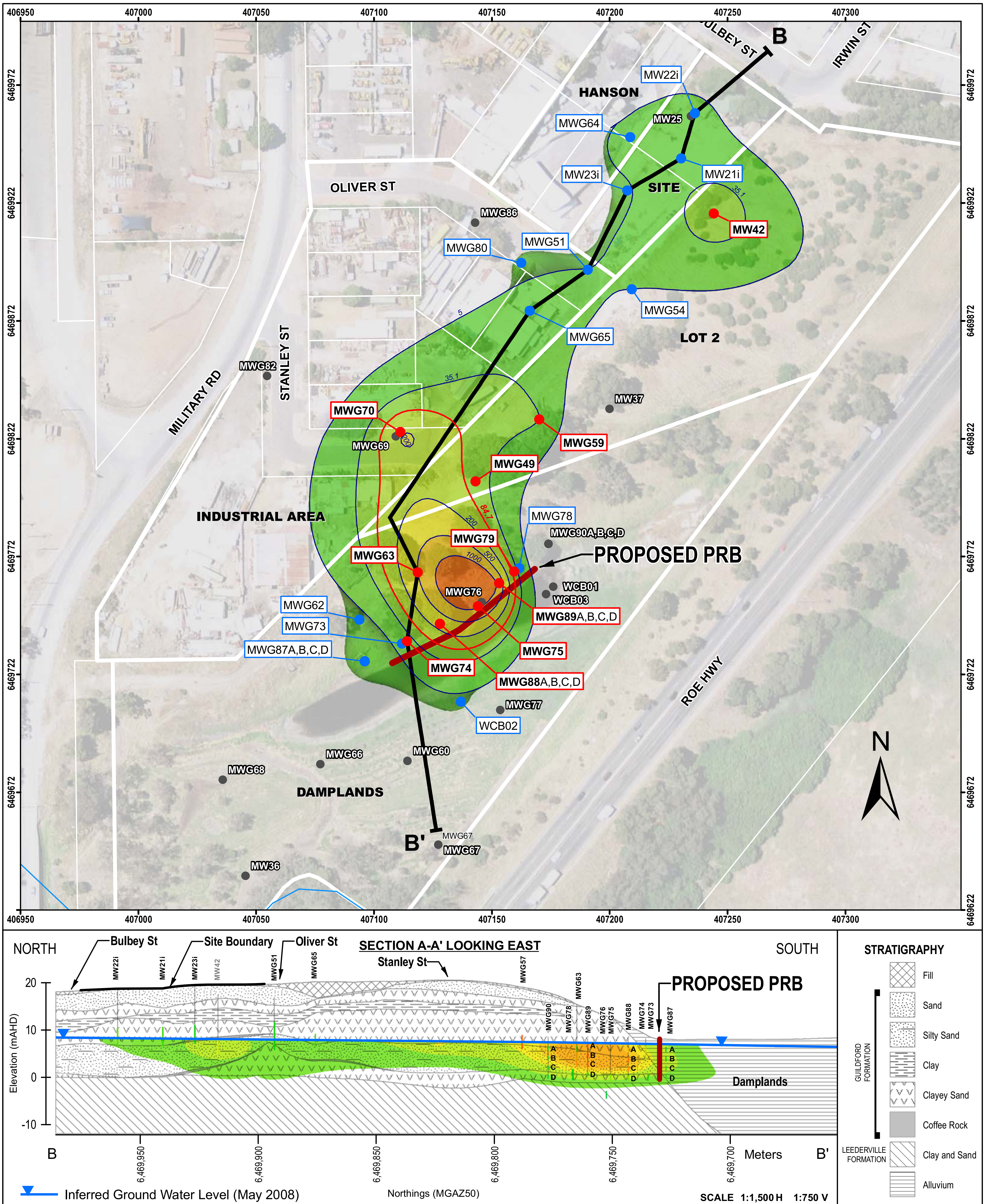

0 15 30 60 90 m

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Datum GDA94, Projection MGA94, Zone 50

TCE Groundwater Concentration (μg/L)

5 35.1 84.7 200 500 1000

(TCE RBC Damplands)

Former Waste Control Site, Bellevue

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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 (84.7μg/L)
- TCE Concentration contour(μg/L)
- Section Location
- Drainage
- Site Boundaries
- Cadastre

PROPOSED PRB LOCATION

Figure 2

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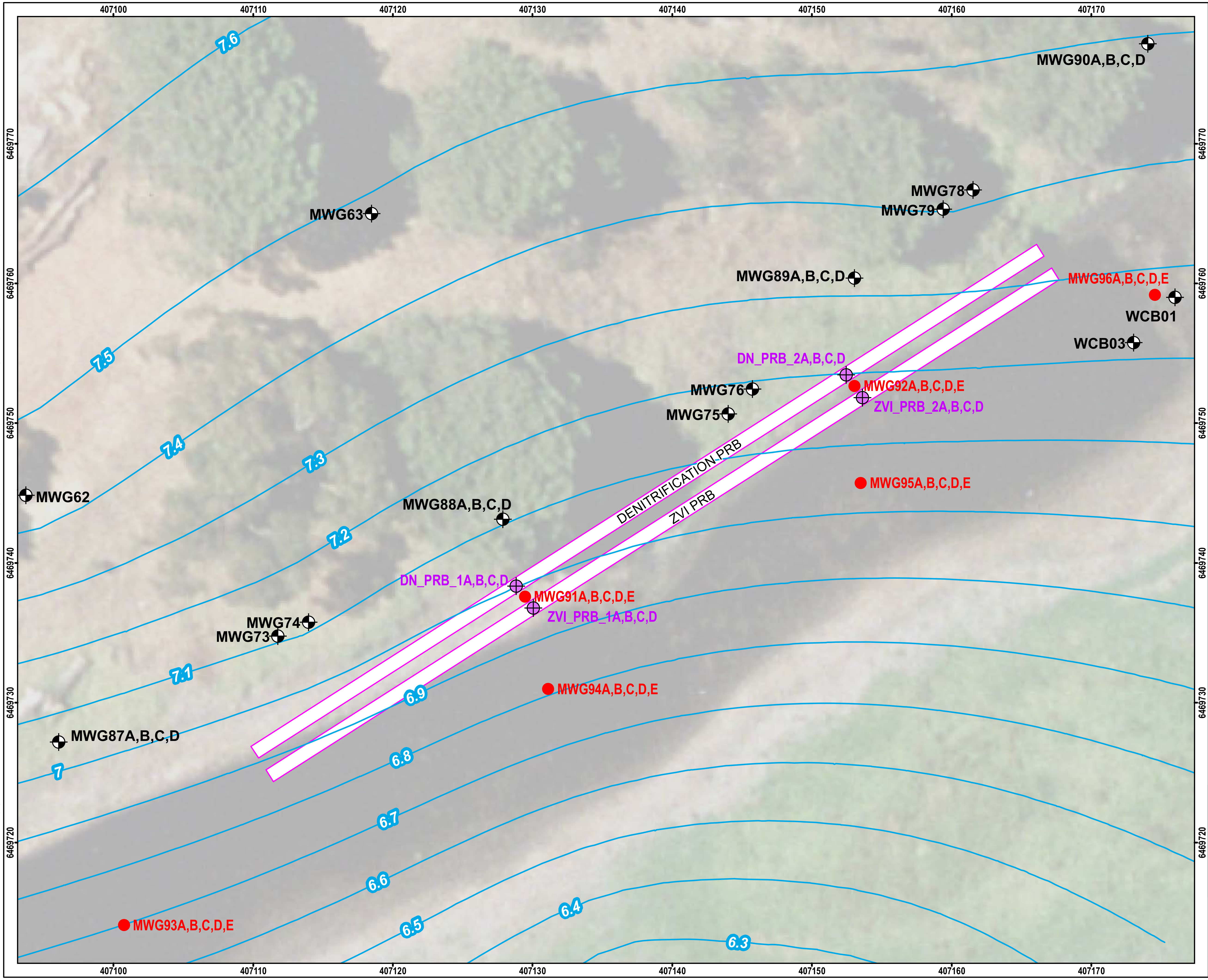
NOTE:
This is one possible interpretation based on three dimensional interpolation using EVS. Multiple interpretations are possible



Legend

- Proposed multilevel well location
- Proposed multilevel well within PRB
- Existing well location
- March 2009 groundwater contour (mAHD)

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Aerial photography source: Landgate SLIP (2006)

N W E S

0 3 6 9 12

Meters

A3 SCALE 1:250

Datum GDA94, Projection MGA94, Zone 50

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Former Waste Control Site, Bellevue

PROPOSED PRB SYSTEM AND MONITORING NETWORK

FIGURE 3

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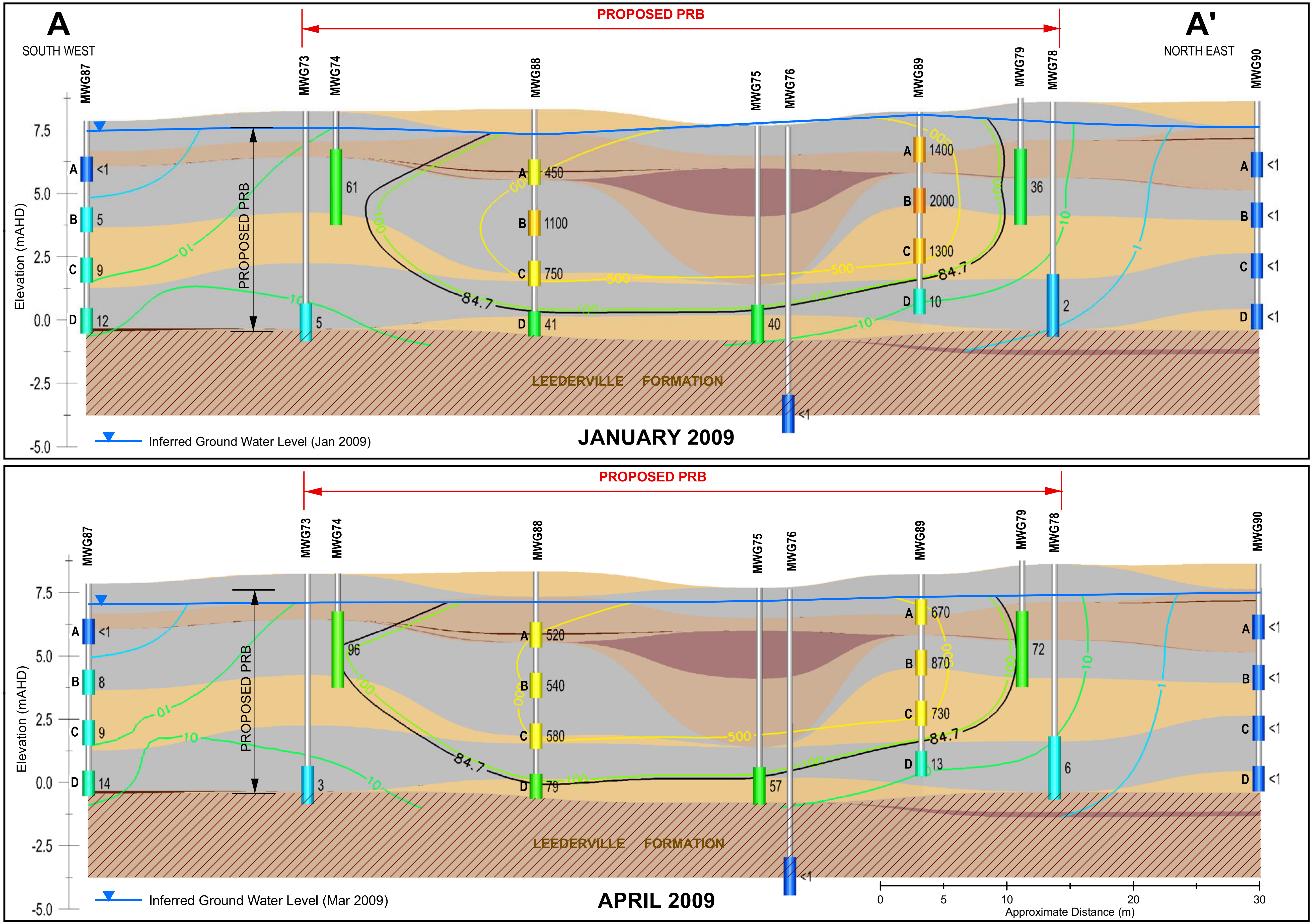

STRATIGRAPHY

- Sand
- Silty Sand
- Clayey Sand
- Coffee Rock
- Clay
- Leederville Formation

TCE Concentration (µg/L) — TCE RBC (Damplands)

0.1 | 1 | 10 | 84.7 | 100 | 1000

CLIENT: Department of Environment and Conservation		PROJECT: Former Waste Control Site, Bellevue	
DRAWN: SR	DATE: MAY 2009	TITLE: STRATIGRAPHY AND TCE CONCENTRATION – SECTION A-A'	
CHECKED: MB	DATE: MAY 2009		
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APPENDIX A

Conceptual PRB Construction Plan

CONCEPTUAL PRB CONSTRUCTION PLAN USING CAISSON SECANT WALL APPROACH

The caisson secant wall was identified as the preferred method for constructing the PRBs. Exact details of how the PRBs will be constructed are subject to the discretion of the contractor undertaking the work and will depend on the equipment available to the contractor and its specific work preferences. Nevertheless, a general approach to the work is provided for discussion and planning purposes. While minor variation to this conceptual construction plan will occur to suit the contractor's equipment and preferences, the overall approach is unlikely to deviate significantly from the activities described below. The project would be executed in three main stages:

1) Mobilisation and site establishment;

2) PRB Construction; and

3) Demobilisation and reinstatement.

Mobilisation and Site Establishment

The first step in constructing the PRBs will be establishing site facilities such as offices, washing and eating facilities, erecting a fence around the work area, site preparation and preparing a work platform for the caisson rig and dewatering system and a water treatment system if required to treat groundwater.

The office and associated facilities will delivered to site ready for use as some form of demountable. A generator will be required to provide power. Given the short duration of the project and location within the Perth Metro area, mobile telephones and wireless broadband will be used for communication.

Site preparation will consist of stripping and stockpiling topsoil from the footprint of the working platform, beneath site offices, and the area of the water treatment system (if required). The stockpiled material will be used to reinstate the site upon completion of the work. Staging areas will be established on areas of relatively higher ground, where water table is likely to be deeper.

In addition to stripping topsoil, there are a number of shrubs that will need to be removed (permit requirements will be investigated) because they are either along the alignment of the proposed PRBs, or because they restrict access to the construction area. A stockpile storage area would similarly be prepared for on-site storage of the PRB materials (sand, granular ZVI and coarse sand).

It is envisaged the caisson rig would work from the dry base of the Damplands Pond. A low (approximately 300 mm high) working platform will be constructed from imported crushed rock to provide a firm, uniform working surface from which the caisson rig will operate. The platform would occupy a swath approximately 4 to 5 m wide along the edge of the pond closest to the PRB site.

A water management plan will be developed for the construction project. Although works are planned for the dry summer months, the possibility of a storm rainfall event still exists. The Damplands Pond functions as a retention pond for stormwater drainage collected over large area of the Bellevue community. Therefore, in addition to the raised platform, a perimeter bund will be established to ensure that stormwater entering the Damplands Pond is separated from the working platform. This will allow the Damplands Pond to continue to function, albeit with a slightly reduced capacity. All works would be stopped in the event of a storm for environmental protection, worker safety and to ensure PRB construction quality.

Arrangements for dewatering will be included to allow the saturated excavated soil to drain prior to transporting off-site. The method of excavating will result in the soil being placed alongside the alignment of the PRB, so the dewatering arrangements will consist of a shallow bunded area or ditch graded to encourage water to drain to one point, and will be lined with a synthetic geo-membrane to prevent water drained from the soil from percolating back into the ground.

A fence will be erected around the construction area to prevent unauthorised personnel from accidentally coming into contact with construction hazards and for security.

The most likely access to the PRB construction site would occur from Military Road. The current access point off Military may be too steep for some of the heavy equipment, or laden trucks and may require construction of a more gradual access. Local signage and traffic control would be established to direct equipment coming and going from the site. Generally, the contractor is responsible for any improvements necessary because the extent of improvements is very dependent upon the specific equipment the contractor proposes to use.

All of these activities will be completed in approximately 1 week from commencement. The only heavy equipment necessary for the Mobilisation and Site Establishment works would be a tracked excavator. Trucks would be required to deliver the construction base material.

Once the site is established, the PRB material would be delivered to the site and stockpiled within reach of the construction area. It is expected that all materials (sand, ZVI and sawdust) would be delivered in bulk bags. As a result there would be no pouring of materials and dust generation would be minimal. Delivery of the required PRB materials would occur over two days, requiring an estimated 60 truck loads.

PRB Construction

The rig used to install the caisson will be a tracked machine similar to the one in the photograph below. The rig will arrive on site in two parts and assembled on site. The contractor may choose to have a second rig on site for caisson extraction. This could be another tracked rig or a wheeled mobile crane capable of pulling the steel tube from the ground.

Figure D: Example of Caisson Drill Rig in Operation in Western Australia.

The exact arrangements for installation and extraction of the steel tube will depend on the contractor's specific work method and this will dictate the duration of PRB construction. Using separate rigs for installation and extraction has the advantage of reducing the time necessary to complete the walls, and should allow each PRB to be completed within approximately three weeks (i.e. total duration of approximately six weeks).

The caisson installation process involves driving a steel tube into the ground to the desired depth. In this particular case, the steel tube will be driven until it intersects a low permeability unit expected at a depth of approximately 9 m. Driving the tube into this unit should substantially reduce the volume of water entering and minimise dewatering requirements.

Soil within the steel tube will be removed using an auger or core barrel grab arrangement and placed in the dewatering cell to allow it to drain. Soil quality will be tested prior to the construction works to determine the most appropriate disposition. If contaminant concentrations are below laboratory detection limits and acid sulfate is not a concern then the soils may be re-used on site for example to establish pads for PRB monitoring wells. This would cut down on truck traffic from the site and re-use of the soil would be beneficial. However, if required soils will be amended on-site and transported off-site for appropriate disposal. Groundwater in the caisson will be pumped out and the PRB mix poured into the empty caisson. Once the empty caisson has been completely filled, the steel tube will be pulled out and the process repeated.

Several options are available for delivering the ZVI –sand and sawdust sand mixtures in the respective PRBs. The simplest and most cost effective would involve mixing during the pouring process at a carefully metered rate according to the desired ratio of the mix. This would be achieved through gate valves using two hoppers or a dual chambered hopper. In this case all materials would be delivered to the site during the site establishment phase of the project.

An alternative option would involve mixing the material off-site. However, this would require additional material handling and may require ongoing deliveries in cement mixing trucks to ensure the mixture remains uniform.

Figure E: Photos showing placement of materials into a PRB using on-site mixing of ZVI (left) and pre-mixed (right).

Depending on the diameter of steel tube used, between five and ten caissons will be completed each day. It is anticipated, based on available equipment in the Perth region, that a caisson diameter of 900 mm would be used. Holes would be aligned and overlapping to achieve a minimum PRB thickness of 500 mm.

Soil and Water Handling

Prior to commencing work the potential for acid sulfate soils will be evaluated. According to the DEC Acid Sulfate Soil Risk map the site is rated as having a low to moderate potential for acid sulfate soils. If acid sulfate soil or potential acid sulfate soil conditions are identified the construction plan will be modified accordingly to address soil and groundwater neutralisation and disposal requirements.

Excavated soil and groundwater drained from the soil or pumped out from the caissons will be treated as contaminated material, with appropriate measures in place to contain the material and protect workers and the environment. As the rig excavates each caisson, it will turn and place the excavated material adjacent to the line of the PRB, in the purpose built lined and bunded dewatering area. The process will be repeated until the desired depth of excavation is achieved. Excavated soil and groundwater will be sampled and tested to select the most appropriate option for re-use or disposal.

If water treatment is required, the water will be stored in a tank and treated using activated carbon filters to remove TCE, and the treated water either disposed of to sanitary sewer or to the adjacent Damplands. Appropriate approvals will be obtained for discharge of treated water.

Demobilisation and Reinstatement

Once construction of the PRBs and associated monitoring bores has been completed, the contractor will demobilise (remove equipment and offices), and reinstate the work area. Reinstatement will involve removal of the work platform, grading the site back to the original contours, and placing and seeding the stripped topsoil. Access for construction traffic created by the contractor between adjacent public roads and the PRB construction work area will be similarly reinstated to the original ground levels.

Immediately after reinstatement, the only sign at ground level of the work having occurred will be disturbed ground and the covers for the monitoring wells. Once the vegetation is re-established, the monitoring well covers should be the only sign of the work having occurred. Examples of completed PRB sites with reinstated ground conditions are provided below.

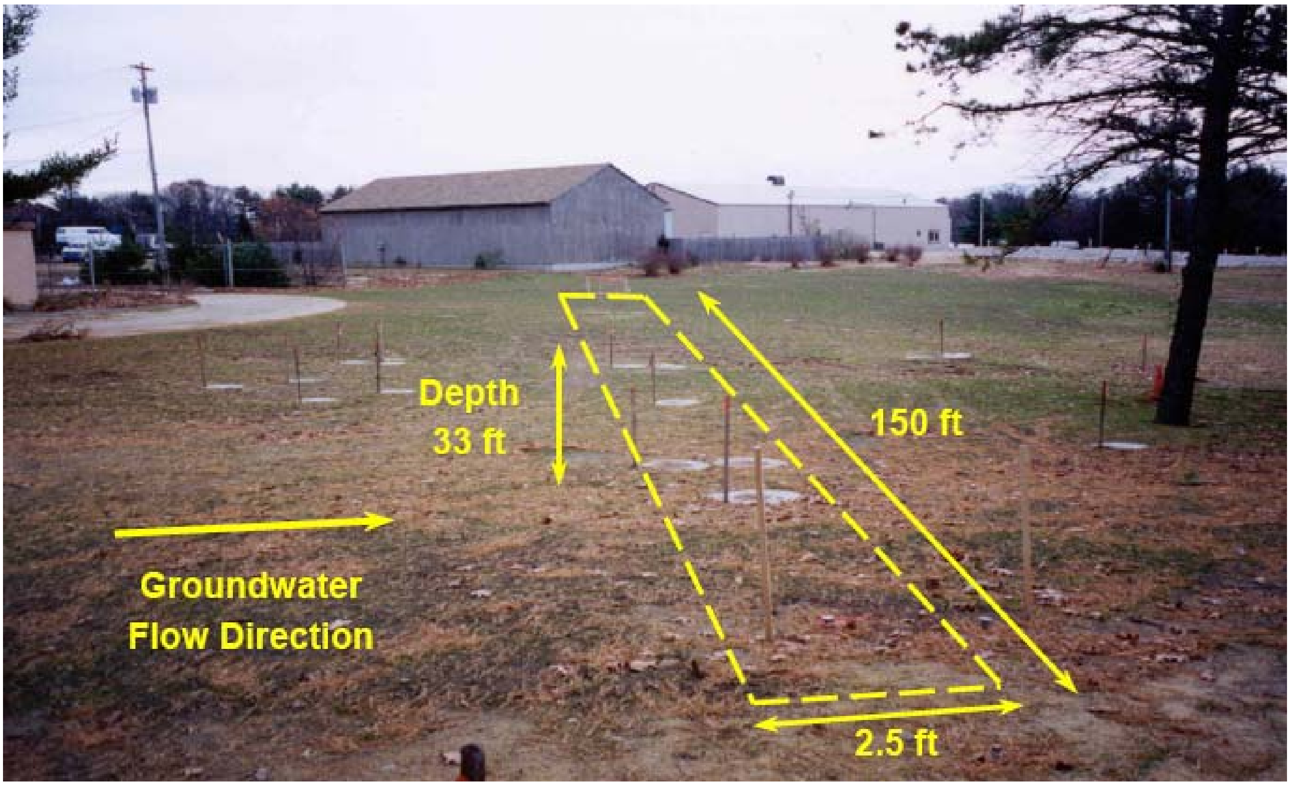

Figure F: Photo showing site of PRB at Pease Air Force Base, USA after surface reinstatement. Note monitoring wells under ground level gatic covers.

Figure G: Photos showing reinstated ground conditions approximately one year after PRB installation in Cambridge, Canada. Blue line shows approximate location of PRB. Note monitoring point in the foreground of left photo.

TIMING AND CONSTRUCTION SCHEDULE

Construction will occur over the summer and early autumn (January to March) when the Damplands are generally dry and ground conditions are relatively firm. Completing work during summer/early autumn will minimise environmental impacts in terms of vehicle tracks, scarring and impact on vegetation and management of runoff. In practical terms, it is unlikely that the work could be completed effectively at any other times of the year as soft and potentially saturated ground conditions would make the site inaccessible for heavy equipment without significant engineering.

Construction of the PRBs will take approximately eight weeks from initial mobilisation to final reinstatement. The first week will be taken up with mobilisation and establishing the site facilities. Once mobilisation and site establishment is completed, the actual caisson construction work should take approximately six weeks. Following completion of PRBs, a final week will be required for installation of monitoring bores, demobilisation, and final reinstatement. Altogether the PRB construction will require approximately 8 weeks from start to finish.

As is typical of construction work, the working hours are expected to be 7:00 AM to 5:00 PM, Monday to Friday. The contractor may wish to work on Saturday, though this is often a shorter working day (say, 7:00 AM to 3:00 PM). When work is not taking place (during the night and on weekends), the site will be fully fenced and locked to prevent unauthorised access.

EFFECTS OF CONSTRUCTION ON ADJACENT PROPERTY AND THE ENVIRONMENT

No significant impacts are anticipated at adjacent properties in terms of noise, air pollution, dust or vibration.

The excavator, caisson rig, and extraction rig are all heavy diesel equipment, but will be equipped with silencers to reduce noise emissions. The level of noise produced will be similar to that produced by a large road-going truck and trailer units. The diesel generator for power will be enclosed and appropriately silenced to reduce noise to acceptable levels.

The installation of the steel tubes will not require the use of heavy percussion type piling equipment, so the high noise levels associated with driving steel piles will not occur. A vibrating head may be required during steel tube installation and will almost certainly be required during steel tube extraction. The noise associated with this technique is more like a muffled rumbling than the piercing metallic ringing that occurs when a percussion piling hammer strikes a steel pile.

Outside of working hours, there should be no noise except possibly an electric pump from the water treatment system (similar noise level to that of a residential pool pump) and the diesel generator necessary to supply the power.

Given that the soil will be saturated when excavated from the caisson, there is no reason to suspect dust will be a problem. Nor is dust from construction traffic associated with the work likely to generate nuisance levels of dust as the maximum number of trucks visiting the site is likely to be less than 10 on a daily basis. Some dust may be generated during filling of the caissons with the PRB materials. If required a light water spray or mist may be required to suppress dust generated during filling of the caisson. However this needs to be carefully planned and executed so that materials are able to flow freely into the caisson.

Effects on the environment are likely to be short term in nature. Once reinstated, the site will look as it did prior to the work occurring. During construction, run-off from excavated soil will be collected to avoid discharging contaminated groundwater to the local environment. Storm water management plans will be implemented to divert surface water from rainfall events, and to limit any off-site discharge of silt or other deleterious material from the site itself.

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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