Groundwater Monitoring Plan – Peka Peka to Ōtaki Project

FCCL-EV-MPN-008

Final C – September 2017

NZ TRANSPORT AGENCY WAKA KOTAHI
Peka Peka to Ōtaki Expressway
New Zealand Government

Contents

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Revision	Action	Name	Position	Date	Signature
	Approved by:	Richard Percy	Project Leader	18/9/17	
	On behalf of GWRC:				

1 PROJECT INTRODUCTION

1.1 Project Scope

This Groundwater Management Plan (GMP) has been developed for the State Highway 1 Peka Peka to Ōtaki Expressway. Works will occur over a 200 week period commencing 25 November 2016. The works will entail 12km, 4-lane Expressway, consisting of:

- 1.4Mm3 Earthworks
- 9km local road
- 10 No. Bridges, including 330m, Ōtaki River Crossing
- Ōtaki Intersection - split
- East-West connections – Ōtaki, Te Horo
- Grade separation – Taylors Road
- 1.6km railway realignment

The works will follow a general programme of enabling works and site establishment, followed by rail realignment and bridge construction and then road construction.

The key Project parameters are given in Table 1.

Table 1: Contract details

Item	Details
Project Name	Peka Peka to Ōtaki Expressway
Nature of Project	12 Kms of new expressway and 10 new bridges
State Highway Classification	SH 1
Commencement	25 November 2016
Project End Date	07 January 2021
Project Manager	Craig Pitchford (NZTA)
Principals Advisor - Engineer	Muir Coup
Principals Advisor – Engineer's Rep	Ron McFadyen (Opus)
Contractor	Fletcher Construction
Contract Manager	Andrew Goldie (Fletcher)
Councils with Jurisdiction	Greater Wellington Regional Council (GWRC) Kāpiti Coast District Council (KCDC)

The potential for expressway construction to have an impact on groundwater was identified in the resource consent applications and also addressed in the Board of Inquiry conditions. The main impact is thought to be on groundwater users on the south bank of the Ōtaki River from a lowering of groundwater due to the excavation to create the southern approach to the new Ōtaki River Bridge. The lowering of groundwater on the south bank of the Ōtaki River has already occurred with the construction of the approaches to the current road and rail bridges and any effects are anticipated to be localised.

1.2 Groundwater Management Plan Scope

The scope of this Groundwater Management Plan is to outline how groundwater will be managed to ensure that there are:

- No significant changes to wetland hydrological conditions, and
- No permanent changes to the ability of existing bore owners to abstract water from their existing water supply bores.

This plan will define the means of measuring these outcomes through monitoring and reporting in accordance with the relevant consent conditions.

There are two aspects covered in the consents relevant to groundwater: groundwater monitoring and groundwater take and use.

Construction activities that may potentially impact groundwater are:

- Damming of groundwater.
- Earthworks construction in the vicinity of the deeper cuts located south of Ōtaki River and north of Ōtaki resulting in permanent draw down of groundwater.
- Subsoil drain constructions.
- Temporary dewatering during construction including undercut beneath bridge and other structures and undercut of the peats and other unsuitable materials during progressive excavation and backfilling.
- Bridge pile construction at the Waitohu Stream and Ōtaki River.
- Geotechnical investigation boreholes.
- Geotechnical instrumentation installation.

At this stage, the consent relating to take and use (NSP13/01.0046) is not intended to be utilised. Water for construction will be sourced from stored surface water, commercial providers or alternative consented sources. However, consent conditions GT.4-7 do have some wider implications for the management of the Project.

1.3 Referenced Consent Conditions

Table 2 below lists all resource consents relevant to groundwater management.

Table 2: Referenced Consent Conditions

Consent Number	Consent Type	Activity
NSP13/01.005	Land use consent – s9(2)	Bore construction.
NSP13/01.007	Water permit – s14(2)(a)	Damming and diversion of groundwater.
NSP13/01.008	Discharge permit –s15 (1)(a)	Discharge of sediment-laden (including chemically-treated) water to water.
NSP13/01.0010	Land use consent –s9(2)	Construction of boreholes (bores for bridge piles where they intercept groundwater).
NSP13/01.019	Land use consent –s9(2)	Construction of boreholes (bores for bridge piles where they intercept groundwater).
NSP13/01.0045	Land use consent s9(2)	Construction of boreholes (including bores for the purpose of abstracting groundwater).
NSP13/01.0046	Water permit –s14(2)(a)	The take and use of groundwater for bore testing, dust suppression and construction purposes.
NSP13/01.0047	Land use consent –s9(2)	Bore construction.
NSP13/01.0050	Land use consent –s14(2)(a)	To dam groundwater and surface water via a new wetland.
NSP13/01.0051	Water permit –s14(2)(a)	To permanently divert groundwater and surface water.

Table 3 below lists all consent conditions relevant to groundwater management.

Table 3: Resource Consent Conditions

Condition No.	Activity	Condition	Where addressed
GT.1	*Groundwater monitoring*	In managing the construction of the Project and the potential for changes to the groundwater levels to occur, the consent holder shall prepare a GMP. The consent holder shall submit the GMP to the Manager for certification at least 20 Working Days prior to Commencement of Construction. The GMP shall be submitted as an appendix to the CEMP. The GMP shall achieve the following outcomes:	Noted
		a) That there shall be no changes to the groundwater levels that result in a significant change to wetland hydrological conditions; and	Noted
		b) That there shall be no permanent changes to the ability of existing bore	Noted

Condition No.	Activity	Condition	Where addressed
		owners to abstract water (including at maximum consented rates or volumes) from their existing water supply bores. The definition of and means by which these outcomes will be measured and achieved shall be confirmed in the GMP and through the monitoring and reporting required in accordance with Conditions GT.2 and GT.3. Construction shall not commence until the consent holder has received the Manager's written certification of the GMP.	
GT.2	*Groundwater monitoring*	The consent holder shall implement measures identified in the GMP to manage the groundwater level as part of any relevant SSEMP. The purpose of the measures to manage groundwater level in the GMP is to set out the BPO for groundwater monitoring and management and procedures to minimise changes in groundwater levels. The groundwater level detail in the GMP shall include information regarding:	
		a) the schedule of groundwater monitoring bores identifying piezometer depth, screen length and geological unit;	7.4 Appendix E
		b) the locations of groundwater monitoring bores shown on plans;	Appendix B
		c) the locations of monitoring stations;	Appendix B
		d) duration of monitoring pre and post construction;	2.4.6
		e) monitoring frequency;	2.4.6
		f) monitoring methods;	2.4.7
		g) reporting requirements including identification of departure from 'natural' groundwater levels;	2.4.10
		h) details of mitigation options including, if appropriate, triggers for implementation of mitigation measures;	2.5
		i) response management, including minimum flow cut-offs or any other restrictions on the operation of the construction water supply bores;	NA
		j) review procedures;	2.7
		k) definition of terms (e.g. 'significant change' and 'proactively monitor'); and	2.4.6

Condition No.	Activity	Condition	Where addressed
		l) Surveys and monitoring of existing groundwater users within 500m of any abstraction well, and within 500m of the Project footprint between stations at chainage 4100 and 4400, unless otherwise agreed to by the Manager.	2.4.3
GT.3	*Groundwater monitoring*	At 6 monthly intervals during construction, and for 12 months following completion of construction within each Stage, the consent holder shall review and report the results of monitoring as compared with expected effects on groundwater levels assessed from groundwater modelling and the established range of groundwater levels determined from groundwater monitoring prior to the construction. This review will have regard to the final construction methodology and progress at the time of the review. In addition, an annual report will be prepared and submitted to the Manager by 1 May each year that describes: a) The groundwater monitoring that has been undertaken since the Commencement of Construction;	2.4.10
		b) The actual and potential effects arising from the groundwater level changes;	2.4.8
		c) Any remedial or mitigation measures that have been implemented;	2.5
		d) Any changes to proposed remedial and mitigation measures; and	2.5
		e) Any changes proposed for the future monitoring programme or to alert levels.	2.7
GT.4	*Extraction rate*	The consent holder shall ensure, in relation to groundwater takes and use a) The location, design, implementation and operation of the groundwater takes shall be in general accordance with the consent application. b) The rate at which water is taken from the water supply bores, other than for well testing, including simulation of effects shall not exceed: i) 110,000 m3/year at a maximum of 300 m3/day (cumulatively, across all bores); and	NA

Condition No.	Activity	Condition	Where addressed
		ii) A maximum pumping rate of 35 litres/sec from each bore.	
GT.4A	*Monitoring*	The consent holder shall, subject to landowner access being provided, survey the water supply wells within 500m of any abstraction well, and within 500m of the Project footprint between the stations at chainage 4100 and 4400, to obtain a list of existing water supply wells, their depths, and abstraction volumes and rates. This shall be used to develop proactive monitoring measures to assess the impact of the abstraction of water for construction.	2.4.3
GT.5	*Monitoring*	The consent holder shall undertake the following: a) Install and maintain a water meter on each water supply bore prior to the commencement of the take and for the duration of the abstraction from the point of take. The water meter shall measure both cumulative water abstraction and the instantaneous rate of take, and be capable of providing a pulse counter output; and b) The water meter shall be calibrated to ensure that the error does not exceed +/- 5%. The water meter shall be installed in accordance with manufacturer's specifications. ***Advice Note**: Where any consumptive water take for site office use exceeds 5 litres/second, the Resource Management (Measuring and Reporting of Water Takes) Regulations 2010 will apply.*	NA
GT.6	*Mitigation measures*	a) The consent holder shall proactively monitor and ensure that existing groundwater users (consented and permitted users) who cannot use their own water supply due to construction of the Project receive a replacement water supply.	2.5.1
		b) The consent holder shall avoid adversely affecting KCDC's public water supply bores and shall ensure access to those bores for maintenance and servicing is maintained throughout the Project.	2.3.2

Condition No.	Activity	Condition	Where addressed
		c) A replacement water supply shall be provided within 2 Working Days of monitoring results identifying a change in ability to use their own water supply.	2.5.1
		d) The replacement water supply shall provide not less than the volume and quality of water which existed before any change as a result of Construction of the Project.	2.5.1
GT.7	*Notification*	The consent holder shall notify the registered drinking-water supply operators concerned and KCDC, as soon as reasonably practicable, if an event occurs due to the Project that may have a significant adverse effect on the quantity or quality of the water at any registered drinking-water supply abstraction point.	2.3.1 2.6

Table 4 below identifies the Principal's Requirements relating to Groundwater Monitoring.

Table 4: Principal's Requirements

Requirement No.	Requirement Type	Description
A4.4.1	Monitoring Reports	A4.4.1.1 During construction the Contractor shall provide monitoring reports to the Engineer every 3 months providing detailed monitoring data on ground movements, groundwater and pore water pressures and variations in the characteristics, including strength gain, of underlying materials. The reports shall provide comparison of monitored results against the baseline design predictions in both tabular and graphical formats. Where results are not following the predictions, the Contractor shall detail their proposed design and/or construction strategy to address these issues. These reports shall also meet the reporting requirements of the resource consents, in particular water well monitoring reports.
A4.12.1	Groundwater and Water Wells	A.4.12.1.1 The consents for the Project require groundwater monitoring and monitoring of the wells in the area, particularly where: a The cutting for the expressway to the south of Ōtaki River has the potential to lower the groundwater level in the area. b Extraction of water from water abstraction wells has the potential to affect the existing water takes

		from water bores (wells) in the area, including consented and unconsented water takes. A.4.12.1.2 The Contractor shall fulfil the consent requirements to monitor the groundwater levels and water wells in the surrounding area, as identified in the consents, and if any existing water takes are affected, then provide them a temporary water supply, or replacement water bores as may be appropriate.
A4.12.2	Contaminated Land	A.4.12.2.4 Management of contaminated groundwater shall be allowed for in the Groundwater Management Plan (GWMP).

2 GROUNDWATER MANAGEMENT

2.1 Introduction

There are two groundwater zones identified along the express route by GWRC. The location and characteristics of these groundwater zones are set out in Table 5.

Table 5: Groundwater Zones in Project Area

Ōtaki Groundwater Zone
The Ōtaki groundwater zone extends across the coastal plain from the southern margin of the Ōtaki River valley to the northern boundary of the Wellington Region, combining the existing Ōtaki and Waitohu groundwater zones. To the east of SH1 the southern boundary of the Ōtaki groundwater zone follows the prominent river terrace that forms a hydraulic divide between the Q2 gravels of the Hautere Plain and the Q1 alluvium of the Ōtaki River floodplain. To the west of SH1 this boundary becomes less well defined, particularly near the coast where it is partially obscured by Holocene sand deposits. The eastern boundary follows the approximate contact between the Q5 and Q6 alluvial terraces (and associated alluvial fans) and the greywacke bedrock of the Tararua foothills. Primary surface water features in the Ōtaki groundwater zone include the Ōtaki River and the Waitohu Stream. Both streams exhibit significant interaction with the adjacent unconfined aquifer, losing water downstream of their emergence from the Tararua foothills and gain appreciable base flow in their lower reaches. Some smaller spring-fed streams also occur on the Ōtaki River floodplain including Waimanu Stream east of SH1 and Rangiuru Stream which drains into the Ōtaki River near Ōtaki Beach. Although the groundwater resources in the Q1 gravels and underlying Q5/Q6 alluvium are laterally continuous across the zone (essentially forming a single groundwater resource), due to the varying nature of groundwater/surface water interaction in the Ōtaki River and Waitohu Stream catchments, the larger zone is sub-divided into two smaller units (the Ōtaki sub-zone and Waitohu subzone) for groundwater allocation purposes to reflect the differing nature of groundwater / surface water interaction in these catchments.
Te Horo Groundwater Zone
The Te Horo groundwater zone extends across the coastal plain from the Ōtaki River in the north to a southern boundary running parallel with Peka Peka Road combining the existing Hautere and Coastal groundwater management zones. The eastern boundary follows the contact between the coastal plain and the Tararua foothills. Groundwater resources in this area are hosted in a thick succession of alluvial gravel materials accumulated on the alluvial fan formed by the Ōtaki River over the late Quaternary period. These materials host a succession of waterbearing intervals which become increasingly well confined at depth. West of the prominent marine terrace running parallel to SH1, the upper portion of the alluvial materials have been replaced by Holocene sand and gravel deposits up to 35 metres thick accumulated as a result of shoreline progradation over the past 6,500 years forming a shallow unconfined aquifer system. The primary surface water feature in the Te Horo groundwater zone is the Mangaone Stream which traverses the coastal plain to reach the coast at Te Horo Beach. The Mangaone stream loses water to the underlying unconfined aquifer as it crosses the Hautere Plain and gains flow from the unconfined sand aquifer over its lower reaches. Significant wetland areas occur in the Te Hapua complex located near Peka Peka
Source: KapitiCoastGroundwaterResourceInvestigationProposedFrameworkforConjunctiveWaterManagement.pdf

Appendix A shows locations where groundwater may be affected by the construction works, including wetlands, deep excavations and bridge piles. Appendix B shows the locations of existing and proposed geotechnical standpipes, groundwater monitoring stand pipes and groundwater wells which will be monitored during construction.

A schedule of the existing groundwater monitoring bores identifying the piezometer depth, screen length and geological unit is presented in Appendix C.

2.2 Groundwater Conditions

Table 6 presents the expected groundwater conditions at the location of proposed deep cuts which may extend below groundwater level, and existing wetlands which may be affected by the proposed earthworks.

Table 6: Expected Ground Conditions

Location	Description
Deep cuts north of Ōtaki (Chainage 01220 to 01440)	The cut for the expressway formation and associated subsurface drainage is not expected to extend below the observed groundwater level in this area.
Ōtaki North Wetlands (Chainage 01440 to 01640)	The existing wetlands will be removed as part of the expressway construction and will be replaced with lined wetlands. The pavement subgrade is expected to be at or very close to the seasonal high groundwater levels observed in the standpipes in the vicinity of the Ōtaki North wetlands. The typical groundwater level is 1 to 3m below the seasonal high. Subsoil drainage will be constructed which will result in the drawdown of groundwater up to 1m below the seasonal high water level but not below the seasonal fluctuations.
Deep cuts south of Ōtaki River (Chainage 03880 to 04800[1])	The cut for the expressway formation and associated subsurface drainage is expected to extend below the observed groundwater level in this area. This may result in permanent groundwater draw down of up to 2m below the water level. The draw down is expected to be greatest immediately adjacent to the excavation and diminish with distance from the excavation. The area groundwater regime immediately to the west has already been modified by the construction of the rail cutting on the south bank of the Ōtaki River.
Mary Crest Wetland (Chainage 10120 to 10220)	The local road and expressway formations are on embankments elevated above the wetlands and groundwater surface. There will be no connection or outlet to drainage that is likely to lower the groundwater levels in this area.
Deep cuts south of Mary Crest (Chainage 10260 to 10620)	The cut for the expressway formation and associated subsurface drainage is expected to extend below the observed groundwater level in this area. This will result in permanent groundwater draw down of up to 3m below the seasonal high water level. The draw down will be greatest immediately adjacent to the excavation and will diminish with distance from the excavation.

Note: 1. Chainages are where the proposed expressway is 2.5m below existing ground levels

2.3 Existing Groundwater Users

A schedule of existing groundwater users potentially affected by the construction works is presented in Appendix D. These typically comprise bores that are a) operated under permitted activity or RMA conditions permitting takes without requirement for consent, b) consented groundwater takes, and c) registered drinking water users (which are also likely consented).

Although a significant number of historical groundwater users have been identified by reviewing historical data, information on current users is sparse. Many of the possible users' bores predate the Resource Management Act. Further work will be done to determine the current users and in particular the aquifers they draw from and the quality and quantity of takes.

2.3.1 Registered drinking water users

A register of Drinking Water Suppliers is maintained by the Ministry of Health. The register can be accessed at http://www.esr.cri.nz/assets/WATER-CONTENT/Images-and-PDFs/RegisterofSuppliers-2016a.pdf.
The registered drinking water suppliers in the wider Project area are;

- **Gary Road Water Committee**
  - c/- 61 Gary Road, Peka Peka, Kāpiti .
  - Community: GAR003 Gary Rd Water Supply
  - Size: Neighbourhood
  - Volume Capability: -
  - Category: Networked Supply
  - Source: G01100 Gary Rd Bore

The Gary Road supply bore is located approximately 600m beyond the southern boundary of the Project. The nearest construction works to the supply are filling activities. The water bores are closer to the already completed section of expressway between MacKays and Peka Peka. It is considered that there will be no impact on the water supply from the Project.

- **Kāpiti Coast District Council (A0409) Private Bag 60601, Paraparaumu**
  - Community: HAU003 Hautere
  - Size: Minor
  - Volume Capability: 1,200 m3/day
  - Category: Networked Supply
  - └ Source: S00081 Bores next to Ōtaki River
  - Community: OTA003 Ōtaki
  - Size: Medium
  - Volume Capability: 8,986 m3/day
  - Category: Networked Supply
  - Source: G00303 Rangiuru Road Bores

- Source: G00302 Tasman Road Bores

Kāpiti Coast District Council (KCDC) have advised that the 3 groundwater supply wells for the Ōtaki Water Scheme are more than 2.5km from the proposed expressway alignment. These wells are unlikely to be affected by the proposed construction.

- **Te H2Oro Water Company Ltd**
  - PO Box 72, Te Horo
  - Community: TEH008 Te H2Oro Water Supply
  - Size: Neighbourhood
  - Volume Capability: -
  - Category: Networked Supply
  - Source: G00993 Te H2Oro Bore

The company's bores are located to the east of the construction area and are unlikely to be affected.

2.4 Groundwater Monitoring

Groundwater monitoring has already been undertaken by Opus and AECOM. Refer to report titled Peka Peka to Ōtaki Expressway, Groundwater Monitoring Results, December 2014 to December 2016 (Opus 2016) and Notice to Contractor NTC18 in Appendix E. This information along with further monitoring prior to construction commencing will be used to establish current groundwater levels. A schedule of all groundwater monitoring bores in Appendix C presents details of the bore location and screen details.

The existing wells which can be located and are still in working condition will continue to be monitored. A number of monitoring bores are located within the construction footprint. These monitoring bores will be destroyed and it is not intended to replace them. This is with the exception of monitoring bores between chainage 3900 and 4500 (south bank Ōtaki River) where the ground level will be lowered below the current groundwater level. Table 7 shows that 2 monitoring bores will be destroyed and replaced by 6 new ones.

Table 7: Groundwater Monitoring Standpipes South Bank Ōtaki River

Monitoring bore	Location	Comment
BH 810	4000	To be installed and baseline established against BH 236
BH 812	4000	To be installed and baseline established against BH 236
BH 236	4000	Will be destroyed in construction process
BH 818	4100	To be installed and baseline established against BH 236
BH 819	4100	To be installed and baseline established against BH 236
BH 820	4400	To be installed and baseline established against BH 214
BH 821	4400	To be installed and baseline established against BH 214
BH 214	4500	Will be destroyed in construction process

2.4.1 Further information

The Opus report has identified a number of potential groundwater users but does not include information on the nature of the take, such as: well location, well depth, screening levels and take volumes and rates. Further work will be undertaken to gather this information to more accurately define potentially affected parties.

2.4.2 River levels

The shallow aquifer next to the Ōtaki River is expected to be strongly influenced by the flow level in the Ōtaki River. Information on flow levels will be collected and correlated against the levels in the stand pipes and existing bores. The purpose of this is to determine how strong the influence of the river on the groundwater levels is.

2.4.3 Groundwater wells to be monitored

As per Condition GT.2 we will undertake surveys and monitoring of existing groundwater users within 500m of any abstraction well, and within 500m of the Project footprint between stations at chainage 4100 and 4400. Refer to Appendix B showing the location of groundwater wells to be monitored during construction. The monitoring of existing bores is subject to being given permission by bore owners to undertake monitoring.

2.4.4 Groundwater monitoring standpipes

Groundwater monitoring standpipes (Table 7) will be installed between the proposed deep excavations and the groundwater wells which are being monitored. The purpose of these standpipes is to identify the impact of the earthworks at the designation boundary to provide early warning of potential impact to the groundwater wells. Locations of proposed groundwater monitoring standpipes in BH818 to BH821 are shown on Figure PP2Ō-FG-GT-0-0003 in Appendix B. The standpipes will be constructed with the response zone just below the lowest point of the expressway cut. The standpipe to the east of the road alignment will be used to provide a control.

2.4.5 Geotechnical standpipes

Groundwater levels in both existing and proposed geotechnical standpipes will also be monitored to assess the impact of construction works on groundwater. The locations of the existing and proposed geotechnical standpipes are shown on Figures PP2Ō-FG-GT-0-0001 to 0008 in Appendix B. Geotechnical standpipe piezometers which are located within the earthworks footprint will be decommissioned during construction and will not be replaced. The Monitoring Bore Schedule in Appendix C has identified those bores that are expected to be within the earthworks footprint.

2.4.6 Duration and frequency of pre and post construction monitoring

Monitoring of groundwater monitoring standpipes will be done on a monthly basis following installation and continue for 12 months following construction completion as per condition GT.3. Monitoring frequency for wells and standpipes within 100m of excavations which extend below the seasonal high groundwater level will be proactively monitored weekly during excavation and for 1 month following completion of the excavation. Monitoring of the geotechnical standpipes will be

monthly until either access is no longer available (due to construction of the expressway) or will continue for 12 months following construction completion. Additionally, data from wells (in 200 series) and the geotechnical standpipes shown in the Figures PP2Ō-FG-GT-0-0001 to 0008 in Appendix B is available from May 2012 and will assist in assessing construction impacts.

2.4.7 Monitoring methods

Groundwater levels in standpipes and groundwater wells will be monitored manually using a water level meter to measure the depth of groundwater below the ground surface.

A water level logger will be installed in the groundwater monitoring standpipes to provide continuous water level monitoring. The water level logger will record water levels at least every minute. Data from the level loggers will be downloaded monthly or weekly during the construction phase.

2.4.8 Assessment

An assessment of the monitoring data collected prior to commencement of bulk earthworks will be undertaken. The assessment is to determine what would be a significant change in groundwater levels to impact upon existing groundwater users. This will then be used to set trigger levels. The assessment will consider;

- Individual bore data against all bores,
- Seasonal trends,
- Climatic conditions, and
- River levels

2.4.9 Trigger levels

Monitoring of the groundwater at the existing and proposed piezometers, plus the private wells (where permission has been obtained) will be undertaken on a regular basis until the commencement of bulk earthworks, anticipated for February 2018. Prior to the commencement of bulk earthworks, a revised GMP will be submitted to GWRC for certification. The revised GMP will provide groundwater trigger levels as ‘alert levels’ which will require additional monitoring, or ‘action trigger’ which will require mitigation measures.

The alert trigger will be set to respond to a change in groundwater level between the control locations and those in the impact zone. The action trigger level is set to respond to a change in groundwater level that will adversely affect water yield and is not a seasonal effect. If trigger levels in the monitoring wells are exceed then additional assessment will be undertaken (refer to following sections 2.5 and 2.6) and mitigation measures implemented if required.

The interim trigger levels are as follows;

- Alert level: a 7.5% decrease groundwater level from maximum depth level (based upon the groundwater range),

- Action level: a 10% decrease groundwater level from maximum depth level (based upon the groundwater range)

Prior to the commencement of bulk earthworks a schedule of groundwater triggers will be submitted to GWRC for approval. The schedule will identify monitoring bores installed for the Project and private groundwater bores within the monitoring zone. The schedule will provide location information, monitoring results to date and the trigger levels. In addition a report will provide a record of the efforts made to gain access to private wells for monitoring the impacts on groundwater users.

2.4.10 Reporting Requirements

Groundwater monitoring reporting will take place at 6-monthly intervals prior to construction, 3-monthly during bulk earthworks and for 12 months following completion of construction within each Stage.

These reports will provide a brief summary of seasonal conditions (e.g. rainfall/groundwater levels +/- "normal" along with any anomalies/changes/trends).

In addition, an annual report will be prepared and submitted to the Manager by 1 May each year that describes:

a) The groundwater monitoring that has been undertaken since the commencement of construction;
b) The actual and potential effects arising from the groundwater level changes;
c) Any remedial or mitigation measures that have been implemented;
d) Any changes to proposed remedial and mitigation measures; and
e) Any changes proposed for the future monitoring programme or to alert levels.

2.5 Mitigation Techniques

2.5.1 Groundwater within wetlands

If groundwater levels within the existing wetlands which are to remain, are affected by the earthworks or associated subsurface drainage then mitigation measures will be developed. These mitigation measures may include, but are not limited to:

- Redesign of the surface water system in vicinity of the wetland
- Reforming the wetland with a lining system

2.5.2 Quality

The potential to contaminate groundwater from drilling activities will be avoided by ensuring all drilling and piling is undertaken in accordance with “NZS 4411:2001 Environmental standard for drilling of soil and rock”. All drilling contractors will be contractually obligated to meet this standard. The potential interconnecting aquifers will be identified by proof drilling. The proof drilling will provide information on groundwater so the design and construction of piles can ensure the aquifer is sealed off. This minimises the potential for contamination of the aquifer or leakage.

The contamination of groundwater from other activities is addressed in the CEMP, particularly Appendix E- the Hydro Carbon Spill Plan.

2.6 Response Management

Where an Alert trigger level is exceeded, the Construction Manager, Environmental Manager, Design Manager and Geotechnical Design Lead will be notified by the Environmental Management Team within 3 working days with details of actions to be undertaken. Actions are outlined below:

- Repeat monitoring of piezometer exceeded and closest piezometers in the vicinity;
- Increase frequency of groundwater level monitoring to daily for all piezometers and groundwater wells within 50 m radius of the affected monitoring piezometer.

Where an Action trigger level for a monitoring bore is exceeded, activities that have the potential to cause adverse effects will be ceased or mitigated. The following people will be notified:

- Construction Manager
- Environmental Manager
- Design Manager
- Geotechnical Design Lead
- Engineer to Contract

In addition GWRC will be notified of the exceedance and the proposed mitigation will be discussed with them.

Works may recommence without mitigation once groundwater levels return to sub-action levels. Alternatively, works may recommence if written notice is received from GWRC.

If groundwater contamination is encountered, GWRC will be notified as soon as practical. An assessment will be undertaken to determine if the contamination is project-related, and if so, the source of contamination will be isolated. If the contamination is project-related, FCC will report to GWRC on the cause of contamination, the impact, measures taken to stop the contamination and the clean-up undertaken. An interim report will be prepared within 10 days of the contamination being reported.

If a change in quantity or quality affecting a registered drinking water supply is identified the registered drinking water supplier (see section 2.3.1) will be contacted as soon as practicable.

2.6.1 Ground water levels- existing users

If construction activities result in significant change in monitored ground water levels and yield, the cause and impact of these changes will be assessed. If attributable to the Project the following mitigation measures will be instigated;

- Providing temporary storage tanks and delivery water using trucks. A replacement drinking water supply will be provided within 2 days of a water user being unable to use their supply.
- Lower pump levels in existing wells (if feasible).
- Increase depth of current users' bores.
- Provide new bores to current users if the existing bore is rendered inoperable.

2.7 Complaints

Complaints relating to groundwater will be treated as part of the CEMP complaints process. The process allows;

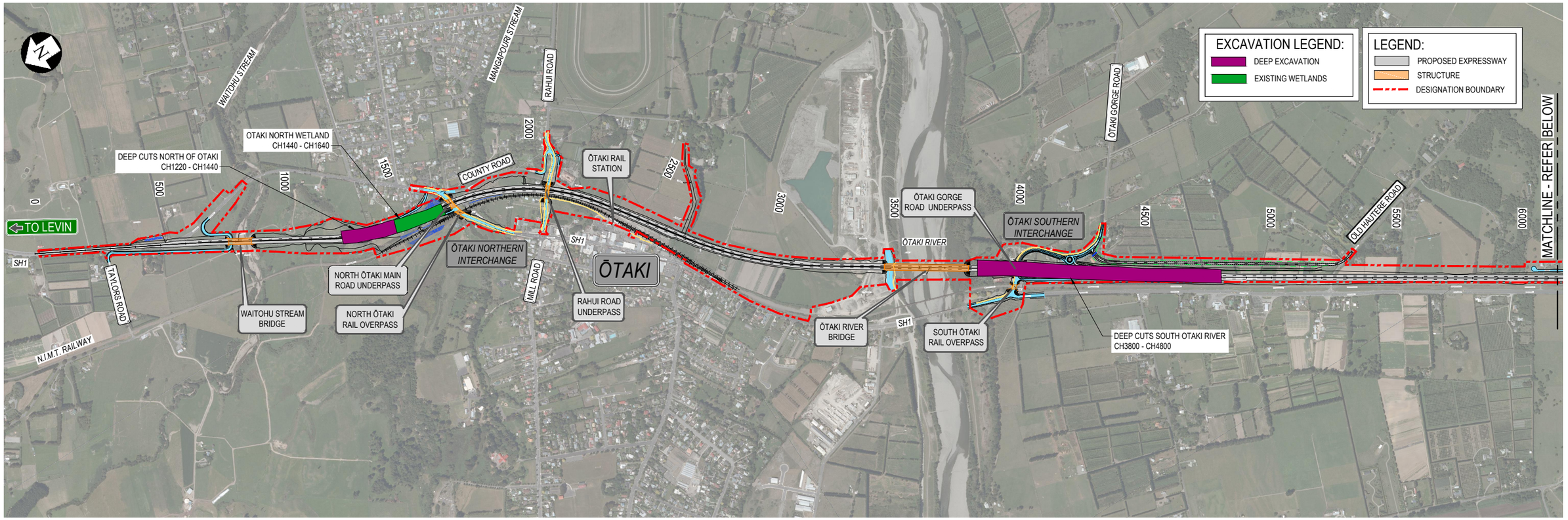
- A complaints register is maintained by the Stakeholder & Communications Manager and updated regularly as new complaints are received.
- A summary of complaints will be provided to KCDC/GWRC on a monthly basis. The complaints register will be made available at all times to KCDC/GWRC upon request.
- Complaints can be received by email to pp2o@nzta.govt.nz, by calls to the 0800 line or recorded messages if out of manned hours for the phone, in person to Project staff, or in writing.

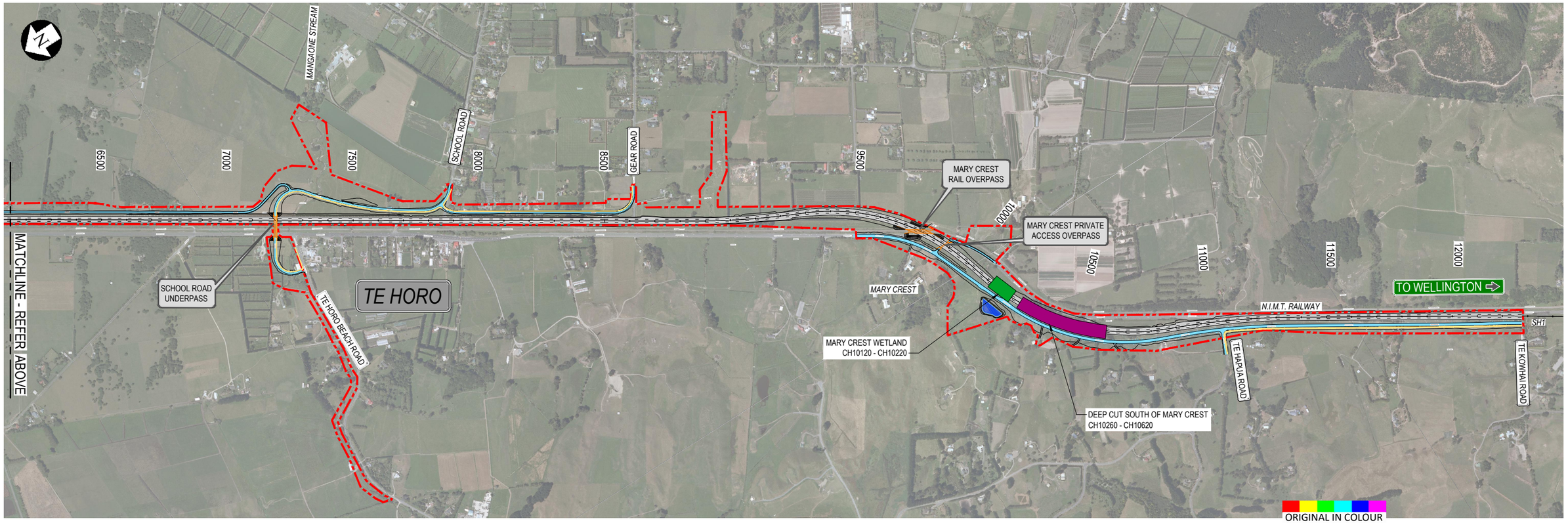
2.8 Review Procedures

On an annual basis (May each year) a review of the GMP would be undertaken to ensure that the monitoring captures any potential adverse effects on groundwater and that mitigations methods are effective. If the review results in modification of the GMP, it will be submitted to GWRC for certification.

APPENDIX A - LOCATIONS WHERE GROUNDWATER MAY BE AFFECTED BY THE CONSTRUCTION WORKS

Save Date: 06 Mar 2017 2:16 p.m.





ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject: FIGURE - GROUNDWATER MANAGEMENT PLAN	Discipline: GEOTECHNICAL
Title: LOCATION PLAN	Drawing No.: PP2O-FG-GT-0-0009
	Rev.: 0

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Document No. R:\30DD - DESIGN DEVELOPMENT GENERAL\09 CAD\FIGURES\GT\FIG-GT-0001.DWG

APPENDIX B – LOCATION OF STANDPIPES AND GROUNDWATER WELLS

Save Date: 06 Mar 2017 2:13 p.m.

LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

- BH1XX — STANDPIPE (AECOM 2011)
- BH2XX — STANDPIPE (OPUS 2016)
- BH2XX — STANDPIPE (OPUS 2017)
- BH8XX — PROPOSED STANDPIPE (T+T 2017)
- SXX/XXX — GROUNDWATER WELL (MONITORED BY OPUS)
- SXX/XXX — GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
- CPTXXX — CONE PENETROMETER (AECOM 2011)

KEY PLAN

1 2 3 4 5 6 7 8

MANGAPOURI STREAM

WAITOHU VALLEY ROAD

TE MANUAO ROAD

EXISTING STATE HIGHWAY 1

MATCHLINE - REFER SHEET 2

2 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400

BH226

BH228

BH1181

BH102

BH225

WAITOHU STREAM BRIDGE

TAYLORS ROAD

NORTH ISLAND MAIN TRUNK RAILWAY

ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

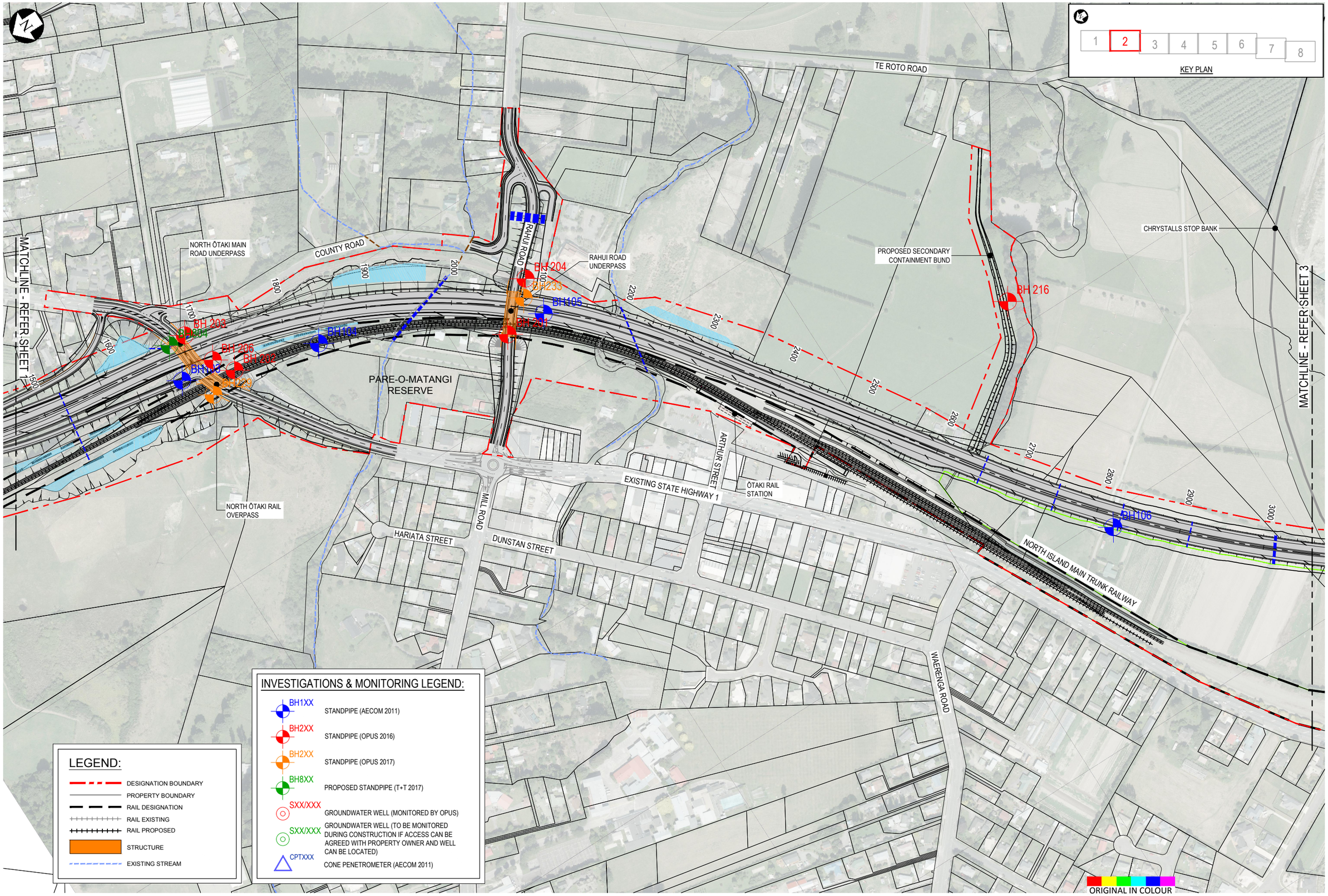
Subject: GEOTECHNICAL INVESTIGATION	Discipline: GEOTECHNICAL
Title: TEST LOCATIONS SHEET 1 OF 8	Drawing No.: PP2O-FG-GT-0-0001
	Rev.: 0

Document No. R:\30OD - DESIGN DEVELOPMENT GENERAL\09 CAD\FIGURES\GT\FIG-GT-0002_0009.DWG

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Save Date: 06 Mar 2017 2:13 p.m.



LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

BH1XX	STANDPIPE (AECOM 2011)
BH2XX	STANDPIPE (OPUS 2016)
BH2XX	STANDPIPE (OPUS 2017)
BH8XX	PROPOSED STANDPIPE (T+T 2017)
SXX/XXX	GROUNDWATER WELL (MONITORED BY OPUS)
SXX/XXX	GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
CPTXXX	CONE PENETROMETER (AECOM 2011)

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject: GEOTECHNICAL INVESTIGATION	Discipline: GEOTECHNICAL
Title: TEST LOCATIONS SHEET 2 OF 8	Drawing No.: PP2O-FG-GT-0-0002 Rev.: 0

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Document No. R:\300DD - DESIGN DEVELOPMENT GENERAL\09 CAD\FIGURES\GTFIG-GT-0002_0009.DWG

Save Date: 06 Mar 2017 2:14 p.m.

LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

- BH1XX — STANDPIPE (AECOM 2011)
- BH2XX — STANDPIPE (OPUS 2016)
- BH2XX — STANDPIPE (OPUS 2017)
- BH8XX — PROPOSED STANDPIPE (T+T 2017)
- SXX/XXX — GROUNDWATER WELL (MONITORED BY OPUS)
- SXX/XXX — GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
- CPTXXX — CONE PENETROMETER (AECOM 2011)

KEY PLAN

1 2 3 4 5 6 7 8

MATCHLINE - REFER SHEET 2

MATCHLINE - REFER SHEET 4

ŌTAKI GORGE ROAD

ŌTAKI GORGE ROAD UNDERPASS

STRESSCRETE PLANT

WINSTONES AGGREGATES

ŌTAKI RIVER BRIDGE

NORTH ISLAND MAIN TRUNK RAILWAY

EXISTING STATE HIGHWAY 1

SOUTH ŌTAKI RAIL OVERPASS

RIVERBANK ROAD

ADDINGTON ROAD

EXTENT OF GROUNDWATER WELLS TO BE MONITORED (CONSENT CONDITION GT4)

S25/5273, S25/5272, S25/5267, S25/5278, S25/5274, 50, S25/5280, S25/5275, BN33/0011, BN33/0012, BH818, BH 205, BH232, BH 215, BH107, BH810, BH820, BH188, BH114, BH819, BH821, BH236, S25/5342, S25/5270, BN33/0008, S25/5352, S25/5268, S25/5365

3100 3200 3300 3400 3500 3600 3700 3800 3900 4000 4100 4200 4300 4400 4500

ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject: GEOTECHNICAL INVESTIGATION	Discipline: GEOTECHNICAL
Title: TEST LOCATIONS SHEET 3 OF 8	Drawing No.: PP2O-FG-GT-0-0003 Rev.: 0

Document No. R:\30D0 - DESIGN\DEVELOPMENT GENERAL\09 CAD\FIGURES\GT\FIG-GT-0002_0009.DWG

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Save Date: 06 Mar 2017 2:14 p.m.

LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

- BH1XX — STANDPIPE (AECOM 2011)
- BH2XX — STANDPIPE (OPUS 2016)
- BH2XX — STANDPIPE (OPUS 2017)
- BH8XX — PROPOSED STANDPIPE (T+T 2017)
- SXX/XXX — GROUNDWATER WELL (MONITORED BY OPUS)
- SXX/XXX — GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
- CPTXXX — CONE PENETROMETER (AECOM 2011)

KEY PLAN

1 2 3 4 5 6 7 8

MATCHLINE - REFER SHEET 3

MATCHLINE - REFER SHEET 5

OLD HAUTERE ROAD

4600 4700 4800 4900 5000 5100 5200 5300 5400 5500 5600 5700 5800 5900 6000 6100

BH 214

NORTH ISLAND MAIN TRUNK RAILWAY

EXISTING STATE HIGHWAY 1

S25/5350

S25/5386

S25/5257

S25/5114

S25/5359

S25/5261

EXTENT OF GROUNDWATER WELLS TO BE MONITORED (CONSENT CONDITION GT4)

5/5365

S25/5260

ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject: GEOTECHNICAL INVESTIGATION

Title: TEST LOCATIONS SHEET 4 OF 8

Discipline: GEOTECHNICAL

Drawing No. PP2O-FG-GT-0-0004

Rev. 0

Document No. R:\30OD - DESIGN\DEVELOPMENT GENERAL\09 CAD\FIGURES\GT\FIG-GT-0002_0009.DWG

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Save Date: 06 Mar 2017 2:15 p.m.

LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

- BH1XX — STANDPIPE (AECOM 2011)
- BH2XX — STANDPIPE (OPUS 2016)
- BH2XX — STANDPIPE (OPUS 2017)
- BH8XX — PROPOSED STANDPIPE (T+T 2017)
- SXX/XXX — GROUNDWATER WELL (MONITORED BY OPUS)
- SXX/XXX — GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
- CPTXXX — CONE PENETROMETER (AECOM 2011)

KEY PLAN

1 2 3 4 **5** 6 7 8

MATCHLINE - REFER SHEET 4

MATCHLINE - REFER SHEET 6

SCHOOL ROAD UNDERPASS

6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100 7200 7300 7400 7500 7600

BH 221

BH235

BH 211

NORTH ISLAND MAIN TRUNK RAILWAY

EXISTING STATE HIGHWAY 1

TE WAKA ROAD

TE HORO BEACH ROAD

ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject: GEOTECHNICAL INVESTIGATION

Title: TEST LOCATIONS SHEET 5 OF 8

Discipline: GEOTECHNICAL

Drawing No.: PP2O-FG-GT-0-0005

Rev.: 0

Document No. R:\30DD - DESIGN DEVELOPMENT GENERAL\09 CAD\FIGURES\GTIFIG-GT-0002_0009.DWG

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Save Date: 06 Mar 2017 2:15 p.m.

LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

- BH1XX — STANDPIPE (AECOM 2011)
- BH2XX — STANDPIPE (OPUS 2016)
- BH2XX — STANDPIPE (OPUS 2017)
- BH8XX — PROPOSED STANDPIPE (T+T 2017)
- SXX/XXX — GROUNDWATER WELL (MONITORED BY OPUS)
- SXX/XXX — GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
- CPTXXX — CONE PENETROMETER (AECOM 2011)

KEY PLAN

1 2 3 4 5 6 7 8

MATCHLINE - REFER SHEET 5

MATCHLINE - REFER SHEET 7

SCHOOL ROAD

GEAR ROAD

7600 7700 7800 7900 8000 8100 8200 8300 8400 8500 8600 8700 8800 8900 9000 9100

BH109

NORTH ISLAND MAIN TRUNK RAILWAY

EXISTING STATE HIGHWAY 1

ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject:	GEOTECHNICAL INVESTIGATION
Title:	TEST LOCATIONS SHEET 6 OF 8
Discipline	GEOTECHNICAL
Drawing No.	PP2O-FG-GT-0-0006
Rev.	0

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

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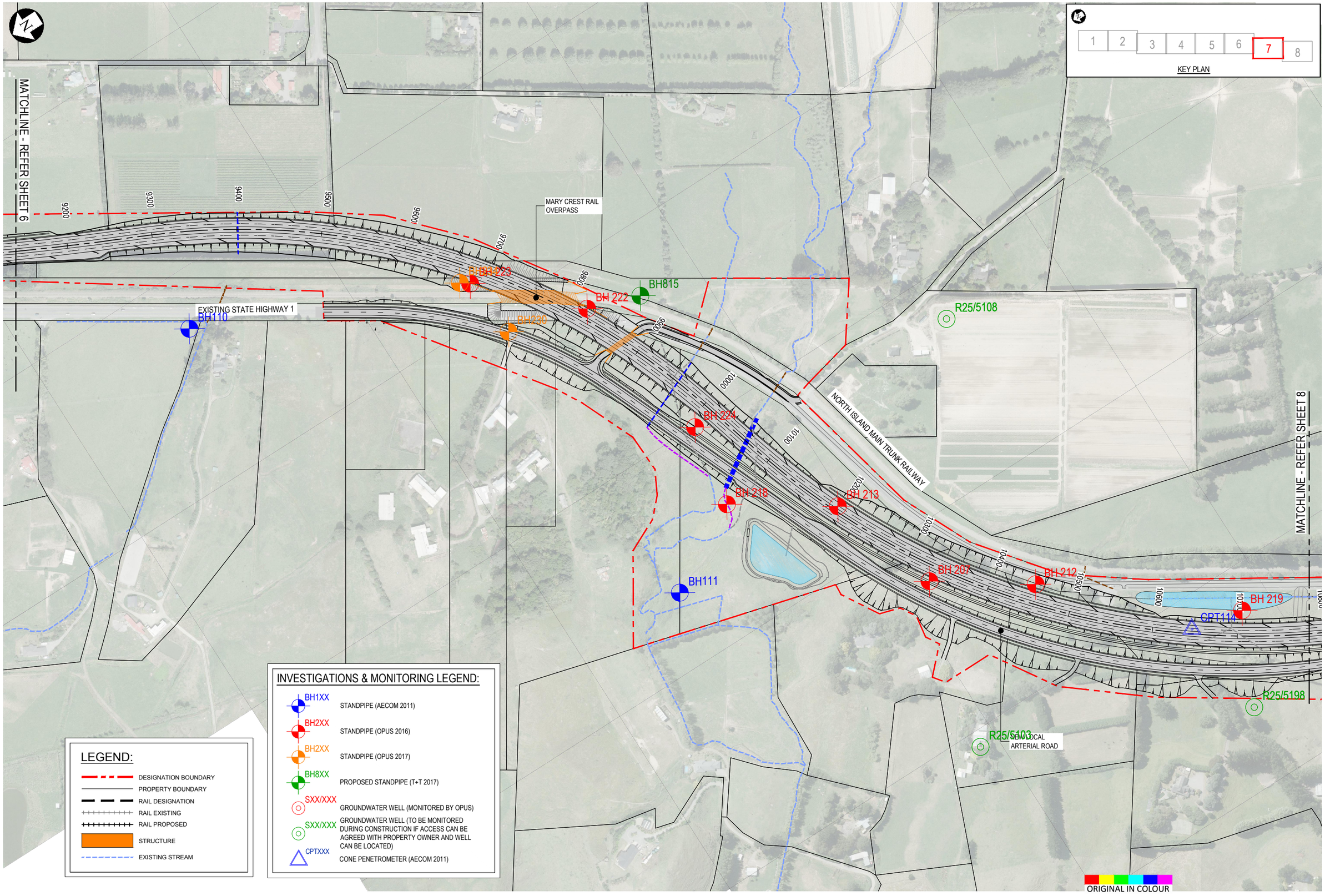

KEY PLAN

1 2 3 4 5 6 **7** 8

LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

- BH1XX — STANDPIPE (AECOM 2011)
- BH2XX — STANDPIPE (OPUS 2016)
- BH2XX — STANDPIPE (OPUS 2017)
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- SXX/XXX — GROUNDWATER WELL (MONITORED BY OPUS)
- SXX/XXX — GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
- CPTXXX — CONE PENETROMETER (AECOM 2011)

ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject:	GEOTECHNICAL INVESTIGATION
Title:	TEST LOCATIONS SHEET 7 OF 8
Discipline	GEOTECHNICAL
Drawing No.	PP2O-FG-GT-0-0007
Rev.	0

Document No. R/30OD - DESIGN DEVELOPMENT GENERAL\09 CAD\FIG\FIGURES\GT\FIG-GT-0002_0009.DWG

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Save Date: 06 Mar 2017 2:16 p.m.

LEGEND:

- DESIGNATION BOUNDARY
- PROPERTY BOUNDARY
- RAIL DESIGNATION
- RAIL EXISTING
- RAIL PROPOSED
- STRUCTURE
- EXISTING STREAM

INVESTIGATIONS & MONITORING LEGEND:

- BH1XX — STANDPIPE (AECOM 2011)
- BH2XX — STANDPIPE (OPUS 2016)
- BH2XX — STANDPIPE (OPUS 2017)
- BH8XX — PROPOSED STANDPIPE (T+T 2017)
- SXX/XXX — GROUNDWATER WELL (MONITORED BY OPUS)
- SXX/XXX — GROUNDWATER WELL (TO BE MONITORED DURING CONSTRUCTION IF ACCESS CAN BE AGREED WITH PROPERTY OWNER AND WELL CAN BE LOCATED)
- CPTXXX — CONE PENETROMETER (AECOM 2011)

KEY PLAN

1 2 3 4 5 6 7 8

MATCHLINE - REFER SHEET 7

10800 10900 11000 11100 11200 11300 11400 11500 11600 11700 11800 11900 12000 12100 12200 12300

NORTH ISLAND MAIN TRUNK RAILWAY

BH 209 BH 220 BH115 BH112 BH113 BH 208 CPT118 CPT117

TE HAPUA ROAD

TE KOWHAI ROAD

ORIGINAL IN COLOUR

NZ TRANSPORT AGENCY WAKA KOTAHI

PEKA PEKA TO ŌTAKI EXPRESSWAY

Fletcher HIGGINS Beca Tonkin+Taylor

Subject:	GEOTECHNICAL INVESTIGATION
Title:	TEST LOCATIONS SHEET 8 OF 8
Discipline	GEOTECHNICAL
Drawing No.	PP2O-FG-GT-0-0008
Rev.	0

ORIGINAL SIZE A3 : DO NOT SCALE

IF IN DOUBT ASK

Document No. R30DD - DESIGN DEVELOPMENT GENERAL\09 CAD\FIGURES\GT\FG-GT-0002_0009.DWG

APPENDIX C - SCHEDULE OF GROUNDWATER MONITORING BORES

Borehole ID	Location			Response Zone						Comment
	Easting (NZTM)	Northing (NZTM)	BH RL (NZVD2009)	Top of Screen (mbgl)	Bottom of Screen (mbgl)	Top of Screen (mRL)	Bottom of Screen (mRL)	Screen length (m)	Geological Unit	
BH101	1782715.3	5486569.7	24.6	0.5	15	24.1	9.6	14.5	Recent alluvium (Q1a) and quaternary beach alluvium (Q5b)	AECOM Standpipes. Monitored May 2012 to April 2013
BH102_A	1782516.8	5486191.3	25.4	0.5	2.4	24.9	23.0	1.9	Quaternary beach alluvium (Q5b)	
BH102_B			25.4	8.0	18.5	17.4	6.9	10.5	Quaternary beach alluvium (Q5b)	
BH103_A	1782397.3	5485851.0	17.4	0.5	5.0	16.9	12.4	4.5	Inter-dune deposit (Q1sd) and quaternary beach alluvium (Q5b)	
BH103_B			17.4	6.0	17.0	11.4	0.4	11.0	Quaternary beach alluvium (Q5b)	
BH104	1782347.7	5485692.6	12.2	1.5	17.0	10.7	-4.8	15.5	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH105	1782235.1	5485451.6	13.1	1.0	10.0	12.1	3.1	9.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH106	1781664.3	5485023.8	14.2	2.0	12.5	12.2	1.7	10.5	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH107	1781240.4	5484500.7	14.8	7.0	10.0	7.8	4.8	3.0	Quaternary beach alluvium (Q5b)	
BH108	1780824.7	5483837.3	22.8	2.0	19.5	20.8	3.3	17.5	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH109	1778861.0	5480817.5	18.8	2.0	20.0	16.8	-1.2	18.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH110_A	1778015.9	5479621.2	15.5	7.0	9.0	8.5	6.5	2.0	Quaternary beach alluvium (Q5b)	
BH110_B			15.5	15.0	17.0	0.5	-1.5	2.0	Quaternary beach alluvium (Q5b)	
BH111_A	1777444.2	5479302.5	15.2	5.5	11	9.7	4.2	5.5	Quaternary beach alluvium (Q5b)	
BH111_B			15.2	18.5	25	-3.3	-9.8	6.5	Quaternary beach alluvium (Q5b)	
BH112_A	1776731.0	5478246.9	13.0	1.5	3.5	11.5	9.5	2.0	Inter-dune deposit (Q1sd)	
BH112_B			13.0	7.8	9.8	5.2	3.2	2.0	Dune sand (Q1s)	
BH113	1776451.0	5477776.4	13.3	1.5	14	11.8	-0.7	12.5	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
BH114	1780939.4	5484043.0	22.7	3	20	19.7	2.7	17.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH115	1776910.2	5478514.6	12.3	5	20	7.3	-7.7	15.0	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
CPT114 (CN)	1777084.0	5478818.4	12.3	0	3	12.3	9.3	3.0	Inter-dune deposit (Q1sd) and dune sand (Q1s)	
CPT117 (CQ)	1776640.1	5478135.8	12.4	0	3	12.4	9.4	3.0	Inter-dune deposit (Q1sd)	
CPT118 (CR)	1776596.2	5478001.6	14.4	0	3	14.4	11.4	3.0	Inter-dune deposit (Q1sd)	
BH 201	1782237.3	5485500.4	13.7	4.5	12.5	9.2	1.2	8.0	Quaternary beach alluvium (Q5b)	OPUS Standpipes. Monitored December 2014 to December 2016
BH 202	1782374.2	5485792.9	22.6	8.0	13.0	14.6	9.6	5.0	Quaternary beach alluvium (Q5b)	
BH 203	1782440.3	5485820.0	25.1	8.0	13.0	17.1	12.1	5.0	Quaternary beach alluvium (Q5b)	
BH 204	1782281.1	5485447.6	14.6	4.0	10.0	10.6	4.6	6.0	Quaternary beach alluvium (Q5b)	
BH 205	1781121.9	5484210.1	11.5	3.0	9.5	8.5	2.0	6.5	Recent alluvium (Q1a)	
BH 206	1782398.1	5485807.9	17.5	7.5	11.0	10.0	6.5	3.5	Quaternary beach alluvium (Q5b)	
BH 207	1777297.6	5479048.1	29.7	8.0	12.0	21.7	17.7	4.0	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
BH 208	1776912.8	5478590.6	11.7	3.5	6.5	8.2	5.2	3.0	Dune sand (Q1s)	
BH 209	1776826.5	5478353.6	17.8	3.0	6.0	14.8	11.8	3.0	Dune sand (Q1s)	
BH 211	1779180.9	5481431.2	16.7	5.0	9.0	11.7	7.7	4.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH 212	1777227.2	5478944.8	22.3	5.0	9.0	17.3	13.3	4.0	Inter-dune deposit (Q1sd) and dune sand (Q1s)	
BH 213	1777429.6	5479091.3	22.1	2.0	6.0	20.1	16.1	4.0	Quaternary beach alluvium (Q5b)	
BH 214	1780683.5	5483599.8	23.1	5.0	10.0	18.1	13.1	5.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH 215	1781142.8	5484312.1	10.3	1.0	5.0	9.3	5.3	4.0	Recent alluvium (Q1a)	
BH 216	1781953.8	5484985.4	14.6	4.0	8.0	10.6	6.6	4.0	Quaternary beach alluvium (Q5b)	
BH 218	1777501.9	5479200.0	18.4	1.0	4.0	17.4	14.4	3.0	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
BH 219	1777070.7	5478757.0	11.9	1.0	4.0	10.9	7.9	3.0	Inter-dune deposit (Q1sd) and dune sand (Q1s)	
BH 220	1776695.0	5478146.4	12.9	0.5	5.0	12.4	7.9	4.5	Inter-dune deposit (Q1sd)	
BH 221	1779269.7	5481366.4	18.0	4.0	9.0	14.0	9.0	5.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH 222	1777783.9	5479214.5	23.4	1.0	6.0	22.4	17.4	5.0	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
BH 223_A	1777882.8	5479314.5	23.1	2.0	4.0	21.1	19.1	2.0	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
BH 223_B			23.1	9.0	11.0	14.1	12.1	2.0	Quaternary beach alluvium (Q5b)	
BH 224	1777598.4	5479182.6	19.9	0.5	5.0	19.4	14.9	4.5	Quaternary beach alluvium (Q5b)	
BH225	1782469.5	5486312.0	28.9	10.0	14.0	18.9	14.9	4.0	Quaternary beach alluvium (Q5b)	
BH226	1782832.3	5486716.1	25.6	8.0	12.0	17.6	13.6	4.0	Quaternary beach alluvium (Q5b)	
BH228	1782761.4	5486658.4	25.2	9.0	13.0	16.2	12.2	4.0	Quaternary beach alluvium (Q5b)	
BH229	1782363.5	5485829.1	26.9	9.5	14.5	17.4	12.4	5.0	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
BH230	1777810.7	5479306.9	22.3	9.5	15.5	12.8	6.8	6.0	Quaternary beach alluvium (Q5b)	
BH232	1781064.4	5484164.7	12.1	1.0	6.0	11.1	6.1	5.0	Recent alluvium (Q1a)	
BH233	1782263.4	5485461.4	14.3	5.5	8.5	8.8	5.8	3.0	Quaternary beach alluvium (Q5b)	
BH234	1777890.0	5479324.3	23.3	2.0	6.0	21.3	17.3	4.0	Dune sand (Q1s) and quaternary beach alluvium (Q5b)	
BH235	1779230.4	5481392.2	17.8	3.5	8.5	14.3	9.3	5.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH236	1780899.5	5484094.4	22.2	5.0	9.0	17.2	13.2	4.0	Quaternary terrace alluvium (Q2a) and quaternary beach alluvium (Q5b)	
BH810	1781011.5	5484070.8	TBD							Proposed Geotechnical Standpipe
BH812	1780960.0	5484114.4	TBD							
BH815	1777763.1	5479153.7	TBD							
BH818	1780995.04	5483927.338	TBD							Proposed Groundwater Monitoring Standpipe
BH819	1780881.087	5483996.466	TBD							
BH820	1780783.711	5483707.253	TBD							
BH821	1780726.826	5483740.733	TBD							
S25/5342	1780608.0	5483702.0	22.6	Unknown						Existing Ground Water Wells (Monitored by Opus)
S25/5365	1780300.0	5483863.0	22.6	Unknown						

Borehole ID	Location			Response Zone						Comment
	Easting (NZTM)	Northing (NZTM)	BH RL (NZVD2009)	Top of Screen (mbgl)	Bottom of Screen (mbgl)	Top of Screen (mRL)	Bottom of Screen (mRL)	Screen length (m)	Geological Unit	
50	1781283	5484086						TBD		Existing Groundwater Wells (within 500m from chainages 4100 to 4400). Location of wells and access to be confirmed prior to construction.
BN33/0008	1780469	5483835						TBD		
BN33/0011	1781231	5484242						TBD		
BN33/0012	1781172	5484185						TBD		
S25/5114	1780427	5483692						TBD		
S25/5252	1781218	5481785						TBD		
S25/5257	1780296	5483447						TBD		
S25/5260	1780183	5483686						TBD		
S25/5261	1780283	5483686						TBD		
S25/5265	1780183	5483886						TBD		
S25/5267	1781283	5483886						TBD		
S25/5268	1780383	5483886						TBD		
S25/5270	1780683	5483986						TBD		
S25/5271	1781383	5483986						TBD		
S25/5272	1781383	5483986						TBD		
S25/5273	1781483	5483986						TBD		
S25/5274	1781283	5483986						TBD		
S25/5275	1781083	5483986						TBD		
S25/5277	1781383	5484086						TBD		
S25/5278	1781383	5484086						TBD		
S25/5280	1781183	5484086						TBD		
S25/5350	1780353	5483361						TBD		
S25/5352	1780483	5483886						TBD		
S25/5359	1780258	5483436						TBD		
S25/5386	1780493	5483698						TBD		
R25/5103	1777101	5479102						TBD		
R25/5108	1777546	5478865						TBD		
R25/5198	1776967	5478806						TBD		

APPENDIX D – EXISTING GROUNDWATER USERS

LABEL	ID	APPELLATION	OWNER	Address	Phone Number	TITLE	GWRC Database Bores	Known Bores, Wells and Water Take Consents
1	3860923	Lot 2,DP 18929,0.8534	Philip James McPhail Fiona Michele McPhail	39 Addington Road, Otaki		WN880/12		No
2	3782481	Lot 4,DP 18929,1.6137	Alan Keith Colman Mary Patricia Colman	23 Addington Road, Otaki	06 364 7676	WN722/66	S25/5261	Yes
3	3751937	Lot 3,DP 18929,0.8093	Public Trust & Elmswood Trustee Limited (Don Stuart Charlett & Myrna Kathleen Read)	35 Addington Road, Otaki	06 364 6467	WN863/47		No
4	3802702	Lot 1,DP 17292,0.2023	Jennifer Kaye Haugh	40 Addington Road, Otaki	06 364 6080	WN609/296		No
5	3814270	Lot 1,DP 68010,0.3550	Jason Robert John Kemp	36 Addington Road, Otaki		WN38A/922		No
6	7241877	Lot 2,DP 429805,2.2119	Stephen William Forsyth Joanne Louise Forsyth			516277	S25/5114 S25/5386	Yes
7	3807401	Lot 1,DP 20824,0.1012	Rodney Robert Clifton Joy Ruth Clifton,Cullinane Steele Trustees 2003 Limited	1189 State Highway 1, Otaki-Waikanae	06 364 3105	WN902/43		No
8	3871250	Lot 1,DP 22239,0.1115	Penelope Vicky Bertelsen			WN914/27		No
9	3796173	Lot 1,DP 81665,0.0814	Penelope Vicky Bertelsen			WN48B/143		No
11	3941763	Lot 2,DP 81665,0.0027	F R P V Bertelsen Limited			WN48B/144		No
12	3890445	Pt Lot 2,DP 30709,0.1369	Brent Victor Bertelsen Jane Lesley Bertelsen			WN48B/145		No
31	3985175	Pt Lot 1,DP 55964,6.2626	F R P V Bertelsen Limited			WN48B/144	S25/5359 S25/5257	Yes
34	3982198	Lot 2,DP 65764,4.1697	Jane Lesley Bertelsen Robin James Barrie Roger Gerard Downey			WN34B/900		No
10	3803215	Lot 1,DP 65764,0.5577	Kelvin John Smith	1209 State Highway 1, Otaki-Waikanae	06 364 0999	WN34B/899		No
13	3833031	Lot 1,DP 72050,0.3925	Lesley Dawn Mann Albert Henry Mann	26 Addington Road, Otaki	06 364 8528	WN40A/21		No
14	7241876	Lot 1,DP 429805,0.7093	Colin Stanley Fairhurst Kevin Paul Forgeson	1217 State Highway 1, Otaki-Waikanae	06 364 8976	516276		No
15	3830194	Lot 5,DP 18929,0.8169	David Nolan Randall and Jill Marie Frances Randall, and Bruce Curran			WN19A/1225		No
16	3867069	Lot 4,DP 77471,1.5030	Kennott Trust Company Limited (D & J Pritchard, T Nowland) (Land Matters)	20 Addington Road, Otaki		WN43D/81	BN33/0008	Yes
17	7241878	Lot 3,DP 429805,0.1294	Michael Scott Hyland Queenie Rawinia Rikihana Graham John Winterburn Lenore Jane Winterburn	3 Addington Road, Otaki	11 Rangiuru Rd, Otaki 06 364 8676	524962	S25/5342	Yes
18	3821072	Lot 7,DP 18929,0.1280	Michael Scott Hyland Queenie Rawinia Rikihana Graham John Winterburn Lenore Jane Winterburn			524962		No
19	3948905	Lot 3,DP 77471,1.3260	Royden Stuart Mayfield Susan Claire Mayfield	Toad Hall, 4 Addington Road, Otaki	06 364 8900	WN43D/80		No
20	3934410	Section 84,Blk X Waitohu SD,0.2527	Railway Purposes NZGZ 1929 p 2761					No
21	3894305	Lot 1,DP 77010,0.5655	Patricia Kathleen Chapman Kevin William Chapman	40 Otaki Gorge Road, Akatarawa-Otaki	06 364 5470 (Chapman KW & TK)	WN43D/359		No
22	3829246	Lot 1,DP 51817,0.2444	Michael Douglas Nutting Barry Norris Nutting James Clifford Simpson	32 Otaki Gorge Road, Akatarawa-Otaki	06 364 7342 (ME Nutting)	WN21C/421		No
23	6915862	Lot 1,DP 368337,0.7968	Her Majesty the Queen (Ex- Guthrie)	19 Otaki Gorge Road		277591		No
24	4035772	Lot 1,DP 75822,0.6685	Her Majesty the Queen (Ex- Angus & Hall)	15 Otaki Gorge Road		WN43A/409		No
25	3902717	Lot 1,DP 86069,0.0495	Victor John Walker Vivienne Walker	66 Otaki Gorge Road, Akatarawa-Otaki	06 364 5786	WN53D/378		No
26	3822259	Lot 1,DP 77899,0.3860	Victor John Walker Vivienne Walker			WN53D/378		No
27	4035771	Lot 4,DP 75822,0.4735	Graeme Bruce McGregor Gillian Mary Hay	65 Otaki Gorge Road, Akatarawa-Otaki	06 364 8208	WN43A/412		No
28	4036110	Lot 5,DP 75822,0.1123	The Kapiti Coast District Council ,Local Purpose Reserve (Esplanade)			WN43A/413		No
29	3955321	Lot 6,DP 75822,0.1742	Crown Land					No
32	7399197	Lot 3,DP 454823,18.4230	Stephen John Rowland, Sharleen Workman,Advisory Trustees 011 Limited	62 Addington Road, Otaki		584410	S25/5128	Yes
33	4021960	Lot 2,DP 55964,5.6174	Wendy Anne Devenport	45 Addington Road, Otaki		WN25D/986	S25/5260	Yes
35	7399196	Lot 2,DP 454823,4.4095	Richard Hudson Caughley Sarah Elizabeth Playne Caughley Richard Hudson Caughley Sarah Elizbeth Playne Caughley			584409	S25/5289 S25/5288 S25/5290	Yes
36	3899979	Lot 1,DP 34974,4.0468	Neil Jackson Baldwin Betty Dorothy Baldwin	42 Addington Road, Otaki	06 364 5769	WN11C/430		No
37	7128085	Pt,I Waopukatea Block,4.4261	Balance Parcel NZGZ 2009 p 1935 (RAIL)					No

LABEL	ID	APPELLATION	OWNER	Address	Phone Number	TITLE	GWRC Database Bores	Known Bores, Wells and Water Take Consents
38	3758084	Lot 1,DP 27257,4.8562	Her Majesty the Queen (Ex- Bertelsen)	9 Old Hautere Road		WNE2/728	42	Yes
39	3752756	Lot 2,DP 72050,4.5410	Remus Mihaila Lacramioara Daniela Mihaila	30 Addington Road, Otaki		WN40A/22	S25/5268	Yes
40	3975083	Pt Lot 2,DP 27257,5.1975	Sarah Lee Brown Mark Gilbert Maclean	11 Old Hautere Road, Te Horo		WN40D/618	S25/5256	Yes
41	3898990	Lot 3,DP 27257,4.2492	Christopher Morris Wendy Mary Morris	19-21 Old Hautere Road, Te Horo		WNE2/1437		No
42	3918240	Pt Lot 3,DP 52450,5.0616	John Peter Boyle Susan Patricia Boyle	Old Hautere Road, Te Horo	224B Parkes Line Road, Upper Hutt 04 526 7385	WN53C/592		No
43	4031601	Lot 1,DP 77471,5.2850	Simon Dirk Berend van den Berg Jacqueline van den Berg	24 Addington Road, Otaki	221 Manly Street, Paraparaumu Beach 04 904 6143	WN43D/78	S25/5352	Yes
44	3894307	Pt Lot 3,DP 56271,5.0580	Gregory Wayne Elliott Julie Edna Elliott			WN43D/360		No
45	3951014	Lot 2,DP 77471,8.0660	J C Morrison Farm Limited (John M & Christine A Morrison)	4 Addington Road, Otaki	4/38a Roxburgh Street, Mt. Victoria, Wellington 6011 04 385 2559	WN43D/79	S25/5270	Yes
46	3914077	Lot 2,DP 56271,5.5975	Diane Nise Henderson Stephen Peter Henderson Murray Ivan Deans			WN27C/10		No
47	3909578	Lot 1,DP 56271,5.5310	Her Majesty the Queen (Ex- Kilbirnie Animal Health Properties Limited)	34 Otaki Gorge Road		WN27C/9		No
48	3770570	Lot 2,DP 56978,1.4975	Her Majesty the Queen (Ex- Matthews)	12-29 Otaki Gorge Road		WN27B/146		No
49	6915863	Lot 2,DP 368337,5.0740	Gees Thoroughbreds Limited			277592	S25/5275 S25/5280	Yes
50	4063553	Lot 2,DP 52450,6.7450	Greenolive Limited (Brian J B & Sadie J Lange)	68 Otaki Gorge Road, Akatarawa-Otaki	06 364 0664	WN26A/387		No
51	3902719	Pt Lot 1,DP 52450,5.8005	Donald McIntosh McLeod	44 Otaki Gorge Road, Akatarawa-Otaki	06 364 5212	WN53D/379		No
52	3992989	Lot 3,DP 56978,5.1170	Her Majesty the Queen (Ex- Lange)	3 Otaki Gorge Road		WN27B/147	BN33/0012 BN33/0011	Yes
53	3749070	Pt Lot 1,DP 16503,51.0220	Fletcher Concrete and Infrastructure Limited			WN1200/35,84260	S25/5345	No
54	7162767		NZGZ 2012 p 2294 (RAIL)					No
55	7162756	Section 2,SO 417765,14.1129	Wellington Regional Council ,Set apart as Local Purposes Reserve (soil conservation and river control) \ NZGZ 2012 p 2294 [Classification and Vesting of a Reserve. Local Purpose (Soil Conservation and River Control) Reserve and Vests in Wellington R...			596260		No
56	3955322	Lot 3,DP 75822,5.1935	Phillip Andrew Guthrie Tracy Jane Guthrie			WN43A/411		No
57	3760869	Pt Lot 5,DP 59965,5.7669	Martin Arthur Broad Heather Dorothy Lear Linda Jane Broad	70 Otaki Gorge Road, Akatarawa-Otaki	AM & MJ Broad 06 364 5815	WN42C/40	S25/5411	Yes
58	3987108	Lot 7,DP 59965,6.0774	Yurdakul Bagci Naciye Bagci Robert Anthony Elms	86 Otaki Gorge Road, Akatarawa-Otaki	06 364 6046	WN29C/222		No
59	3993194	Lot 2,DP 27891,7.4386	Darren Paul Nicholas Leanne Nicholas	69 Otaki Gorge Road, Akatarawa-Otaki	06 364 6842	WNF1/1231	S25/5271 S25/5272 S25/5267	Yes
60	3895967	Lot 1,DP 27891,5.3216	Max Foster Nevill Green Lee Anne Green Christopher Elliot Ritchie	73 Otaki Gorge Road, Akatarawa-Otaki	06 364 5094	WNF1/1232		No
61	3753433	Pt Lot 2,DP 3527,9.5910	Soil Conservation and River Control NZGZ 1961 p 1862				50 S25/5278 S25/5277 S25/5273 S25/5274	Yes
65	3932262		GWRC					No

TPG (The Property Group) Contact: Rano Lealuga, 027 633 6111

APPENDIX E – EXISTING GROUNDWATER MONITORING DATA

Notice to Contractor No 18 – Groundwater Monitoring Data - BH101 to BH113 & CPT114, CPT117 & CPT118 between May 2012 and April 2013.

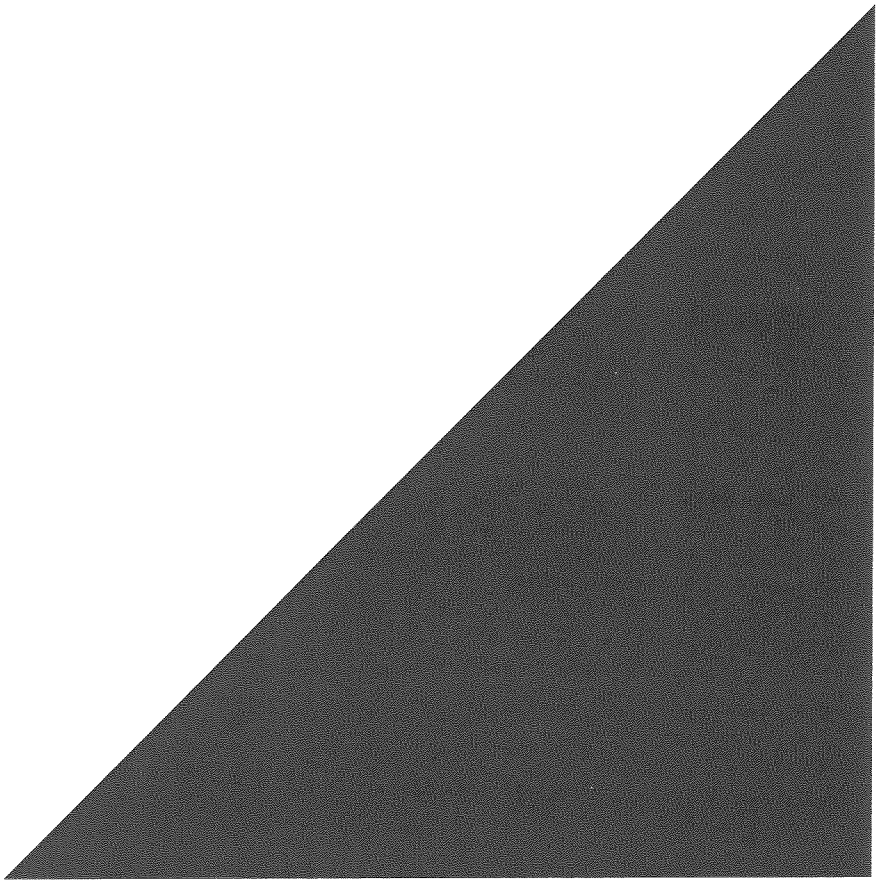
Peka Peka to Ōtaki Groundwater Monitoring Results December 2014 to December 2016, Opus International Consultants December 2016

OPUS

Peka Peka to Otaki Expressway

Groundwater Monitoring Results

December 2014 to December 2016



OPUS

Peka Peka to Otaki Expressway

Groundwater Monitoring Results

December 2014 to December 2016

Prepared By

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Status: Issue 1

Contents

1 Introduction

The NZ Transport Agency (NZTA) commissioned Opus International Consultants (Opus) to prepare a specimen design, and manage construction, of the proposed Peka Peka to Otaki Expressway (PP2O) project. This included geotechnical investigations and monitoring of groundwater levels along the length of the project area. The project area extends 13 km from Taylors Road, north of the Otaki Township, to Te Kowhai Road in Peka Peka in the south. The site project area is illustrated on Figures 1 to 16.

Groundwater levels were monitored in piezometers which were installed within boreholes during the specimen design and tender stage geotechnical investigations. Groundwater levels were also monitored in pre-existing privately owned water wells.

This report presents the groundwater monitoring results for the period from December 2014 to December 2016.

2 Piezometers

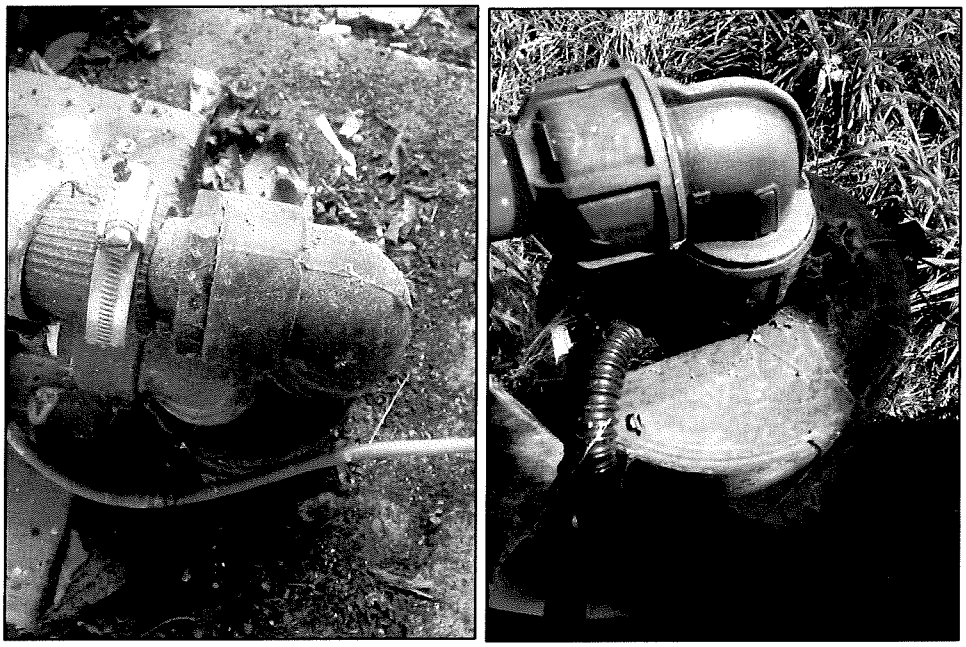
A total of 32 piezometers monitored groundwater conditions across the PP2O project area. The monitoring locations have been professionally surveyed. Their co-ordinates are presented in Table 1 and their positions are shown in Figures 1 to 16.

Piezometer construction consisted of 25 mm PVC pipe and filter fabric, surrounded by well graded sand and sealed with an upper and lower bentonite cap (Appendix A). The groundwater response zones are presented in Table 1.

3 Water Wells

Water wells were pre-existing private bores and their construction details and groundwater response zones are unknown. The area of influence of the construction works and the consented and recorded water wells in the area are shown in Figure 17. Only two of these water wells at the following locations were available for monitoring; S25/5342 (3 Addington Road) and S25/5365 (40 Addington Road). These water wells were monitored and their locations are shown in both Figures 6a and 17. Photographs of these bores are presented below.

Photograph 1 Water Wells S25/532 (3 Addington Road) and S25/5365 (40 Addington Road)



4 Groundwater Monitoring

Groundwater levels were monitored during the specimen design stage and tender stage geotechnical investigations as investigation locations were completed, extending from December 2014 through to December 2016. Monitoring was undertaken using a flat tape water level dip meter with a probe tip sensor.

The monitoring during the investigations was carried out by Griffiths Drilling (NZ) Ltd. The frequency of monitoring has varied over time:

- Approximately trimonthly from February 2015 to July 2015;
- Approximately fortnightly from August 2015 to December 2015;
- Approximately monthly from January 2016 – December 2016.

During the monitoring period, some of the piezometers were destroyed by livestock movements or obscured by flood deposits.

5 Groundwater Monitoring Results

The groundwater monitoring results are summarised in Table 1. The complete monitoring dataset is presented in Appendix B.

6 Groundwater Observations

6.1 Surface Ponding

Locations prone to experiencing periodic surface ponding were observed across the project area and were more common during the winter months. Areas where surface ponding was observed is presented in Table 2. Locations are presented north to south.

Piezometer levels and monitoring data identifies some of these surface ponding sites. However, as piezometer monitoring was not continuous (i.e. measurements fortnightly to trimonthly), and piezometers were not installed in all areas prone to surface ponding, some areas of potential surface ponding may not have been identified through piezometer measurements alone.

6.2 Trial Pit Groundwater Observations

Groundwater observations were recorded within trial pit excavations.

Groundwater flows into trial pits were noted to occur predominantly within the interdune deposits however, some trial pits excavated within terrace and recent alluvium, and also exhibited groundwater seepage. Trial pits excavations were open for approximately 2 hours.

Table 3 presents the locations where groundwater seepage or flow was observed within trial pit excavations. Locations are presented north to south.

6.3 Groundwater Fluctuations

Over the course of the groundwater monitoring period, fluctuations in groundwater levels were noted from ground observations and piezometer levels. As with surface ponding observations, fluctuations in groundwater levels were largely influenced by seasonal variations and rainfall events.

Table 1 presents the maximum and minimum recorded groundwater levels for each piezometer. Locations are presented north to south.

6.4 Surface Water Movement

During the site investigations, surface water movements were observed.

Surface water movement was most notable in the area of recent alluvial deposits situated around BH218, TP325 and TP345 (otherwise known as Marycrest property). The stream/river flowing adjacent to these site investigation locations would often flood over the banks flowing out across the adjacent river flats up to 30 m from the main channel. It was not uncommon for active alluvial deposits to have accumulated above the piezometer at BH218.

Such surface flooding events were common during winter months but were also noted to occur during severe rainfall events.

Tables

Table 1 – Borehole locations and piezometer response zones

Borehole ID	Easting[3]	Northing[3]	Borehole RL (m)	Depth to Response Zone (mbgl)		Depth to Response Zone (mRL)		Results				
				Top of Screen	Bottom of Screen	Top of Screen	Bottom of Screen	Max. (mbgl)	Min. (mbgl)	Max. (mRL)	Min. (mRL)	No. of Records
BH 201	1782236	5485496	14.14	4.50	12.50	9.64	1.64	4.24	2.20	11.94	9.90	38
BH 202	1782375	5485791	23.03	8.00	13.00	15.03	10.03	9.21	8.25	14.78	13.82	39
BH 203	1782438	5485818	25.54	8.00	13.00	17.54	12.54	8.92	6.92	18.62	16.62	39
BH 204	1782282	5485446	14.99	4.00	10.00	10.99	4.99	4.57	2.55	12.44	10.42	39
BH 205	1781115	5484217	11.95	3.00	9.50	8.954	2.454	2.19	0.85	11.10	9.76	38
BH 206	1782405	5485808	17.92	7.50	11.00	10.42	6.92	6.76	2.73	15.19	11.16	39
BH 207	17777309	5479036	30.16	8.00	12.00	22.16	18.16	9.81	2.17	27.99	20.35	39
BH 208	1776918	5478594	12.18	3.50	6.50	8.68	5.68	1.50	0.00	12.18	10.68	38
BH 209	1776822	5478349	18.23	3.00	6.00	15.23	12.23	1.95	0.67	17.56	16.28	38
BH210	1780967	5484080	22.46	No piezometer installed				No piezometer installed				
BH 211	1779181	5481429	17.16	5.00	9.00	12.16	8.16	6.76	5.45	11.71	10.40	39
BH 212	1777216	5478931	22.71	5.00	9.00	17.71	13.71	3.47	1.36	21.35	19.24	39
BH 213	1777411	5479090	22.55	2.00	6.00	20.55	16.55	5.00	2.21	20.34	17.55	37
BH 214	1780678	5483607	23.50	5.00	10.00	18.5	13.5	8.35	5.14	18.36	15.15	38
BH 215	1781144	5484309	10.69	1.00	5.00	9.69	5.69	1.22	0.27	10.42	9.47	38
BH 216	1781914	5485013	15.01	4.00	8.00	11.01	7.01	5.03	3.30	11.71	9.98	36
BH 217	1781201	5484409	10.52	No piezometer installed				No piezometer installed				
BH 218	1777506	5479182	18.88	1.00	4.00	17.88	14.88	1.10	0.00	18.88	17.78	36
BH 219	1777078	5478788	12.37	1.00	4.00	11.365	8.365	1.10	0.00	12.37	11.27	36
BH 220	1776695	5478146	13.37	0.50	5.00	12.87	8.37	1.10	0.50	12.87	11.32	27
BH 221	1779269	5481366	18.43	4.00	9.00	14.425	9.425	8.07	5.95	12.48	10.36	29
BH 222	1777783	5479214	23.81	1.00	6.00	22.81	17.81	4.92	0.85	22.96	18.89	28
BH 223[2]	1777882	5479314	23.50	2.00	4.00	21.50	19.50	9.85	1.06	22.44	13.65	27
				9.00	11.00	14.50	12.50	2.15	1.06	22.44	21.35	25
BH 224	1777598	5479182	20.36	0.50	5.00	19.86	15.36	4.60	0.00	20.36	15.76	28

Borehole ID	Easting[3]	Northing[3]	Borehole RL (m)	Depth to Response Zone (mbgl)		Depth to Response Zone (mRL)		Results				
				Top of Screen	Bottom of Screen	Top of Screen	Bottom of Screen	Max. (mbgl)	Min. (mbgl)	Max. (mRL)	Min. (mRL)	No. of Records
BH225	1782469	5486311	29.29	10.00	14.00	19.29	15.29	14.10	13.20	16.09	15.19	7
BH226	1782832	5486716	26.07	8.00	12.00	18.07	14.07	5.22	4.05	22.02	20.85	9
BH227	1782802	5486741	25.37	No piezometer installed				No piezometer installed				
BH228	1782761	5486658	25.62	9.00	13.00	16.62	12.62	5.62	4.91	20.71	20.00	8
BH229	1782364	5485830	27.36	9.50	14.50	17.86	12.86	13.86	13.24	14.12	13.50	7
BH230	1777811	5479307	22.76	9.50	15.50	13.26	7.26	1.31	0.87	21.89	21.45	7
BH231	1777514	5479112	21.304	No piezometer installed				No piezometer installed				
BH232	1781064	5484165	12.59	1.00	6.00	11.59	6.59	1.93	1.35	11.24	10.66	5
BH233	1782263	5485461	14.79	5.50	8.50	9.29	6.29	3.95	3.52	11.27	10.84	5
BH234	1777890	5479324	23.73	2.00	6.00	21.73	17.73	2.89	2.12	21.61	20.84	5
BH235	1779230	5481392	18.25	3.50	8.50	14.75	9.75	6.73	5.71	12.54	11.52	4
BH236	1780899	5484094	22.62	5.00	9.00	17.62	13.62	8.64	7.35	15.27	13.98	4
3 Addington Road, Otaki[1]	1780608[4]	5483702[4]	23.00[4]	Unknown				5.39	4.88	17.61	18.12	5
40 Addington Road, Otaki[1]	1780300[4]	5483863[4]	23.00[4]	Unknown				7.08	6.69	15.92	16.31	5

Note:

Some of the groundwater records may be influenced by drilling operations using drilling fluids or surface water during storm events.

[1] Water well locations at 3 and 40 Addington Road were pre-existing to the site investigations and response zones are unknown.

[2] BH223 has two piezometers installed.

[3] All coordinates presented are rounded to the nearest meter. Coordinates were professionally surveyed using NZ Map Grid projection and Local Datum Wellington 1953 and are accurate to approximately 100 mm.

[4] Co-ordinates were measured using handheld GPS.

Table 2 – Surface ponding observations

Location of surface ponding observation	Visually observed depth of surface ponding (magl)	Timing and duration of surface ponding
Area of interdune deposits around TP347	~1.0 m	Swampland – continuous ponding for most of the year.
BH206	~0.05 m	Boggy ground only over winter months; days of ponding after heavy rainfall.
Area of terrace alluvium around TP342	~0.05 m	Boggy ground only over winter months; days of ponding after heavy rainfall.
Area of sand dunes and terrace alluvium around TP330 and TP344	~0.05 m	Boggy ground only over winter months; days of ponding after heavy rainfall.
BH218	~0.10 m	Minimal boggy/ponding over winter months; days of ponding from adjacent stream overflow after heavy rainfall.
BH219	~0.30 m	Continuous ponding over winter months; days to a week after heavy rainfall.
BH208	~0.10 m	Boggy ground only over winter months; days of ponding after heavy rainfall.
BH220	~0.10 m	Boggy ground only over winter months; days of ponding after heavy rainfall.
C430	~0.05 m	Boggy ground only over winter months; days of ponding after heavy rainfall.

Table 3 – Trial pit groundwater observations

Location	Depth of excavation (m)	Depth below ground of groundwater seepage (m)	Date of trial pit excavation	Groundwater observations along length of excavation face
TP329	4.10	3.90	16/02/2015	Minor seepage/occasional dripping.
TP348	4.10	0.00	26/06/2015	Swampland, exceptionally high flow.
TP305	4.50	0.70	22/01/2015	Continuous flow.
TP347	3.00	0.00	23/06/2015	Swampland, exceptionally high groundwater flow.
TP304	4.20	0.70	22/01/2015	Continuous flow.
TP346	3.00	0.00	23/06/2015	Swampland, exceptionally high flow.
TP340	4.70	4.50	11/05/2015	Minor seepage/localised dripping.
TP342	3.50	3.00	11/05/2015	Continuous flow.
TP303	4.50	4.00	21/01/2015	Minor seepage/occasional dripping.
TP302	4.10	3.80	21/01/2015	Minor seepage/occasional dripping.
TP301	4.50	4.40	21/01/2015	Minor seepage/continuous dripping.
TP335	3.30	2.40	29/04/2015	Minor seepage/localised dripping.
TP308	4.40	3.80	23/01/2015	Minor seepage/localised dripping.
TP311	4.00	2.41	26/01/2015	Minor seepage/occasional dripping.
TP322	5.40	5.10	12/02/2015	Minor seepage/occasional dripping.
TP330	4.10	0.75	19/02/2015	Continuous flow.
TP343	3.80	0.50	18/05/2015	Continuous flow.
TP344	4.00	1.00	18/05/2015	Continuous flow.
TP331	1.30	0.80	19/02/2015	Continuous flow.
TP325	4.70	1.00	13/02/2015	Continuous flow.
TP345	3.40	2.00	18/05/2015	Continuous flow.
TP324	4.70	3.90	12/02/2015	Minor seepage/localised dripping.
TP337	5.00	4.90	30/04/2015	Minor seepage/localised dripping.

Figures:

Site Project Area, Site Investigation Locations & Water Well Locations

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Prepared for:
NZ TRANSPORT AGENCY
WAKA KOTAHI

Prepared By:
OPUS

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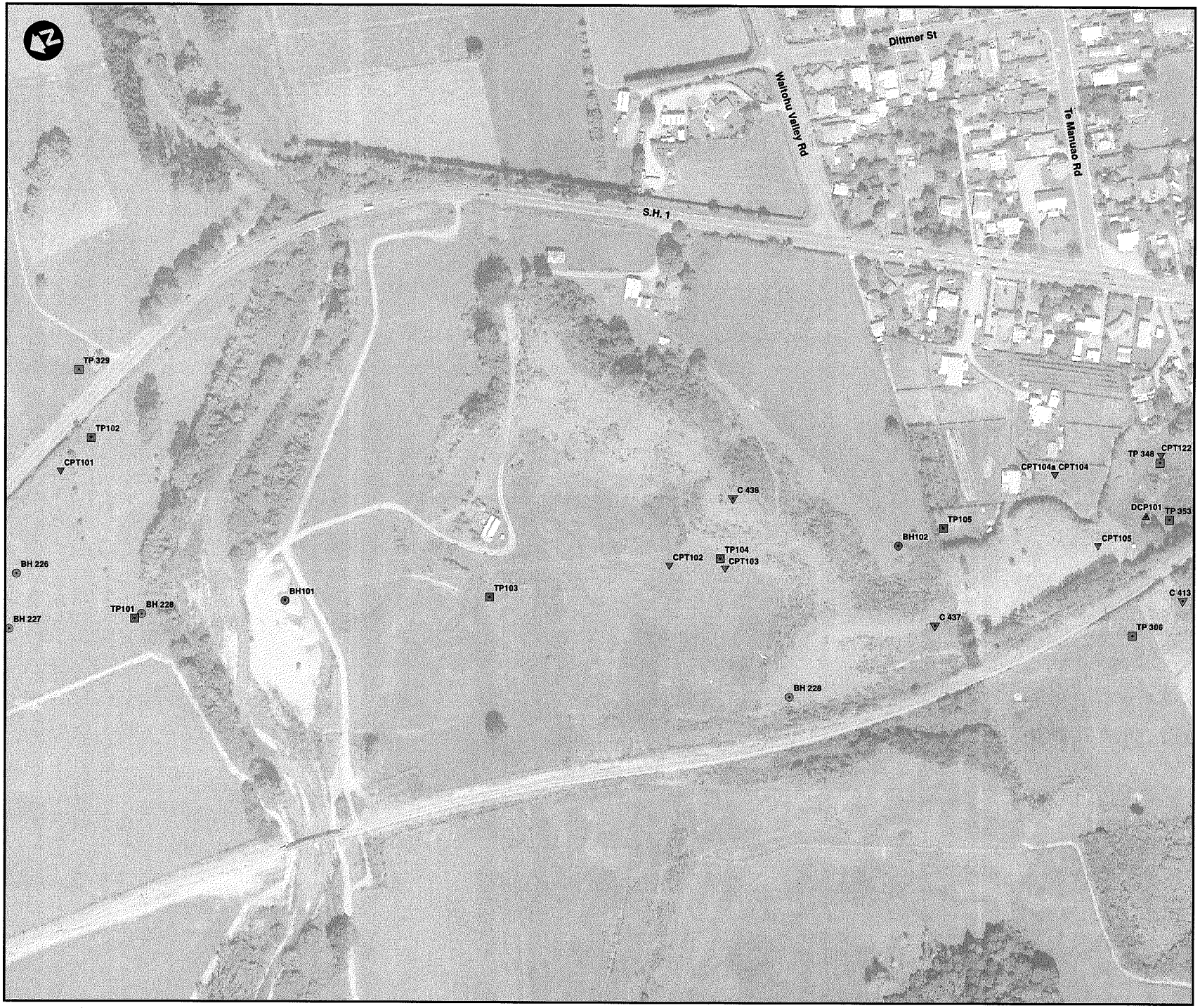

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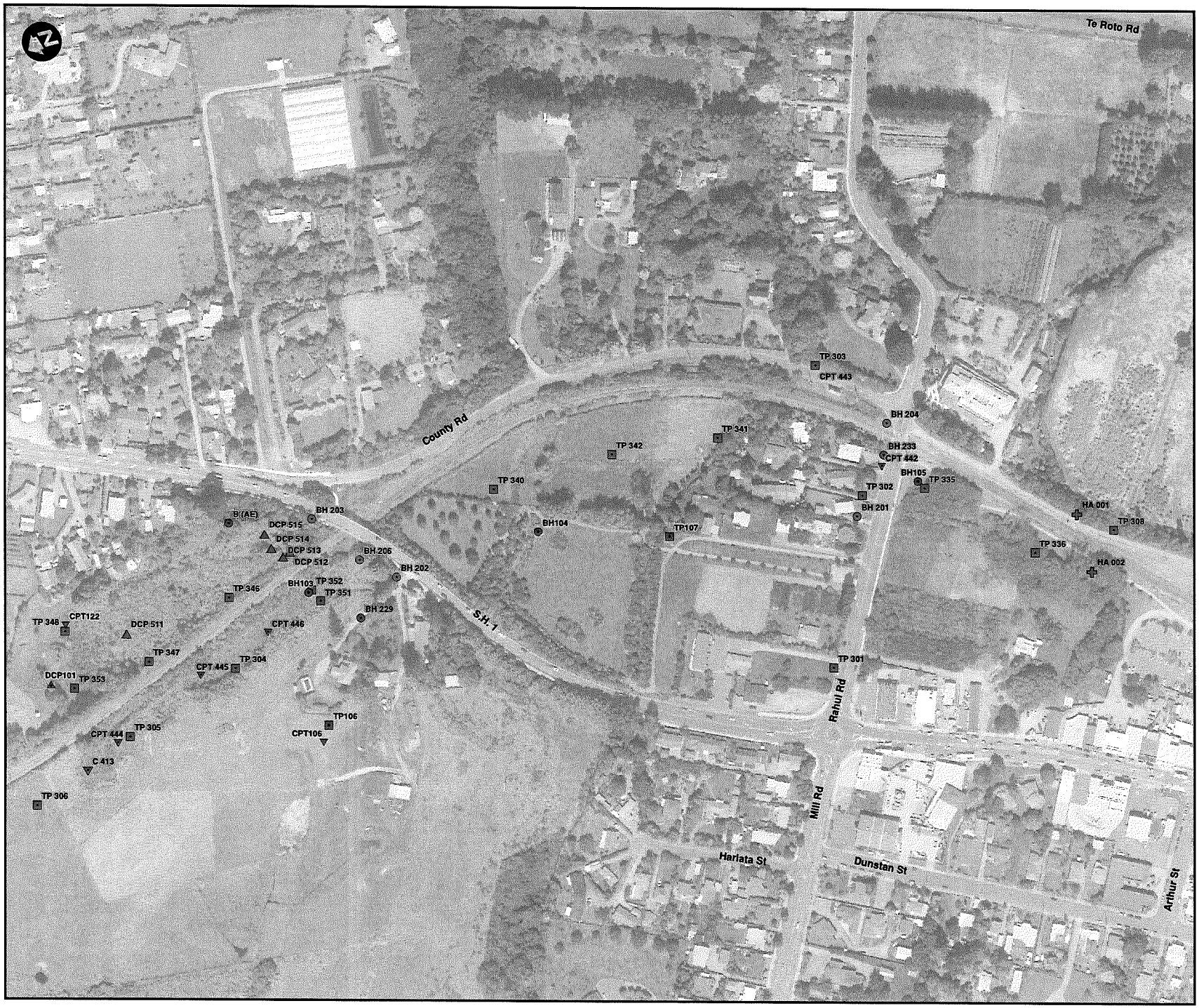

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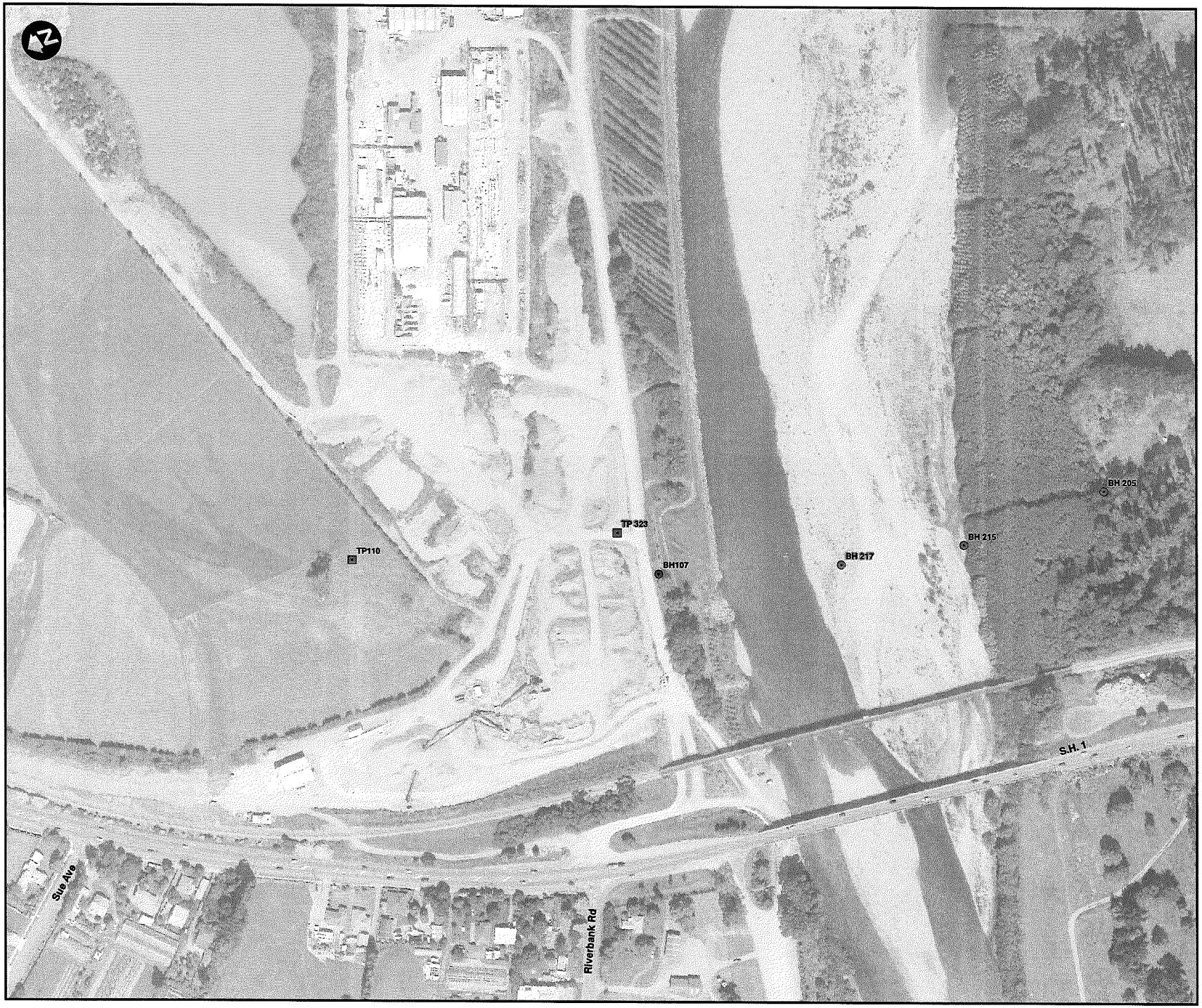

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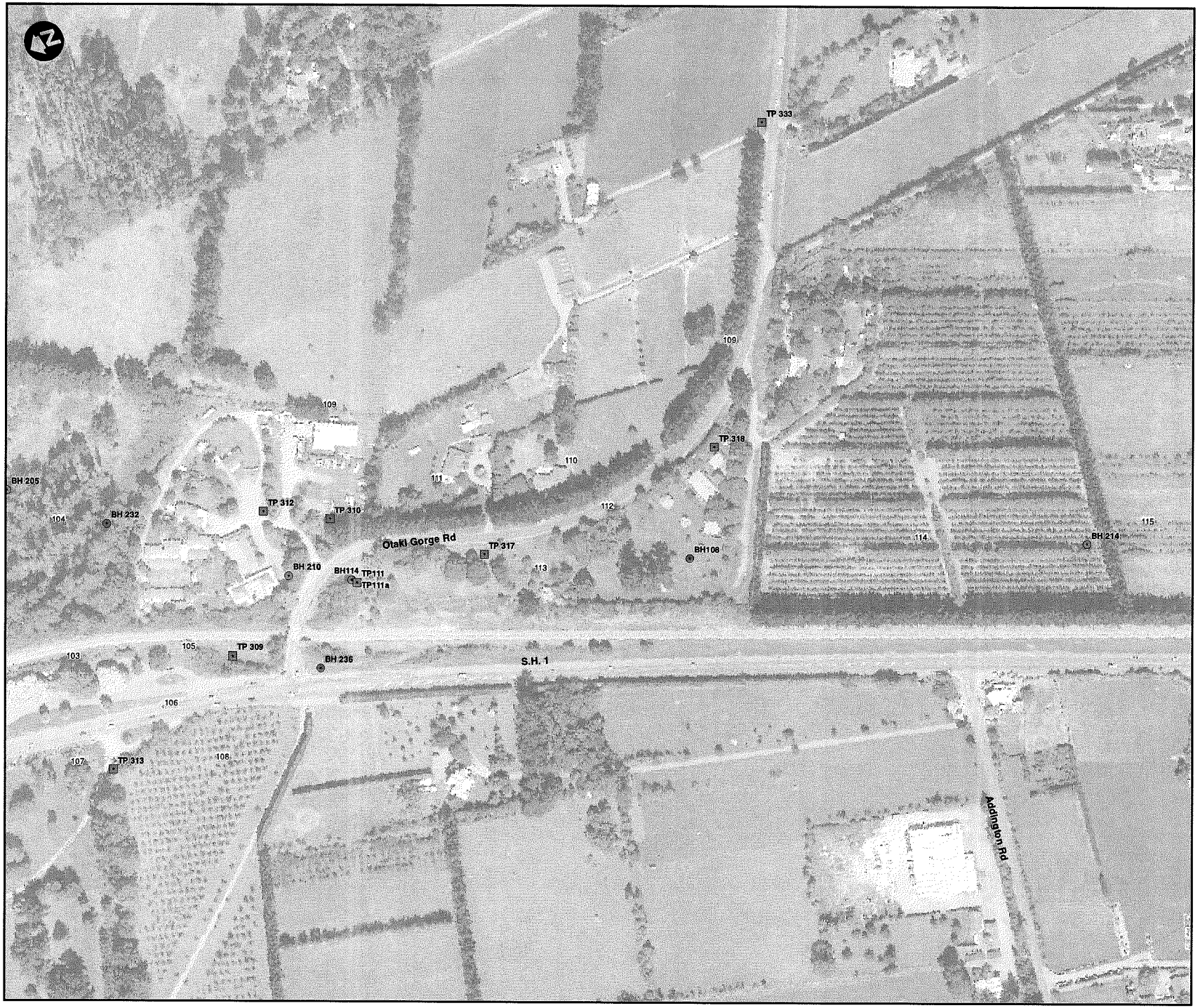

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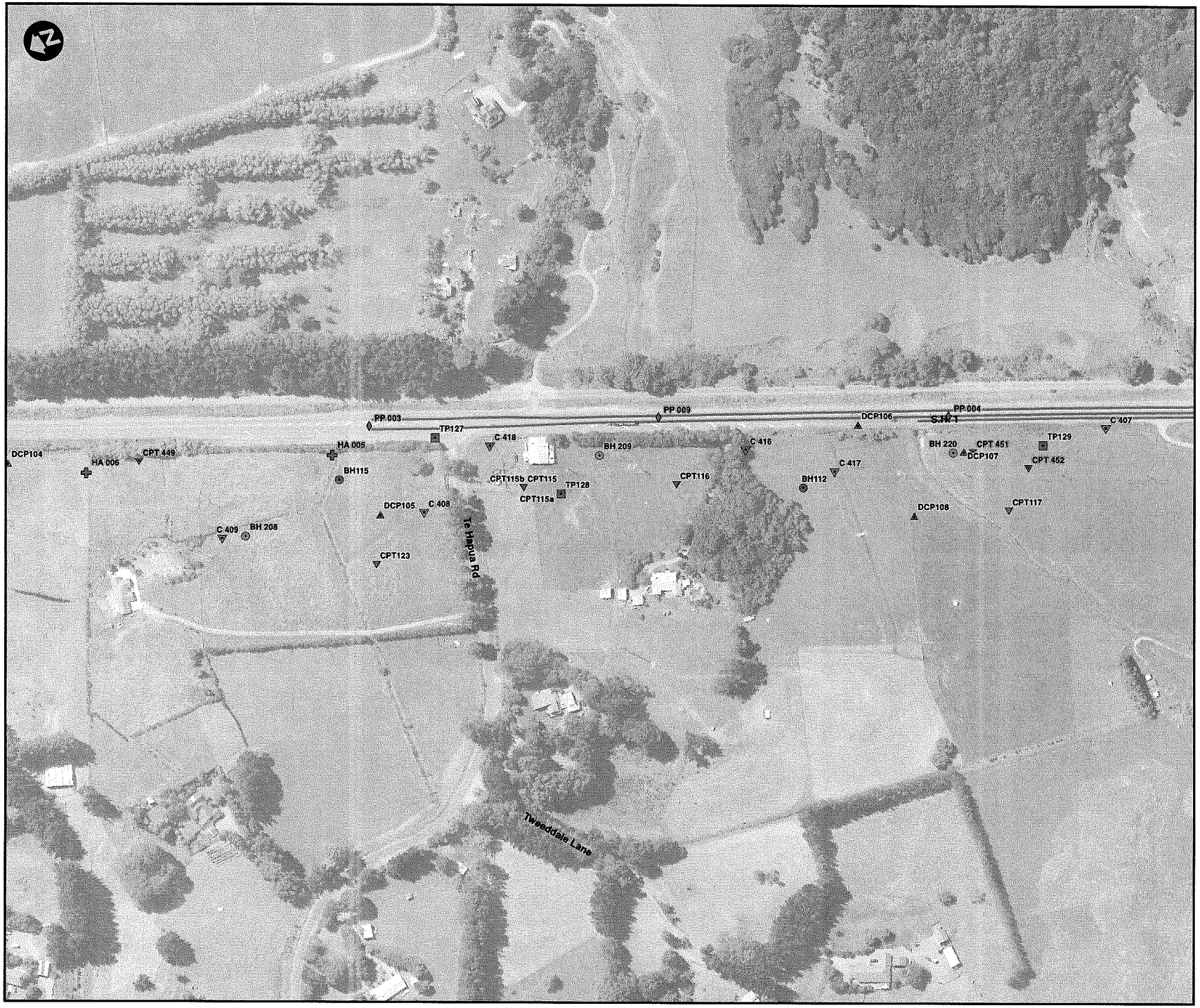

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- GWRC Bores and Wells
- GWRC Water Take Consents
- Buffer (Board of Inquiry)
- Intersected Parcels

Scale: 1:5,000

0 25 50 100 150 200 250 Meters

Title: **Location of Known Water Wells**

Project: **Peka Peka to Otaki Expressway Principals Requirements & Specimen Design Phase**

Prepared for: NZ TRANSPORT AGENCY WAKA KOTAHI

Prepared By: OPUS

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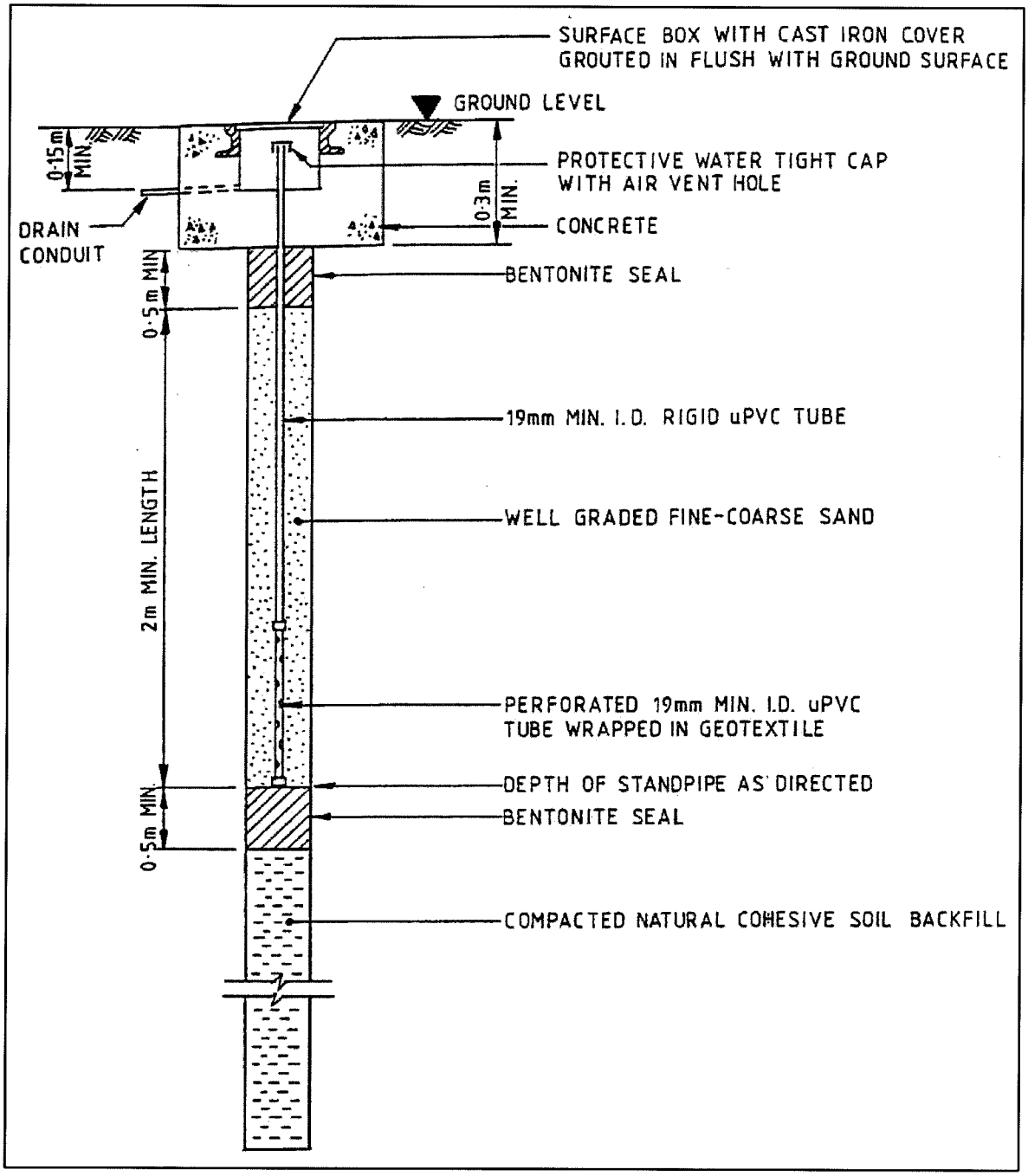
Appendix A:

Piezometer Construction Specification


SURFACE BOX WITH CAST IRON COVER
GROUTED IN FLUSH WITH GROUND SURFACE
GROUND LEVEL
0·15m MIN.
PROTECTIVE WATER TIGHT CAP
WITH AIR VENT HOLE
0·3m MIN.
CONCRETE
DRAIN
CONDUIT
BENTONITE SEAL
0·5m MIN
19mm MIN. I.D. RIGID uPVC TUBE
2m MIN. LENGTH
WELL GRADED FINE-COARSE SAND
PERFORATED 19mm MIN. I.D. uPVC
TUBE WRAPPED IN GEOTEXTILE
DEPTH OF STANDPIPE AS DIRECTED
0·5m MIN.
BENTONITE SEAL
COMPACTED NATURAL COHESIVE SOIL BACKFILL

Appendix B:

Piezometer Monitoring Records

Appendix B –Piezometer monitoring records (mbgl)

Borehole ID	Water level in terms of mbgl								
	16/02/2015	27/02/2015	6/03/2015	13/03/2015	23/03/2015	3/04/2015	10/04/2015	22/04/2015	8/05/2015
BH201	4.24	4.10	4.13	4.07	4.08	4.05	3.55	4.00	3.89
BH 202	9.08	9.16	9.21	9.05	9.10	9.10	8.96	9.10	9.00
BH 203	8.24	8.60	8.66	8.41	8.35	8.30	8.05	8.32	8.25
BH 204	4.41	4.48	4.54	4.41	4.40	4.40	4.00	4.32	4.05
BH 205	2.05	2.12	2.19	2.00	2.05	2.05	1.92	2.00	1.97
BH 206	5.17	5.21	5.16	5.05	5.00	4.95	4.72	4.97	4.90
BH 207	9.09	9.00	9.16	9.21	9.20	9.21	9.10	9.15	9.05
BH 208	0.48	0.52	0.60	0.55	1.50	1.49	1.45	1.47	1.41
BH 209	1.83	1.89	1.92	1.83	1.77	1.70	1.70	1.76	0.67
BH210	No piezometer								
BH 211	6.65	6.71	6.69	6.72	6.76	6.70	5.60	6.75	6.69
BH 212	3.26	3.24	3.24	3.30	3.43	3.42	3.35	3.39	3.28
BH 213			5.00	3.10	3.26	3.25	3.20	3.25	3.21
BH 214		5.28	8.35	8.29	8.20	8.17	7.90	8.16	8.05
BH 215		1.15	1.22	1.07	1.05	1.00	1.00	1.05	1.05
BH 216			4.65	5.03	5.00	4.95	4.60	4.97	4.81
BH 217	No piezometer								
BH 218				0.68	0.60	0.58	0.52	0.60	0.58
BH 219				1.05	1.05	1.00	1.00	1.05	1.03
BH 220									
BH 221									7.62
BH222									
BH223[1]									
BH223									
BH224									
BH225									
BH226									
BH227	No piezometer								
BH228									
BH229									
BH230									
BH231									
BH232	No piezometer								
BH233									
BH234									
BH235									
BH236									

Note:
Blank cells indicate investigation location not completed at monitoring date.
Some early records for each piezometer may be influenced by drilling operations using fluids.
[1] *Shallower response zone of BH223.*

Appendix B –Piezometer monitoring records (mbgl)

Borehole ID	Water level in terms of mbgl								
	11/05/2015	18/05/2015	3/06/2015	8/06/2015	16/06/2015	6/07/2015	15/07/2015	30/07/2015	20/08/2015
BH201	3.65	2.20	2.75	3.00	3.14	3.15	3.20	3.22	3.23
BH 202	8.80	8.25	8.43	8.45	8.80	8.79	8.80	8.80	8.87
BH 203	8.17	7.95	7.88	7.92	6.92	7.25	7.52	7.97	7.91
BH 204	3.72	2.55	2.95	3.02	3.66	3.65	3.60	3.72	3.74
BH 205	1.95	1.45	1.52	1.65	1.15	0.97	0.94	0.87	0.89
BH 206	4.75	4.10	4.10	4.15	6.40	6.39	6.35	6.45	6.40
BH 207	8.91	8.10	9.10	9.15	9.81	8.95	8.70	8.10	8.10
BH 208	1.39	1.29	1.42	1.45	0.97	1.00	0.95	0.86	0.85
BH 209	1.72	1.61	1.72	1.75	1.73	1.80	1.75	1.68	1.70
BH210	No piezometer								
BH 211	6.05	5.95	6.00	6.05	5.84	5.62	5.57	5.45	5.50
BH 212	2.95	2.05	3.40	3.47	2.12	1.85	1.65	1.41	1.45
BH 213	3.00	2.21	3.32	3.37	3.07	3.15	3.18	3.10	3.15
BH 214	7.55	6.25	6.88	6.93	7.25	6.90	6.88	6.85	6.80
BH 215	1.00	0.90	1.15	1.18	0.81	0.52	0.47	0.40	0.41
BH 216	4.40	3.30	3.72	3.77	4.32	4.05	4.10	3.97	3.95
BH 217	No piezometer								
BH 218	0.60	0.55	1.00	1.10	0.65	0.45	0.40	0.30	0.35
BH 219	1.00	0.93	1.05	1.07	0.77	0.67	0.60	0.51	0.54
BH 220	1.05	0.91	1.02	1.09	1.05	1.10	1.00	0.85	0.81
BH 221		7.58	7.77	7.79	8.03	7.85	7.82	7.79	7.75
BH222			4.47	4.53	4.92	1.90	1.70	0.91	0.89
BH223[1]			9.81	9.85	1.34	1.15	1.15	1.07	1.08
BH223					1.38	1.21	1.20	1.10	1.10
BH224			4.52	4.60	0.30	0.42	0.35	0.00	0.02
BH225									
BH226									
BH227									
BH228									
BH229									
BH230									
BH231									
BH232									
BH233									
BH234									
BH235									
BH236									

Note:
Blank cells indicate investigation location not completed at monitoring date.
[1] Shallower response zone of BH223.

Appendix B –Piezometer monitoring records (mbgl)

Borehole ID	Water level in terms of mbgl								
	1/09/2015	14/09/2015	29/09/2015	14/10/2015	23/10/2015	11/11/2015	25/11/2015	11/12/2015	17/12/2015
BH201	3.20	3.33	3.35	3.46	3.58	3.73	3.70	3.71	3.70
BH 202	8.86	8.91	8.88	8.90	8.91	8.94	8.91	8.93	8.90
BH 203	7.98	7.99	7.96	7.82	8.00	8.04	7.00	7.01	6.99
BH 204	3.65	3.72	3.69	3.76	3.81	4.00	3.97	3.97	3.96
BH 205	0.85	0.87	0.90	0.91	0.92	0.97	0.96	0.98	0.98
BH 206	6.36	6.41	6.40	6.36	6.54	6.76	6.69	6.67	6.68
BH 207	8.15	2.17	8.14	8.22	8.27	8.32	8.30	8.31	8.30
BH 208	0.82	0.80	0.81	0.88	0.40	0.95	0.94	0.95	0.97
BH 209	0.71	1.72	1.72	1.76	1.75	1.78	1.77	1.78	0.78
BH210	No piezometer								
BH 211	5.61	5.60	5.58	5.66	5.83	5.99	5.96	5.98	5.97
BH 212	1.49	1.53	1.55	1.71	2.02	2.24	2.21	2.22	2.24
BH 213	3.30	3.33	3.35	3.47	3.55	3.62	3.60	3.60	3.62
BH 214	6.79	6.82	6.81	6.84	6.87	6.95	6.93	6.94	6.92
BH 215	0.38	0.39	0.40	0.44	0.45	0.49	0.48	0.50	0.49
BH 216	3.96	4.00	3.98	4.03	4.02	4.05	4.01	4.00	4.01
BH 217	No piezometer								
BH 218	0.30	0.27	0.42	0.53	0.88	0.92	0.91	0.94	0.94
BH 219	0.49	0.52	0.50	0.59	0.67	0.78	0.76	0.77	0.76
BH 220	0.73	0.71	0.89	0.88	0.86	0.92	0.91	0.93	0.95
BH 221	7.73	7.72	7.70	7.78	7.87	8.05	8.05	8.05	8.04
BH222	0.87	0.88	0.85	0.90	0.92	0.97	0.97	0.98	0.98
BH223[1]	1.06	1.09	1.09	1.09	1.10	1.11	1.09	1.09	1.10
BH223	1.07	1.10	1.09	1.12	1.12	1.15	1.13	1.14	1.13
BH224	0.10	0.50	0.10	0.05	0.01	0.00	0.02	0.01	0.02
BH225									
BH226									
BH227									
BH228									
BH229									
BH230									
BH231									
BH232									
BH233									
BH234									
BH235									
BH236									

Note:
Blank cells indicate investigation location not completed at monitoring date.
[1] Shallower response zone of BH223.

Appendix B –Piezometer monitoring records (mbgl)

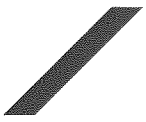
Borehole ID	Water level in terms of mbgl								
	21/01/2016	17/02/2016	7/03/2016	19/04/2016	23/05/2016	20/06/2016	29/06/2016	12/07/2016	22/07/2016
BH201	4.15	4.12	4.10	3.93	3.52	3.10	3.17	3.30	3.37
BH 202	9.16	9.15	9.17	9.08	9.05	8.80	8.85	8.80	8.92
BH 203	8.67	8.65	8.57	8.27	7.97	7.40	7.55	8.50	7.82
BH 204	4.53	4.57	4.48	4.21	3.87	3.60	3.67	3.77	3.86
BH 205	2.13	2.10	2.10	1.99	1.89	1.48	1.47	1.63	1.56
BH 206	5.23	5.20	5.18	4.48	3.98	3.16	3.05	3.16	3.20
BH 207	9.04	9.02	8.97	9.20	9.00	8.60	8.56	8.55	8.62
BH 208	0.55	0.50	0.53	0.48	0.37	0.00	0.00	0.00	0.00
BH 209	1.95	1.93	1.90	1.88	1.95	1.78	1.74	1.78	1.72
BH210	No piezometer								
BH 211	6.74	6.70	6.68	6.42	6.01	5.59	5.64	5.55	6.02
BH 212	3.30	2.27	2.24	2.21	2.36	2.17	1.92	1.77	1.72
BH 213	3.13	3.15	3.10	3.44	3.64	3.83	3.77	3.75	3.77
BH 214	5.30	5.25	5.20	5.41	5.57	5.71	5.67	5.53	5.60
BH 215	1.17	1.15	1.12	0.89	0.78	0.40	0.27	0.64	0.63
BH 216	4.12	4.05	4.05	4.29	4.50	4.50	4.47	4.54	4.69
BH 217	No piezometer								
BH 218	0.70	0.71	0.69	0.42	0.31	0.00	0.00	0.00	0.00
BH 219	1.10	1.05	1.02	0.97	0.48	0.10	0.05	0.03	0.31
BH 220	0.97	0.90	0.87	0.82	0.87	0.69	0.65	0.50	0.54
BH 221	8.07	8.05	8.00	7.41	7.22	6.50	6.12	6.14	6.67
BH222	1.00	0.97	0.95	0.99	1.01	1.01	1.04	1.03	1.04
BH223[1]	1.14	1.11	1.11	1.12	1.11	1.13	2.15	2.21	1.98
BH223	1.15	1.14	1.14	1.07	1.10	1.06	2.12	2.15	2.00
BH224	0.10	0.09	0.11	0.02	0.04	0.00	0.00	0.00	0.00
BH225				13.89	13.56	13.38	13.20	14.10	13.76
BH226				5.22	4.75	4.05	4.17	4.65	4.51
BH227	No piezometer								
BH228				5.62	5.21	4.95	4.91	5.13	5.13
BH229						13.24	13.46	13.44	13.45
BH230						1.21	1.13	1.31	1.26
BH231	No piezometer								
BH232								1.93	1.35
BH233								3.68	3.95
BH234								2.89	2.65
BH235									6.73
BH236									8.64
3 Addington Road						5.39	5.30	5.31	5.15
40 Addington Road						7.08	7.01	7.02	6.89

Note:
Blank cells indicate investigation location not completed at monitoring date.
[1] Shallower response zone of BH223.

Appendix B –Piezometer monitoring records (mbgl)

Borehole ID	Water level in terms of mbgl		
	7/09/2016	14/10/2016	22/12/2016
BH201	3.39	3.16	Could not locate
BH 202	9.05	8.84	8.97
BH 203	8.07	7.89	8.92
BH 204	3.88	3.61	3.92
BH 205	1.52	1.65	Could not locate
BH 206	3.30	2.73	2.96
BH 207	8.51	8.22	8.26
BH 208	0.00	0.00	Could not locate
BH 209	1.91	1.95	Could not locate
BH210	No piezometer		
BH 211	6.07	5.46	6.33
BH 212	1.61	1.36	1.70
BH 213	3.78	3.91	3.79
BH 214	5.42	5.14	7.67
BH 215	0.61	0.74	0.56
BH 216	4.78	4.53	Could not locate
BH 217	No piezometer		
BH 218	0.52	0.00	0.00
BH 219	0.48	0.38	0.00
BH 220	Destroyed	Destroyed	Destroyed
BH 221	6.50	5.95	Could not locate
BH222	1.23	1.20	1.60
BH223'	2.13	1.55	Could not locate
BH223	2.10	1.57	Could not locate
BH224	0.22	0.00	0.00
BH225	13.75	Gate locked	Gate locked
BH226	4.49	4.42	4.49
BH227	No piezometer		
BH228	5.19	5.08	Destroyed
BH229	13.39	13.27	13.86
BH230	0.87	1.19	1.23
BH231	No piezometer		
BH232	1.62	1.74	1.53
BH233	3.92	3.57	3.52
BH234	2.66	2.12	2.85
BH235	6.53	5.71	5.92
BH236	7.45	7.35	7.36
3 Addington Road	5.05	4.88	Could not locate
40 Addington Road	6.81	6.69	Could not locate

Note:
Blank cells indicate investigation location not completed at monitoring date.
' Shallower response zone of BH223.



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