From: Ridge, Ben
To: [redacted]
Cc: Hulbert, Shane; Cook, Alex; Allday, Stephen
Subject: CMA Contamination Report and andy other information
Date: Friday, 27 March 2015 8:31:01 AM
Attachments: image001.png

Hi Alex

We are preparing to release information documents through the Data Room.

Are you able to send to me any PB reports related to your CMA deliverables including contamination?

If they are already on ProjectWise or with us please point me in the right direction.

You help is appreciated.

Thanks
Benjamin

Benjamin Ridge
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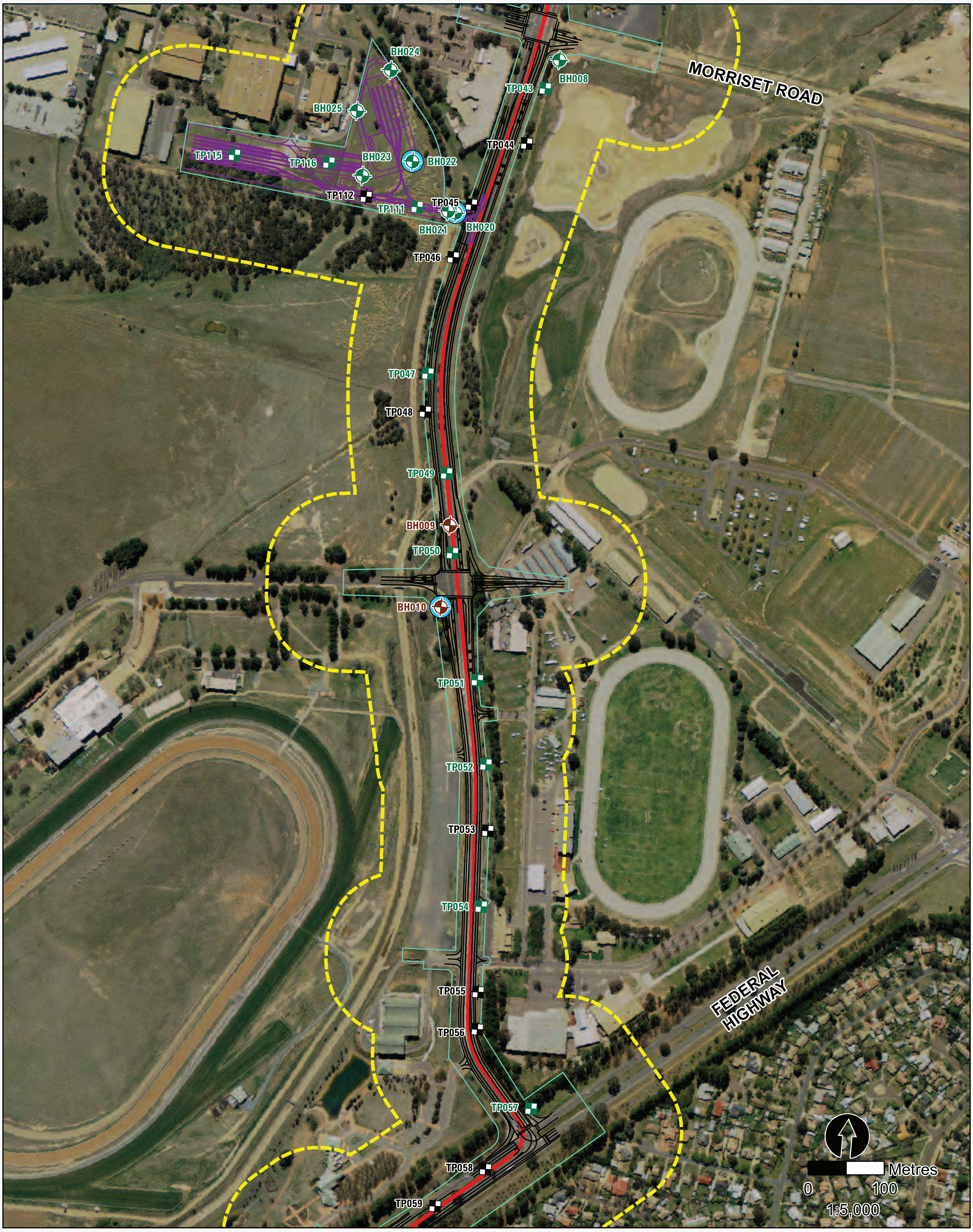

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Flemington southern parcel
Map 5 of 9

\\Apsydfil03\proj\A\Arup\2207509A_Canberra_Light_Rail_TA\10_GIS\Projects\Maps\2207509A_GIS_025_A6.mxd // SaflianK // 30/10/2014

From: Percival, Tom
To: Allday, Stephen
Cc: Cook, Alex; Williams, Cindy
Subject: Contamination samples at depot
Date: Tuesday, 12 May 2015 4:34:27 PM

Steve

The Phase 2 ESA report includes the attached plan, showing that there are 10 sample sites within the depot.

Tom Percival | Manager, Planning and Urban Design

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From: Hulbert, Shane
To: Allday, Stephen; Anderson, Steve; Edghill, Duncan; Giudice, Katrina; Hargreaves, Anita; Jackson, Darrell; Taylor, MelanieA; Thomas, Emma
Cc: [redacted]
Subject: Q&A Daily update 26 May 2015
Date: Tuesday, 26 May 2015 4:41:25 PM
Attachments: Q&A Daily Update 26 May 2015.xlsx
image001.png

Good Afternoon,

Please find attached the Q&A daily update.

regards

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From:	Percival, Tom
To:	Allday, Stephen
Cc:	Cook, Alex; Williams, Cindy
Subject:	Contamination samples at depot
Date:	Tuesday, 12 May 2015 4:34:00 PM
Attachments:	Depot contam sampling locations.pdf image001.png image002.png

Steve

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Capital Metro

Canberra Light Rail – Civic to Gungahlin

Sampling Analysis and Quality Plan

CLR-GLWP-RPT-0866

Draft 2 | 18 September 2014

Job number 2207509A

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Document Verification

ARUP HASSELL PARSONS BRINCKERHOFF

CapitalMetro ACT Government

CABINET IN CONFIDENCE

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Document title	Sampling Analysis and Quality Plan	**File reference**	
Document ref	CLR-GLWP-RPT-0866		

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		Signature			
Draft 2	02 September 2014	**Filename**			
		Description			
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		Name			
		Signature			
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		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

Contents			**1**
1	**Introduction**		**3**
	1.1	Background	3
	1.2	The Project	3
	1.3	Purpose of the SAQP	4
	1.4	Objectives of the SAQP	4
	1.5	Scope of works	4
2	**Site identification**		**6**
	2.1	Background	6
	2.2	Regional topography, geology and hydrology	6
	2.3	Conceptual site model	7
	2.4	Contaminants o[redacted]ncern [redacted]	8
3	**Data quality objectives**		**9**
	3.1	State the problem	9
	3.2	Identify the decisions	9
	3.3	Identify inputs to the decisions	10
	3.4	Define the study boundaries	10
	3.5	Develop a decision rule	10
	3.6	Specify limits on[redacted]rors [redacted]	11
	3.7	Optimise the design for obtaining data	11
	3.8	Data quality indicators for analytical data	11
4	**Scope of work**		**13**
	4.1	Preparatory work	13
	4.2	Soil	13
	4.3	Groundwater	14
	4.4	Laboratory analysis	16
5	**Assessment criteria**		**18**
	5.1	Soil	18
	5.2	Groundwater	22
6	**Quality Assurance/Quality Control**		**25**
	6.1	Field Quality Assurance/Quality Control	25
	6.2	Assessment of data quality	26

7 Reporting 31

8 References 32

Appendices

Appendix A

Figures

[redacted] [redacted]

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1 Introduction

1.1 Background

The ACT Government has identified Canberra’s need for accessible, high capacity and high quality transport to increase the public transport mode share and reduce car dependence. In the Parliamentary Agreement for the 8th Legislative Assembly for the Australian Capital Territory (the Parliamentary Agreement), effective from November 2012, the ACT Government committed to delivering an operational Light Rail Network by 2018/19. In order to achieve this goal, Capital Metro Agency (CMA), a statutory independent authority, was established.

Stage 1 of the development of the network has commenced with CMA identifying the first route as Capital Metro, a 12 kilometre light rail service linking the fast-developing area of Gungahlin in the north, to the City (hereafter, referred to as the Project). The alignment has been confirmed as following Northbourne Avenue, the Federal Highway, Flemington Road and Hibberson Street. The Project will also include the development of a depot and stabling facility and substations along the route.

CMA has appointed a Technical Advisor to develop the Project, assess its feasibility and provide options for construction and operation. The Capital Metro Technical Advisor role for engineering design, environment and light rail operations is being undertaken by Arup, Hassell, Parsons Brinckerhoff and Brown Consulting (AHPB).

1.2 The Project

The Project is anticipated to include the following key features:

- the construction of approximately 12 km of light rail track primarily within existing road corridors with some land take into adjacent properties possible
- approximately 14 stops including major transport interchanges at Gungahlin, Dickson and Civic
- a pedestrianised zone in Hibberson Street, Gungahlin
- overhead line equipment providing traction power and electrical substation facilities for the provision of power along the route
- potential impacts to existing bridge structures and construction of a new bridge
- a series of crossovers and turnback facilities
- the provision of new signals at up to nine existing unsignalised intersections
- passenger information systems at stops and on light rail vehicles (LRVs)
- a depot facility in Mitchell incorporating the Control Centre and the operator’s management and administrative teams as well as operations and maintenance staff, the LRV maintenance building and stabling for the fleet of LRVs
- potential changes to existing utilities
- drainage infrastructure
- changes to some parking conditions along the route

- urban design and landscaping.

1.3 Purpose of the SAQP

This SAQP for the Phase 2 environmental site assessment (ESA) has been prepared by Parsons Brinckerhoff. The area of the assessment includes the section of Northbourne Avenue from London Circuit to the Federal Highway, a section of the Federal Highway to Flemington Road, Flemington Road to Hibberson Street, a section of Hibberson Street to the corner of Gungahlin Place West and a parcel of land extending west of the corner of Sandford Street and Flemington Road (the site). Figure 1 (Appendix A) presents the location of the site and the preliminary impact project footprint.

The purpose of this SAQP is to document the sampling locations and methodology for the planned Phase 2 ESA at the site. The Phase 2 ESA will involve the sampling of soil and groundwater along the route.

1.4 Objectives of the SAQP

The purpose of the Phase 2 ESA is to assess the extent and sources of contamination identified on-site and the potential for these to impact on human health during the development works or during the development works or during operation post development.

The specific objectives of the Phase 2 ESA are to:

- assess the current extent of soil and groundwater contamination related to past and present land uses and the implications it may have to the development of the Project
- assess the potential for soil and groundwater contamination, if present at the site, to impact human health during development and/or during operation of the light rail.

The objectives of this SAQP are to:

- detail the scope of work and methodology to be adopted during soil and groundwater sampling works
- document the rationale for the proposed investigation works
- detail the analytes and parameters to be monitored
- document quality assurance/quality control (QA/QC) requirements.

1.5 Scope of works

The scope of the SAQP comprises the following:

a brief background outlining site history based on information derived from the Phase 1 environmental assessment (Phase 1) previously undertaken by Parsons Brinckerhoff, the results of which are provided in the report titled *Phase 1 Environmental Assessment – Contamination* (ref: CLR-EEM-RPT-0001 dated 11 April 2014) and *Addenda to Phase 1 Environmental Assessment – Contamination – Cabinet in Confidence* (ref: CLR-EEM-RPT-0002 dated 2 May 2014)

- provide a conceptual site model
- identify potential sources of contamination
- outline proposed soil and groundwater sampling locations and analysis

- outline sampling methodologies, including, QA/QC procedures and field screening methods to be adopted during sampling
- provide the rationale for the proposed soil and groundwater sample locations
- outline the adopted assessment criteria to be used to interpret analytical data
- This SAQP has been prepared generally in accordance with the ACT EPA 2009, *Contaminated Sites Environment Protection Policy* and the National Environment Protection Council (NEPC) 2013, *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* (NEPM)

2 Site identification

2.1 Background

The proposed route passes through the Canberra central business district (CBD), past Braddon, Turner, Dickson, Lyneham, Downer, Mitchell, Franklin, Harrison and Gungahlin to the north. The total length of the route is approximately 12.21 kilometres (km).

The Northbourne Avenue and Federal Highway portion of the site is identified as a busy main road located at the centre of the Canberra CBD, comprising three southbound lanes and two northbound lanes and separated by a vegetated traffic island varying in width from 10 metres (m) to 30 m. The total width of Northbourne Avenue and the Federal Highway generally varied from 30 m to 40 m, with narrower sections at the northern portion of the Federal Highway.

The Flemington Road portion of the site was observed to be a main road travelling through northern Canberra suburbs including Lyneham, Mitchell, Franklin, Harrison and Gungahlin. Traffic flows in both directions and varies from one lane to two lanes either side. The road is separated by a traffic island in parts, varying in width from 5 m to 20 m. The total width of Flemington Road varies from 10 m to 30 m.

Hibberson Street is identified to be a main road travelling through the commercial district of Gungahlin, ACT. The road has a single lane in either direction and has a width of approximately 8 m.

The Phase 1 component of the work was conducted by Parsons Brinckerhoff (2014) and identified a number of areas across the proposed alignment that has the potential to have caused historical contamination. Areas were identified across the entire route and included the following sources of contamination:

- potentially contaminated heterogeneous fill material in the subsurface
- potentially dumped contaminated waste on the route or adjacent sites
- petroleum hydrocarbons from the use of adjacent car dealerships and car parks
- chemical residues associated with vehicle storage at the car dealerships and the repair shop where cleaning agents and solvents are stored and an oil water interceptor is present
- pesticides associated with the maintenance of open space public and private land
- bitumen, road base and vehicle emissions from the highway and adjacent roads
- asbestos associated with historically operated landfill sites.

2.2 Regional topography, geology and hydrology

Based on the findings of the site inspection, the topography is generally flat with a rise in elevation towards the northern sector of the route. Slight rises in elevation are noted at Gould Street and Macarthur Avenue along Northbourne Avenue. A larger rise in elevation was noted directly south of Sandford Road along Flemington Road.

The orthophotomap series (reference: Canberra 1:100,000 Sheet 8727-III-N, Hall 1:100,000 Sheet 8727-IV-N) indicates that the topography of the proposed route generally rises in elevation from approximately 562 metres Australian Height Datum (mAHD) to 630 mAHD from the southern end of Northbourne Avenue to the northern end of Hibberson Street. The topography reaches a maximum elevation of approximately 630 m AHD at the northern portion of the site around Hibberson Street and generally slopes downward to a minimum elevation of approximately 562 m AHD to the southern portion of the site towards Lake Burley Griffin.

A review of the geological sheet (reference: Canberra 1:100,000 Geological Series, Sheet 8727, 1992) indicates that the portions of the site along Northbourne Ave south of Morphett Street, the Federal Highway north of Swinden Street and south of Flemington Road and Flemington Road north of Sandford Street are underlain by the Canberra Formation, comprising mudstone, siltstone, minor sandstone, limestone, and volcanic sediments.

A number of surface water body receptors are in proximity to the site include the following:

- Lake Burley Griffin located approximately 400 m south of the site
- Gungaderra Creek which intersects at Flemington Road
- Sullivans Creek which intersects the site north of Clare Burton Circuit
- Yerrabi Pond located approximately 1 km north-west of the site.

2.3 Conceptual site model

The conceptual site model was prepared as part of the Phase 1 Environmental Assessment as provided in Table 2.1 below.

Table 2.1 Conceptual site model

CSM	Factors
Potential sources	Potentially contaminated fill material in the subsurface
	Petroleum hydrocarbons from the use of adjacent car dealerships and car parks
	Chemical residues associated with vehicle storage at the car dealerships and the repair shop where cleaning agents and solvents are stored and an oil water interceptor is present
	Pesticide contamination used to maintain private and public open space
	Coal tar, bitumen, road base and vehicle emissions from the site and adjacent roads
	Contaminated waste stored at the Mitchell Resource Management Centre
	Petroleum hydrocarbons from underground storage tanks located along the route
	Landfill contamination located along the route
	Hydrocarbons, pesticides, heavy metals and asbestos at a site at the north-east of the corner of Mapleton Avenue and Flemington Road
Potential pathways	Leaching and migration of contaminants vertically into underlying groundwater

CSM	Factors
	Surface water flow and lateral migration of contaminated water through preferential pathways such as drainage lines, sewers and infrastructure trenches
	Human exposure to impacted soil and groundwater during below ground infrastructure maintenance works (direct contact with soils and perched groundwater through dermal contact, ingestion and inhalation)
Potential receptors	Surface waters
	Groundwater beneath the site
	Site infrastructure workers and utility/construction personnel undertaking works at the site
	Future users of the light rail
	Recreational users of Lake Burley Griffin (400 m south of the site) and Yerrabi Pond (1 km north-west of the site)

2.4 Contaminants of potential concern

The contaminants of potential concern (COPC) for the site have been developed based on the potential sources of contamination detailed in Table 2.1 and include:

- total recoverable hydrocarbons (TRH)
- polycyclic aromatic hydrocarbons (PAHs)
- benzene, toluene, ethylbenzene and xylene (BTEX compounds)
- arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc (heavy metals)
- organochlorine pesticides (OCPs)
- organophosphate pesticides (OPPs)
- polychlorinated biphenyls (PCBs)
- asbestos.

3 Data quality objectives

The United States Environmental Protection Agency (US EPA) has defined a process for establishing data quality objectives (DQOs) for an investigation (US EPA, 1994). The DQO process has been adopted by the Australian standard AS4482.1-2005 and referenced by NEPM (2013).

The process, as defined by the US EPA involves a seven step process, described in the following terms:

1. State the problem
2. Identify the decisions
3. Identify inputs to the decisions
4. Define the study boundaries
5. Develop a decision rule
6. Specify limits on decision errors
7. Optimise the design for obtaining data.

The process listed above has been followed for this investigation to obtain adequate and defensible data. The steps are detailed in the following sections.

3.1 State the problem

A current road transport corridor road is proposed to be modified to for the development of the Project which will include the light rail route. Adjacent blocks will be developed for the depot facility and substations. A number of properties bordering the site have been identified as potential sources of contamination. Detailed knowledge of the subsurface material at the site is required to assess its suitability for development as a light rail and associated infrastructure. Furthermore, knowledge of subsurface contamination is required to allow an understanding of whether it has the potential to affect human receptors during the development of the light rail and users of the light rail post development. Consequently, Capital Metro has requested an investigation be undertaken to assess the potential contamination within the areas requiring development. To meet this requirement, the objectives of the investigation are to:

- assess the current extent of soil and/or groundwater contamination related to its past and present land uses at the site and the implications to the development of the Project
- assess the potential for soil and/or groundwater contamination to be present at the site with the potential to impact human health during development and or during operation of the light rail.

3.2 Identify the decisions

The principal study questions that arise from Step 1 are:

- Is soil at the site contaminated in accordance with NEPM (2013)?
- If soil is contaminated at the site, will it pose a potential risk to human receptors during and post development of the site?

- If soil is contaminated at the site, what implications will it have in regards to the development of the Canberra light rail?

3.3 Identify inputs to the decisions

To make the decision, the primary inputs will include:

- any relevant background data provided in the Phase 1 report
- visual and olfactory observations made during field investigations, field screening of volatile compounds using a photoionisation detector (PID), and observation of soil for contamination, including observations made during the geotechnical investigation
- visual and laboratory identification of asbestos containing material (ACM) fibres and fragments in soils
- laboratory results of soil samples for contaminants of concern
- appropriate assessment criteria adopted from the NEPM (2013).

3.4 Define the study boundaries

The study area includes the section of Northbourne Avenue from London Circuit to the Federal Highway, a section of the Federal Highway to Flemington Road, Flemington Road to Hibberson Street, a section of Hibberson Street to the corner of Gungahlin Place West and a parcel of land extending of the corner of Sandford Street and Flemington Road.

Test pits and boreholes for the soil contamination assessment will vary in depth according to the subsurface material encountered at each location. Test pits are likely to be advanced to a total depth of approximately 3 metres below ground level (mBGL). Boreholes will be advanced to an approximate depth of 15 mBGL for geotechnical purposes. All soil sampling locations will be logged and sampled for contamination purposes to a maximum depth of approximately 3.0 mBGL.

Six boreholes have been selected to be converted into groundwater monitoring wells and will vary in depth depending on the depth to groundwater at each location. All groundwater monitoring well locations will be logged and sampled to the maximum depth of the well.

3.5 Develop a decision rule

The decision rules for the investigation are:

- If, after initial analytical results are obtained, the contamination status of the areas of concern are still unclear, then further samples originally placed on hold may be scheduled for analysis to further identify or delineate the contamination present at the Site.
- If the concentrations of contaminants in the analysed soil and groundwater samples collected exceed the adopted assessment criteria then assess whether the contamination has the potential to migrate into groundwater beneath the site and/or a potential risk to human health on and off site during and after development works.
- If the concentrations of contaminants in the analysed soil and groundwater samples collected exceed the adopted assessment criteria, then make conclusions pertaining to the potential risks to human health based on statistical analysis (if required).

- If unacceptable risks to human health are identified with respect to soil and groundwater at the site, then assess the requirements for management and/or remediation to mitigate the risks.

3.6 Specify limits on decision errors

There are two types of errors, false positive errors and false negative errors. The false positive errors for this investigation are:

1. Identifying a source of contamination which is actually not a source; the consequence of this error is cost for additional investigation or remediation which is not necessary

2. Deciding that the site is impacted when it is not; the consequences of this error is cost for additional work at the site which is not necessary

The false negative errors for this investigation are:

3. Not identifying a source of contamination which is a source at the site; the consequence of this error is potential risk to receptors

4. Deciding that the site is not impacted when it is, the consequence of this error is potential risk to receptors

The more severe consequences are with decision errors 3 and 4, since the risk of jeopardising human health outweighs the consequences of paying for unnecessary remediation.

This step also examines the certainty of conclusive statements based on the available site data collected. This should include the following points to quantify tolerable limits:

- a decision can be made based on a 95% upper confidence limit (UCL) that the ‘true’ arithmetic average contaminant concentration will be below the calculated 95% UCL value. This follows the guidance given in NEPM (2013) guidelines for comparing 95% UCLs to the relevant site criteria. Therefore, a limit on the decision error will be 5% that a conclusive statement may be incorrect.

- a decision can be made based on the probability that a contamination hotspot of a certain circular diameter will be detected with 95% confidence using systematic sampling data points. The decision error will be limited to a probability of 5% that a contamination hotspot may not be detected.

3.7 Optimise the design for obtaining data

Chapter 4 provides methodology and rationale for the sampling design.

3.8 Data quality indicators for analytical data

The DQOs for sampling techniques and laboratory analyses of collected representative soil samples defines the acceptable level of error required for this investigation. The DQOs will be assessed by reference to data quality indicators (DQIs) as follows:

- Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population or an environmental condition. In the case of the ESA works, targeted sampling locations were selected based on the historical information available. Consistent and repeatable sampling techniques and methods will be utilised throughout the sampling.

- Completeness is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal was set at collecting sufficient valid data during the study. If there was insufficient valid data, as determined by the other DQOs, then additional data will be collected.
- Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This is proposed to be achieved through maintaining a level of consistency in techniques used to collect samples and ensuring analytical laboratories use consistent analysis techniques and reporting methods. Comparability will be achieved by ensuring that precision and accuracy objectives are met.
- Precision measures the reproducibility of measurements under a given set of conditions. The precision of the data will be assessed by calculating the relative per cent difference (RPD) of duplicate samples. The criteria used for the assessment of RPDs (typically 30-50%) follows the guidelines given in Australian standard 4482.1 (2005), although it is acknowledged that these are not binding in a regulatory sense. Accordingly, the NEPM sets the industry requirements for DQOs. If duplicate results were not within acceptable RPD range limits, investigation into the cause was initiated. If a cause could not be determined, the validity of the data is questioned.
- Accuracy measures the bias in a measurement system. Accuracy can be undermined by such factors as field contamination of samples, poor preservation of samples, poor sample preparation techniques and poor selection of analysis techniques by the analytical laboratory. Accuracy will be assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards. Accuracy of field works will be assessed by examining the level of contamination detected in blank samples. The accuracy of the laboratory data that is generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value.

4 Scope of work

4.1 Preparatory work

Prior to mobilisation to the site a site health and environmental safety plan (HESP) will be prepared and submitted to Capital Metro for review, relevant utility clearances will be obtained by Arup who are in control of the investigation works.

4.2 Soil

4.2.1 Soil sampling rational

The contamination assessment works have been scheduled to be undertaken concurrently with the geotechnical investigation works at the site. The geotechnical investigation has proposed sampling from 22 borehole locations and 116 test pit locations (a total of 138 locations).

Contamination investigation locations have been selected from proposed geotechnical sampling locations. The selection of locations took into account the linear nature of the route and the second objective for the site to assess the potential for soil contamination, if present at the site, to impact human health during development and/or during operation of the light rail. As a result, a sampling density of approximately one in 500 m was applied and spaced to provide adequate coverage of the route with the addition of targeted locations at areas previously identified as a contaminated site. Ten boreholes and 44 test pit locations have been selected for the contamination investigation (a total of 54 locations).

Soil bores will be advanced using a drill rig to a maximum depth of 15 mBGL. Test pit locations will be excavated using a backhoe to a maximum depth of 3 mBGL. Soil bores and test pits will be logged and sampled to a total depth of approximately 3 mBGL for contamination sampling purposes. These depths are considered likely to be sufficient to reach natural soil.

The rational for the selection of soil sampling locations is outlined in Table 4.1. Locations are presented in Figure 2 (Appendix A).

Table 4.1 Soil sampling summary

Proposed locations	Rational
TP003, TP008, TP12, TP024, TP030, TP085, BH22	Assist in providing adequate coverage of the proposed route.
TP015, TP021, TP038, TP043, BH020, BH021, TP111, TP047, TP049, TP098, TP105, TP106, TP107, TP109, TP110, BH022, BH023, BH024, BH025, TP115, TP116, BH014, BH016, BH018, BH019	In proximity to EPA identified contaminated site.
TP041, TP082, TP090, TP092, TP096, TP113	Potential for neighbouring site to cause petroleum hydrocarbon contamination and in proximity to EPA identified contaminated site.

Proposed locations	Rational
TP050, TP051, TP052, TP054, TP057, TP063, TP064, TP070, TP076, TP077, TP079, TP080, TP101, TP102	Potential for neighbouring site to cause contamination and in proximity to EPA identified contaminated site.
TP058, TP059, TP060	Potential for neighbouring site to cause contamination.

4.2.2 Soil sampling methodology

Soil samples will generally be collected from the surface (0.1 to 0.2 m BGL), 0.5 m BGL, 1.0 mBGL, and every metre thereafter or where changes in lithology, evidence of contamination is noted. A minimum of one sample will be selected per borehole for laboratory analysis; additional samples will be analysed in boreholes where evidence of contamination is present. Dedicated disposable nitrile gloves will be worn and replaced at each new sampling location/depth to avoid the potential for cross contamination.

Subsurface conditions and other relevant information during the investigation works (e.g. in situ testing and any groundwater inflow or levels) will be logged by a qualified and experienced environmental scientist. Soil samples will be screened for volatiles compounds with a photoionisation detector (PID) during sampling and any visual or olfactory signs of contamination or visibly identified ACM material will be recorded. The PID will be calibrated each day to a known concentration of isobutylene gas. Soil samples will be placed in 500 mL glass jars, leaving minimal headspace and closed using Teflon-coated lids. Samples will be stored in a dark, chilled cooler and transported to the laboratory under chain of custody documentation.

4.3 Groundwater

4.3.1 Groundwater well installation

Six boreholes will be converted into groundwater monitoring wells. Each location will be drilled to a depth of at least 2.0 m below the suspected water table. Locations will vary at each location depending on the depth of the water table. If water is not encountered to this depth, the bore will be backfilled and abandoned.

The monitoring well will be installed using threaded Class 18 flush-jointed polyvinyl chloride (PVC) casing, and screened with machine-slotted PVC pipe with a minimum outside diameter of 50 mm. The length of the screened section will be adjusted specifically for the well. A PVC plug will be used to cap the bottom and top of the well during installation to keep out debris. A filter pack will be installed in the annulus between the boring and the well screen to approximately 0.5 m above the slotted section. A bentonite seal of at least 0.5 m thickness will then be placed above the sand pack, and the annulus grouted from the bentonite seal to the surface. The monitoring well will be completed with a grout finish to the ground surface and a gatic cover will be installed.

Following installation, the new wells will be developed to remove fines from the borehole and to promote the flow of groundwater from the surrounding formation into the well for subsequent sampling.

4.3.2 Groundwater monitoring methodology

The groundwater monitoring event (GME) will take place approximately one week after the installation of the final groundwater monitoring well.

After development, the monitoring wells will be left for the formation to equilibrate for a minimum of 7 days. A Parsons Brinckerhoff environmental scientist will return to the site to undertake a GME comprising gauging and sampling of the well in accordance with standard industry practice and the Parsons Brinckerhoff documented standard field procedures.

The wells will be gauged prior to sampling with an oil-water interface probe to detect light non-aqueous phase liquids (LNAPLs) such as petroleum hydrocarbons.

A low flow sampling pump will be employed for sample collection. The unit will be slowly lowered into the screened section of the well to minimise disturbance and set to purge at a rate of four cycles per minute (equating to approximately 0.4 L per minute). Water quality parameters (pH, dissolved oxygen, electrical conductivity, reduction/oxidation potential and temperature) will be recorded during purging and groundwater will also be visually assessed for turbidity. Samples will be collected when the water quality parameters have stabilised in accordance with Parsons Brinckerhoff's standard procedures. Samples will be obtained directly from the dedicated polyethylene tubing connected to the pump and decanted into laboratory-supplied bottles. Samples will be stored in a dark, chilled cooler and transported to the laboratory under chain of custody documentation.

4.3.3 Groundwater sampling rationale

Six boreholes are proposed to be converted into groundwater monitoring wells as a part of the geotechnical investigation. Two locations have been selected from the geotechnical installed bores and four additional locations have been selected to install groundwater monitoring wells for the contamination purposes (a total of six locations).

The rational for the selection of groundwater sampling locations is outlined in Table 4.1. Locations are presented in Figure 2 (Appendix A).

Table 4.2 Groundwater sampling summary

Proposed location	Rationale
BH014	Potential for neighbouring site to cause petroleum hydrocarbon contamination and in proximity to EPA identified contaminated site.
BH016	Potential for neighbouring site to cause petroleum hydrocarbon contamination and in proximity to EPA identified contaminated site.
BH018	Potential for neighbouring sites to cause contamination petroleum hydrocarbon contamination and in proximity to EPA identified contaminated site.
BH019	Potential for neighbouring sites to cause contamination petroleum hydrocarbon contamination and in proximity to EPA identified contaminated site.

Proposed location	Rationale
BH020	Assist in assessing the nature of groundwater in proximity to the proposed depot facility and areas identified as an EPA landfill contaminated site.
BH022	Assist in assessing the nature of groundwater in proximity to the depot facility and areas identified as an EPA landfill contaminated site.

4.4 Laboratory analysis

4.4.1 Soil

At least one soil sample is proposed to be analysed per borehole. However a second sample will be selected for analysis at locations displaying field indicators of contamination and some sampling locations at the depot facility (BH020 to BH025, TP111, TP115 and TP116) which has been identified as an area of potential contamination. Samples will be selected for analysis based on field indicators of contamination and the potential contamination sources and migration pathways identified in Section 2.3. Refer to Figure 1 and 2 for more information (Appendix A).

Asbestos samples will be collected from subsurface fill material and/or locations identified to visibly contain potential ACM and analysed for asbestos by quantitative method (percentage weight by weight). Soil samples for asbestos analysis will be collected by passing soil through a 7 mm sieve until a weight of approximately 500 grams (g) to 1000 g is collected. in accordance with the NEPM (2013). Both the greater than 7 mm and less than 7 mm portions of the sample will be retained for quantitative analysis of bonded asbestos and friable asbestos/asbestos fines, respectively.

Based on the classification of the site north of the corner of the Federal Highway and Phillip Avenue as '*Class B4 Low probability/very low confidence acid sulfate soil area'* and the portion of the site south of the corner of the Federal Highway and Phillip Avenue as '*Class C4 Extremely low probability/very low acid sulfate soil area'* samples will be collected and analysed for SPOCAS below the depth of 2 mBGL in areas displaying potential signs of acid sulfate soil and/or locations located adjacent to a water body.

Table 4.2 outlines the proposed soil sampling regime and analysis.

Table 4.2 Soil analysis

Proposed number of samples	Analysis	Number of samples					
		Primary	Intra-lab (Duplicate)	Inter-lab (Triplicate)	Trip blank	Trip spike	Rinsate Blank
61	TRH ,	55	3	3	1	-	25
61	BTEX compounds	55	3	3	1	1	25
61	PAHs	55	3	3	-	-	25
61	heavy metals	55	3	3	-	-	25
36	OCP	31	2	2	-	-	25
36	OPP	31	2	2	-	-	25
36	PCB	31	2	2	-	-	25
21	Asbestos	21	-	-	-	-	-
10	SPOCAS	10	-	-	-	-	-

4.4.2 Groundwater

One sample will be collected from each groundwater monitoring well (a total of six samples). Table 4.3 outlines the proposed groundwater sampling regime and analysis.

Table 4.3 Groundwater analysis

Proposed number of samples	Analysis	Number of samples					
		Primary	Intra-lab (Duplicate)	Inter-lab (Triplicate)	Trip blank	Trip spike	Rinsate Blank
8	TRH	6	1	1	1	-	2
8	BTEX compounds	6	1	1	1	1	2
8	PAH	6	1	1	-	-	2
8	heavy metals	6	1	1	-	-	2

5 Assessment criteria

The assessment criteria for the investigation will be based on an analysis of land uses and potential receptors. Based on this, assessment criteria provided in the following guidelines have been identified as being applicable for assessing laboratory analytical data:

- NEPC, 2013, NEPM
- Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical Report No. 10 (Friebel & Nadebaum), 2011, *Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater, Part 2: Application Document*.
- Acid Sulfate Soils Management Advisory Council (ASSMAC) 1998, *Acid Sulfate Soils Assessment Guidelines*

5.1 Soil

5.1.1 Health investigation levels and health screening levels

In consideration of the proposed future land use of the site as a light rail and associated infrastructure, the health investigation level (HIL) corresponding to commercial/industrial (HIL-D) will be considered. Additionally, health screening levels (HSLs) will be utilised to assess potential vapour intrusion in addition to direct contact resulting from impacted soils. The HSLs corresponding to a commercial/industrial setting for sandy soils will be applied at the relevant depth where the sample was collected for laboratory analysis. Criteria corresponding to sandy soils will be adopted as a conservative measure.

The CRC CARE Technical Document No. 10 (2011) provides HSLs for petroleum hydrocarbons specifically for vapour inhalation for intrusive maintenance workers in shallow trenches and direct contact for intrusive maintenance workers.

Table 5.1 provides a summary of the adopted soil assessment criteria for the project

Table 5.1. Selected soil assessment criteria

Analytes	HILs[a]	HSLs[b]			HSLs direct contact[e]	HSL shallow trench[f]	
		0 m to <1 m	1 m to <2 m	2m to <4m	intrusive worker	0 m to < 2m	2 m to <4 m
	(mg/kg)						
Hydrocarbons							
TRH C_6-C_{10}	-	-	-	-	82,000	NL	NL
TRH C_6-C_{10} less BTEX (F1)	-	260	370	630		-	-
TRH $>C_{10}$-C_{16}	-				62,000	NL	NL
TRH $>C_{10}$-C_{16} less naphthalene (F2)	-	NL	NL	NL		-	-
TRH $>C_{16}$-C_{34} (F3)	-	-	-	-	85,000	-	-
TRH $>C_{34}$-C_{40} (F4)	-	-	-	-	120,000	-	-
Benzene	-	3	3	3	1,100	77	160
Toluene	-	NL	NL	NL	120,000	NL	NL
Ethylbenzene	-	NL	NL	NL	85,000	NL	NL
Xylene	-	230	NL	NL	130,000	NL	NL
Naphthalene[c]	-	NL	NL	NL	29,000	NL	NL
Benzo(a)pyrene	-	-	-	-		-	-
Carcinogenic PAHs (BaP TEQ)[8]	40	-	-	-		-	-
Total PAHs	4,000	-	-	-		-	-
Metals							
Arsenic	3,000	-	-	-		-	-
Cadmium	900	-	-	-		-	-
Chromium	3,600	-	-	-		-	-
Copper	240,000	-	-	-		-	-
Lead	1,500	-	-	-		-	-
Mercury	730	-	-	-		-	-
Nickel	6,000	-	-	-		-	-
Zinc	400,000	-	-	-		-	-
Pesticides							
DDT+DDE+DDD	3,600	-	-	-		-	-

Analytes	HILs[a]	HSLs[b]			HSLs direct contact[e]	HSL shallow trench[f]	
		0 m to <1 m	1 m to <2 m	2m to <4m	intrusive worker	0 m to < 2m	2 m to <4 m
	(mg/kg)						
Aldrin and dieldrin	45	-	-	-		-	-
Chlordane	530	-	-	-		-	-
Endosulfan	2,000	-	-	-		-	-
Endrin	100	-	-	-		-	-
Heptachlor	50	-	-	-		-	-
HCB	80	-	-	-		-	-
Methoxychlor	2,500	-	-	-		-	-
Asbestos							
Bonded ACM	-	0.05% w/w				-	-
Friable asbestos and asbestos fines	-	0.001% w/w				-	-
All forms of asbestos	-	Not visible in surface soil				-	-
Other							
PCBs	7	-	-	-		-	-

a) NEPM (2013) Schedule B1 Table 1A(1) Health investigation levels for soil contaminants (mg/kg), Commercial/industrial D

b) NEPM (2013) Schedule B1 Table 1A(3) Soil HSLs for vapour intrusion (mg/kg), Commercial/Industrial in sand

c) HSL for naphthalene refers to results by volatile analysis, not semi-volatile analysis

d) CRC CARE (2011) Technical document no. 10 Table B4 Soil HSLs for direct contact(mg/kg) HSL D commercial industrial

e) CRC CARE (2011) Technical document no. 10 Table B4 Soil HSLs for direct contact (mg/kg) Intrusive maintenance worker (shallow trench)

f) CRC CARE (2011) Technical document no. 10 Table B4 Soil HSLs for direct contact (mg/kg) Intrusive maintenance worker

g) NEPM (2013) Schedule B1 Table 1B(6) ESLs for TPH fractions F1 – F4, BTEX and benzo(a)pyrene in soil

BaP TEQ Benzo(a)pyrene toxic equivalency quotient; calculated as a weighted sum of selected PAHs. Further details available in NEPM Schedule B1

NL: Non-limiting, maximum potential vapour concentration in soil vapour do not exceed maximum allowable vapour risk

5.1.2 Ecological screening levels and ecological investigation levels

The NEPM provides ecological screening levels (ESLs) for TRH, BTEX and benzo(a)pyrene, used as an initial screening risk assessment to determine whether laboratory analysed concentrations of contaminants potentially pose a risk to the environment or relevant environmental values. Ecological investigation levels (EILs) are adopted for the assessment of selected metals, naphthalene and DDT for purposes of assessing the physiochemical properties of soil and contaminants and the capacity of the local ecosystem to accommodate increases in the contaminants levels.

The EILs are derived using the following equation:

$$EIL = added\ contaminant\ limit\ (ACL) + ambient\ background\ concentration\ (ABC)$$

The ABC is the background contaminant level and requires measurement at appropriate reference points at the site. The ACL, which is provided in the NEPC, 2013, NEPM, is the maximum contaminant concentration added to the naturally occurring background level, exceedances of which may result in adverse effects on plant health. EILs corresponding to commercial/industrial land use will be applicable for this investigation and will be calculated in the Stage 2 DSI report based on laboratory analytical results.

The growth of vegetation is not anticipated as a part of the development works; furthermore, sensitive ecosystems are not located along the light rail route. However, ESL and EIL criteria will be adopted as a conservative initial screening corresponding to a commercial/industrial land use. The EIL criteria will not be calculated as a part of the investigation and the ABC concentration corresponding to the applicable contaminant criteria will be adopted as the EIL criteria to provide a conservative initial assessment of laboratory analytical data. Table 5.2 outlines the ESL criteria adopted for the investigation, the EIL criteria will be assessed as a part of the ESA investigation.

Table 5.1 Soil assessment criteria - ESLs

Analyte	ESLs (mg/kg dry soil)[1]
TRH C_6-C_{10} minus BTEX (F1)	215
TRH >C_{10}-C_{16} (F2)	170
TRH >C_{16}-C_{34} (F3)	1,700
TRH >C_{34}-C_{40} (F4)	3,300
Benzene	75
Toluene	135
Ethylbenzene	165
Xylene (Total)	180
Benzo(a)pyrene	0.7

(1) NEPM (2013) Schedule B1 Table 1B(6) Health investigation levels for soil contaminants (mg/kg), Commercial/industrial D

5.1.3 ASS action criteria

The ASSMAC 1998, *Acid Sulfate Soils Assessment Guidelines* action criteria (action criteria) are categorised according to the texture and clay content of the soil being analysed and the total volume of soil to be disturbed. Table 5.3 outlines the action criteria according to size of the material proposed to be removed and the soil description. The applicable criteria will be adopted according to soil description at the ESA portion of the investigation.

Table 5.3 Soil assessment criteria

Analyte	Action criteria for coarse textured soils3	Action criteria, medium textured soils3		Action criteria for fine textured soils3	
		1-1000 tonnes (t)	>1000 t	1-1000 tonnes (t)	>1000 t
S_{POS} (% S oxidisable)	0.03	0.06	0.03	0.1	0.03
TSA (mol H^+/tonne)	18	36	18	62	18
TPA	18	36	18	62	18

(1) ASSMAC (1998)

S_{POS} – Peroxide oxidisable sulfur

TPA – Titratable peroxide acidity

TSA – Titratable sulfidic acidity

S_{POS} criteria in % S oxidisable, TSA and TPA criteria in mol H^+/ tonne

5.2 Groundwater

To assess the contamination status of groundwater at a site, the NSW EPA refers to the NEPC, 2013, NEPM, specifically Schedule B-1 Investigation Levels for Soil and Groundwater. Schedule B-1 provides a framework for the use of investigation and screening levels based on a matrix of human health and ecological soil and groundwater risks.

NEPM Schedule B-1 presents groundwater investigation levels (GILs) for protection of receiving water (ecological protection) and for human health (drinking water guidelines). It is necessary to assess the potential uses and receptors of groundwater downgradient of the site in order to correctly apply the GILs.

Groundwater is expected to discharge into various freshwater sources across the route, Based on this, the GILs for the protection of freshwater ecosystems have been considered for this assessment. As the guidelines apply to receiving waters, it is generally conservative to apply these to groundwater discharging into receiving waters.

Trigger values for recreational water quality and aesthetics are provided in the ANZECC, 2000, *Guidelines for Fresh and Marine Water Quality*. These have also been adopted for this assessment based on the potential receiving water bodies.

The drinking water GILs have been adopted because domestic groundwater bores exist within a 1 km radius of the site in the bore search results. Several locations are considered likely to be downgradient of the alignment.

Schedule B-1 of the NEPM also assesses the risk of vapour intrusion arising from groundwater impacted by hydrocarbons (HSLs). The adopted carbon fraction ranges for the HSLs are based on TRH analysis after subtraction of BTEX compounds.

The HSLs have been developed for sand, silt and clay soils based on texture classifications and criteria are listed for several depth intervals. A subsurface profile of sand has been assumed based on our preliminary understanding of the site. As with the soil HSLs, groundwater HSLs also depend on land uses scenarios. For the purpose of this investigation, the ‘HSL D’ criteria for commercial/industrial land use with gardens/accessible soil have been adopted.

With respect to the risk to maintenance/excavation workers from identified impacts in groundwater via inhalation pathways and dermal contact, the risk-based HSLs detailed in CRC CARE Technical Report No. 10: *Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater, Part 2: Application Document* (Friebel & Nadebaum, 2011) have been considered.

Groundwater HSLs for vapour intrusion are provided in Table B2 of Friebel & Nadebaum (2011). A subsurface profile of sand has been adopted for the purposes of this investigation,

A summary of the adopted groundwater assessment criteria is included in Table 5.4.

Table 5.4 Groundwater assessment criteria

Analyte	GILs[1] (µg/L)		Recreational water quality and aesthetics[2]	NEPM HSLs (µg/L)		
				Commercial/industrial (HSL D, in sand)[3]		
	Marine waters	Drinking water		2 to <4 m	4 to <8 m	8 m +
TRH/BTEX compounds						
TRH C_6-C_{10} minus BTEX (F1)	-	-	-	6,000	6,000	7,000
TRH >C_{10}-C_{16} minus naphthalene (F2)	-	-	-	NL	NL	NL
TRH C_6-C_{10}	-	-	-	-	-	-
TRH >C_{10}-C_{16}	-	-	-	-	-	-
Benzene	500	1	10	5,000	5,000	5,000
Toluene	-	800	-	NL	NL	NL
Ethylbenzene	-	300	-	NL	NL	NL
m&p-Xylene	-	-	-	NL	NL	NL
o-Xylene	-	-	-	-	-	-
Xylene (Total)	-	600	-	NL	NL	NL
PAHs						
Naphthalene	50	-	-	NL	NL	NL
Benzo(a)pyrene	-	0.01	0.01	-	-	-
Heavy metals						
Arsenic	-	10	50	-	-	-
Cadmium	0.7	2	5	-	-	-
Chromium	4.4[4]	50[4]	50	-	-	-
Copper	1.3	2,000	1,000	-	-	-
Lead	4.4	10	50	-	-	-
Mercury	0.1	1	1	-	-	-

Analyte	GILs[1] (µg/L)		Recreational water quality and aesthetics[2]	NEPM HSLs (µg/L)		
	Marine waters	Drinking water		Commercial/industrial (HSL D, in sand)[3]		
				2 to <4 m	4 to <8 m	8 m +
Nickel	7	20	100	-	-	-
Zinc	15	-	5,000	-	-	-

(1) NEPM (2013) Schedule B1 Table 1C Groundwater Investigation Levels (GILs)

(2) ANZECC (2000) Table 5.2.3 Summary of water quality guidelines for recreational purposes: general chemicals

(3) NEPM (2013) Schedule B1 Table 1A(4) Groundwater HSLs for vapour intrusion (mg/L)

(4) GIL for chromium VI adopted for total chromium as a conservative approach

\- No assessment criteria available

NL Non-limiting due to maximum vapour concentrations being below the acceptable health risk level

6 Quality Assurance/Quality Control

6.1 Field Quality Assurance/Quality Control

6.1.1 Sample collection, handling and preservation

Field sampling procedures conforming to regulatory guidelines and Parsons Brinckerhoff Quality Assurance/Quality Control (QA/QC) procedures are to be used to minimise potential for cross-contamination and preserve sample integrity. The non-disposable sampling equipment is to be decontaminated by triple washing between each sample location. The triple washing technique comprises washing equipment with water, scrubbing with phosphate free detergent (Decon 90) and water, followed by a final rinse with demineralised water. Disposable nitrile gloves are to be worn and replaced before collecting each sample.

All samples collected are to be placed into laboratory supplied containers. Sample containers will be filled to the maximum level attainable to assist in minimising the loss of volatile contaminants. All samples are to be placed on ice in coolers for transport to the National Association of Testing Authorities (NATA) accredited laboratories. Standard chain of custody documentation is to accompany the samples to the laboratories.

Suitably qualified personnel will collect asbestos samples in accordance with the NEPM (2013). If asbestos is identified in soil, an ACT WorkSafe licenced hygienist will be called to site to complete asbestos sampling.

6.1.2 Field duplicates

Field intra-laboratory duplicate and inter-laboratory duplicate samples will be collected at a rate of at least 1 per 20 primary samples for each type of duplicate, according to NEPM (2013) standards during soil sampling events.

6.1.3 Rinsate blanks

Rinsate blank samples comprise de-ionised water supplied by the laboratory. Rinsate blanks are collected by running the de-ionised water over a piece of sampling equipment, that has been decontaminated using field procedures, and into a sample bottle. The rinsate blank is submitted to the laboratory with the other samples. The purpose of rinsate blank samples is to assess if cross-contamination has occurred through the use of sampling equipment that has not been decontaminated appropriately.

One rinsate blank sample will be collected per piece of non-disposable sampling equipment per day of sampling.

6.1.4 Trip blanks

Trip blank samples comprise clean sand supplied by the laboratory. Trip blanks samples are placed within the cooler containing all the other sample containers. Trip blank samples remain within the cooler for the extent of the 'trip'. The purpose of the trip blank samples is to assess if any volatile or semi-volatile contaminants have entered the sample containers during their journey from either an outside source or from the sample container itself.

One trip blank sample should be collected for each sample shipment submitted to the laboratory.

6.1.5 Trip spikes

Trip spikes comprise sand or water spiked with a known concentration of BTEX compounds supplied by the laboratory. Trip spikes are placed within the cooler containing all other sample containers. Trip spikes will remain within the container for the extent of the trip. The purpose of the analysis of trip spike samples is to assess if there has been any loss of volatile contaminants in samples collected.

6.1.6 Calibration

Isobutylene gas will be used to calibrate the PID at the beginning of each day of sampling and recoded on a field calibration sheet. If there is evidence to suggest calibration of the PID has been effected during the sampling day, the PID will be calibrated again and recorded on the field calibration sheet. The calibration will be in accordance with manufacturer's instruction manuals.

6.2 Assessment of data quality

The quality of the data collected during the monitoring program is required to be assessed. A data validation process is used to assess the effect of the site sampling program on the data quality. The data quality assessment is based upon requirements of NSW EPA, the NEPM, US EPA Functional Guidelines for Data Validation and Parsons Brinckerhoff validation procedures.

Data quality is typically discussed in terms of precision, accuracy, representativeness, comparability and completeness. These are referred to as the PARCC parameters. The PARCC and additional QA parameters are discussed in what follows as indicators of data quality. The QA criteria examined included:

- RPD evaluation of laboratory matrix duplicates
- RPD evaluation of field duplicates
- matrix spikes
- surrogate spikes
- sample method blanks
- laboratory blanks
- holding times
- sample handling and analysis protocols (e.g. correct sample preservation, correct sample containers and chilling of the samples)
- laboratory control samples.

6.2.1 Precision

Precision is a measure of the ability to reproduce results, and is assessed on the basis of agreement between a set of replicate results obtained from duplicate analyses. The precision of a set of duplicates is measured as RPD, and is calculated from the following equation:

$$RPD = \left[\frac{X1 - X2}{\left(\frac{X1 + X2}{2} \right)} \right] \times 100$$

where: X1 is the first duplicate value

X2 is the second duplicate value

Laboratory personnel calculate the RPDs of laboratory duplicates (also referred to as matrix duplicates) as a measure of precision. Laboratory duplicates are a sample which has been split by the laboratory and both portions are subject to the same analytical processes as if they were individual samples. Laboratory duplicates are generally analysed at a rate of one duplicate per 20 samples. The target RPD values range depending on the sample matrix and analyte as shown in Table 6.1 below.

Table 6.1 Acceptable Laboratory duplicate RPD values

Analyte	(<10 x PQL) %RPD	(10-20 PQL) %RPD	(>20 X PQL)
All analytes	no criteria	50%	20%

If the RPD for a sample does not fall within the control limits, laboratory based corrective action is taken; however, the sample is not necessarily reanalysed.

It should be noted that a laboratory batch may contain samples from other sources, therefore laboratory duplicates may be analysed on other samples from the batch. However, the laboratory's QA/QC procedures require all batch laboratory duplicates to conform to prescribed criteria.

6.2.1.1 Field duplicates

An assessment of the precision of the laboratory results is also undertaken by Parsons Brinckerhoff following a similar method. A sample is split into three representative samples termed the primary, intra-laboratory duplicate and inter-laboratory duplicate samples. Primary samples and intra-laboratory duplicates are analysed by the nominated primary laboratory, while the inter-laboratory duplicate sample is submitted to a secondary laboratory. RPD values are calculated between the primary sample and the intra-laboratory duplicate sample, and the primary sample and the inter-laboratory duplicate sample. Acceptance criteria for RPD values are documented in Australian standard 4482.1-2005 section 8.2.6 as 30% - 50% of the mean concentration. Field duplicates are collected on a frequency of at least one sample per 20 primary samples.

6.2.2 Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured.

6.2.2.1 Matrix spikes

The determination of accuracy can be achieved through the analysis of known reference materials or assessed by the analysis of matrix spikes. Matrix spikes are analysed by splitting a field sample. Each portion is spiked with known quantities of the target compound in order to ascertain the effects of the specific sample matrix on the recovery of analytes. Accuracy is measured in terms of percentage recovery as defined by the following equation:

$$\%R = \frac{SSR - SR}{SA} \times 100$$

where: %R = percentage recovery of the spike
SSR = spiked sample result
SR = sample result (native)
SA = spike added

Laboratory personnel calculate percentage recoveries of spiked compounds, which are evaluated against control or acceptance limits taken from the appropriate method or the Laboratory Program Statement of Work. If the spike recovery for a sample does not fall within the prescribed control limits, laboratory based corrective action is taken, although the sample is not necessarily re analysed. Matrix spikes are analysed at a rate of one matrix spike per twenty samples. Acceptance criteria for matrix spikes are shown in Table 6.2.

Table 6.2 Acceptance criteria for matrix spikes

Analyte	Acceptance criteria (% recovery)
TRH, BTEX, PAHs	70-130
Dissolved or total metals	80-120
Total metals	70-130

Typically, results are qualified when percentage recovery is below QA acceptance criteria, indicating that sample results may be biased low. However, results are also qualified when percentage recovery is above QA acceptance criteria, indicating that sample results may be biased high.

The sample batch may contain samples from other sources. Therefore, matrix spikes may be analysed on other samples from the batch. However, the laboratory's QA/QC procedures require all batch matrix spikes to conform to the prescribed criteria. The laboratory may report this analysis as laboratory control samples, which may be used to assess the laboratory's methods and procedures.

6.2.2.2 Laboratory control samples

A laboratory control sample comprises clean sand and is spiked with a known quantity of a target analyte. The laboratory control sample is extracted and analysed with the other samples. The aim of the laboratory control sample is to evaluate the efficiency of the extraction and analysis. The target recovery is 100%, although the range of acceptable results can vary depending on the type of analysis at an acceptance limit of 20%. The laboratory control sample also confirms the accuracy of the calibration, as the target analytes are obtained from an alternate source to the calibration standards.

6.2.2.3 Surrogate spikes

A surrogate spike is a sample which has been spiked with a pure substance that has similar chemical properties to the target analyte, and is unlikely to be found in the environment. The spiked compounds are expected to behave during analysis in the same way as the target compounds. Every sample is spiked prior to extraction or analysis with known concentrations of surrogate compounds that are representative of the analysis. If surrogate spike recovery does not meet the prescribed control limits, samples are generally re analysed. The target criteria for surrogate spikes are the same for matrix spikes Table 4-2. It should be noted that for inorganic analyses, no surrogate spikes are conducted.

6.2.2.4 Laboratory method blanks

Laboratory method blanks monitor externally introduced contaminants that potentially derive from glassware, cleaning reagents and digestion reagents during the analysis process. The method blank consists of de-ionised water or clean sand only and is prepared in the laboratory. The method blank is treated as a sample in the laboratory, going through the same sample preparation and analysis procedures as the corresponding batch.

To meet the QC acceptance criteria, the laboratory blanks should have no detectable concentrations of the target compounds. The laboratory blank results are presented in the laboratory analytical reports. Laboratory blanks are analysed at a rate of one laboratory blanks per twenty samples.

6.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition.

Representativeness is primarily dependent on the design and implementation of the sampling program and is partially ensured by the avoidance of cross-contamination, adherence to sample handling and analysis protocols, and use of proper chain of custody and documentation procedures. Sample blanks, holding times and field duplicates are QA parameters that can assist in the analysis of representativeness.

6.2.3.1 Holding times

Holding times from field sampling to laboratory analysis must be minimised to ensure the representativeness of the result obtained. Delays between sampling and analysis can lead to analytes changing due to such processes such as volatilisation, mineralisation and biological modification.

Where standard holding times are exceeded, professional judgement as to the integrity of the data will be required, taking into account such factors as field storage, laboratory storage and even sample-bottle characteristics.

6.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This will be achieved through maintaining a level of consistency in techniques used to collect samples and ensuring analytical laboratories used consistent analysis techniques and reporting methods. Comparability is also achieved by ensuring that precision and accuracy objectives were met.

6.2.5 Completeness

The following information is required to check for completeness of data sets:

- chain of custody forms
- sample receipt notification or sample receipt advice
- certificates of analysis
- quality control report
- all sample results reported
- all blank data reported
- all laboratory duplicates reported and RPDs calculated
- NATA stamp on reports.

6.2.6 Sensitivity

Sensitivity criteria are used to monitor achievement of quantification using method detection limits. Method detection limits depend on the method of analysis, the instrument's ability to measure analytes, and the sample matrix, in particular, background interferences.

When interferences are present in the sample, a loss of sensitivity can occur resulting in an increase in the method detection limit. In some instances (e.g. where one or more compounds have particularly high concentrations) the sample must be diluted for analysis. This increases the method detection limit by the dilution factor.

Method detection limits for soil/sediments are based on 'wet weight'. Actual detection limits are calculated on a 'dry weight' basis and are higher. The detection limits achieved by the laboratory should be below the adopted criteria for all analytes.

7 Reporting

Following the completion of fieldwork and receipt of the laboratory results, a draft Phase 2 ESA report will be prepared generally in accordance with the NEPM and would include:

- a summary of the historical and background information reviewed
- observations made during the subsurface investigation
- presentation and discussion of field observations, logs and laboratory results
- figures showing
    - the site features
    - locations of the sampling locations
    - soil analytical results which exceed assessment criteria.
- a summary of potentially contamination sources, exposure pathways and revision of the site conceptual site model
- undertaking and documenting the applicable quality assurance/quality control (QA/QC) procedures
- a summary of any recommended further investigation and/or remediation works.

8 References

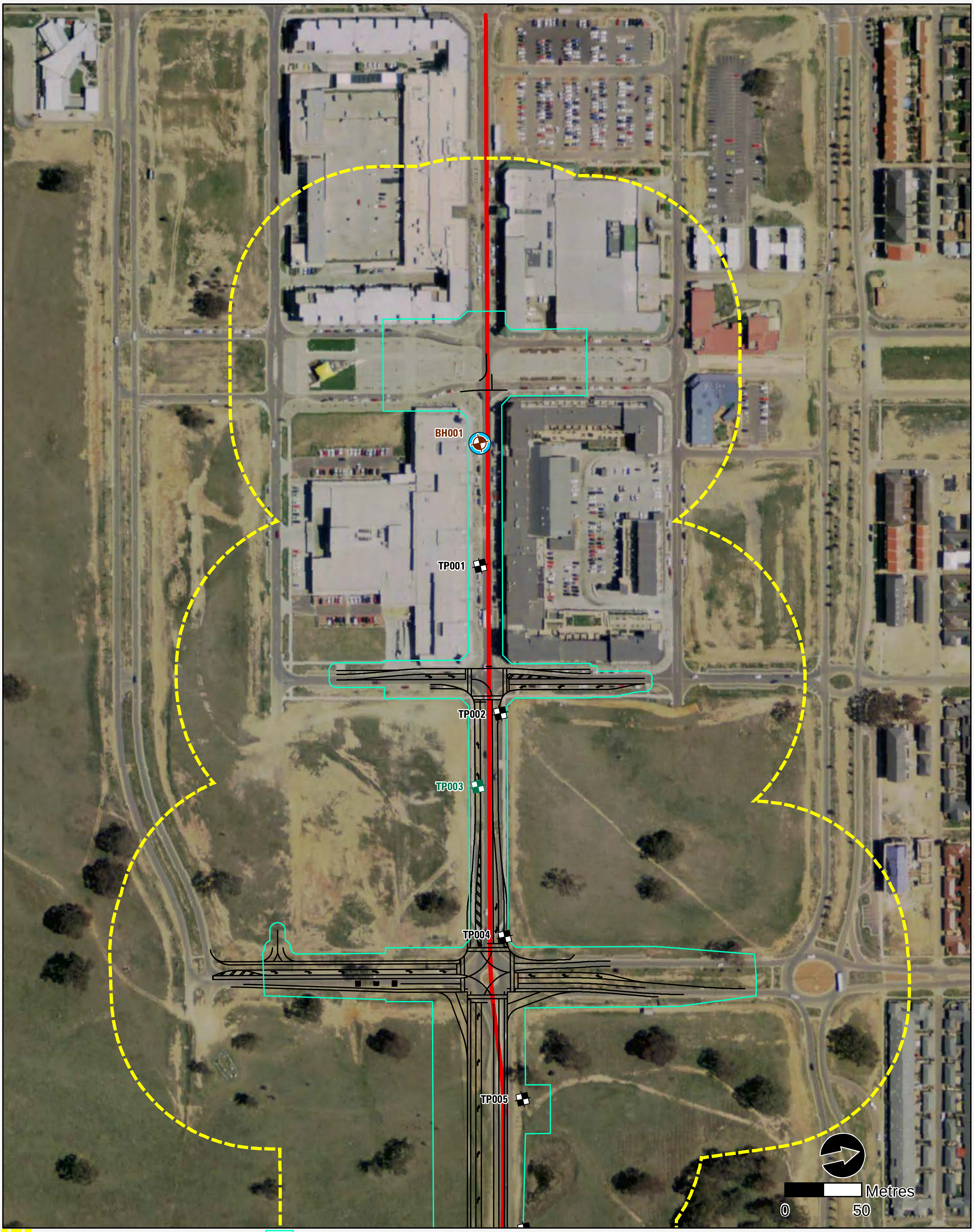
- ACT EPA (2009), Contaminated Sites Environment Protection Policy
- ANZECC (1992) Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites.
- Acid Sulfate Soils Management Advisory Council (1998), Acid Sulfate Soils Assessment Guidelines
- BMR Geology and Geophysics Australia (1992) Canberra 1:100,000 Geological Series, Sheet 8727.
- National Environment Protection Council (2013), National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1).
- NSW DECC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Edition).
- NSW EPA (1997) Guidelines for Consultants Reporting on Contaminated Sites.
- NSW EPA (1995) Sampling Design Guidelines.
- Parsons Brinckerhoff (2014) Phase 1 Environmental Assessment – Contamination
- Parsons Brinckerhoff (2014) Addenda to Phase 1 Environmental Assessment – Contamination – Cabinet in Confidence
- Western Australian Department of Health (2009) Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia

Appendix A

Figures

PARSONS BRINCKERHOFF

CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 1 of 27

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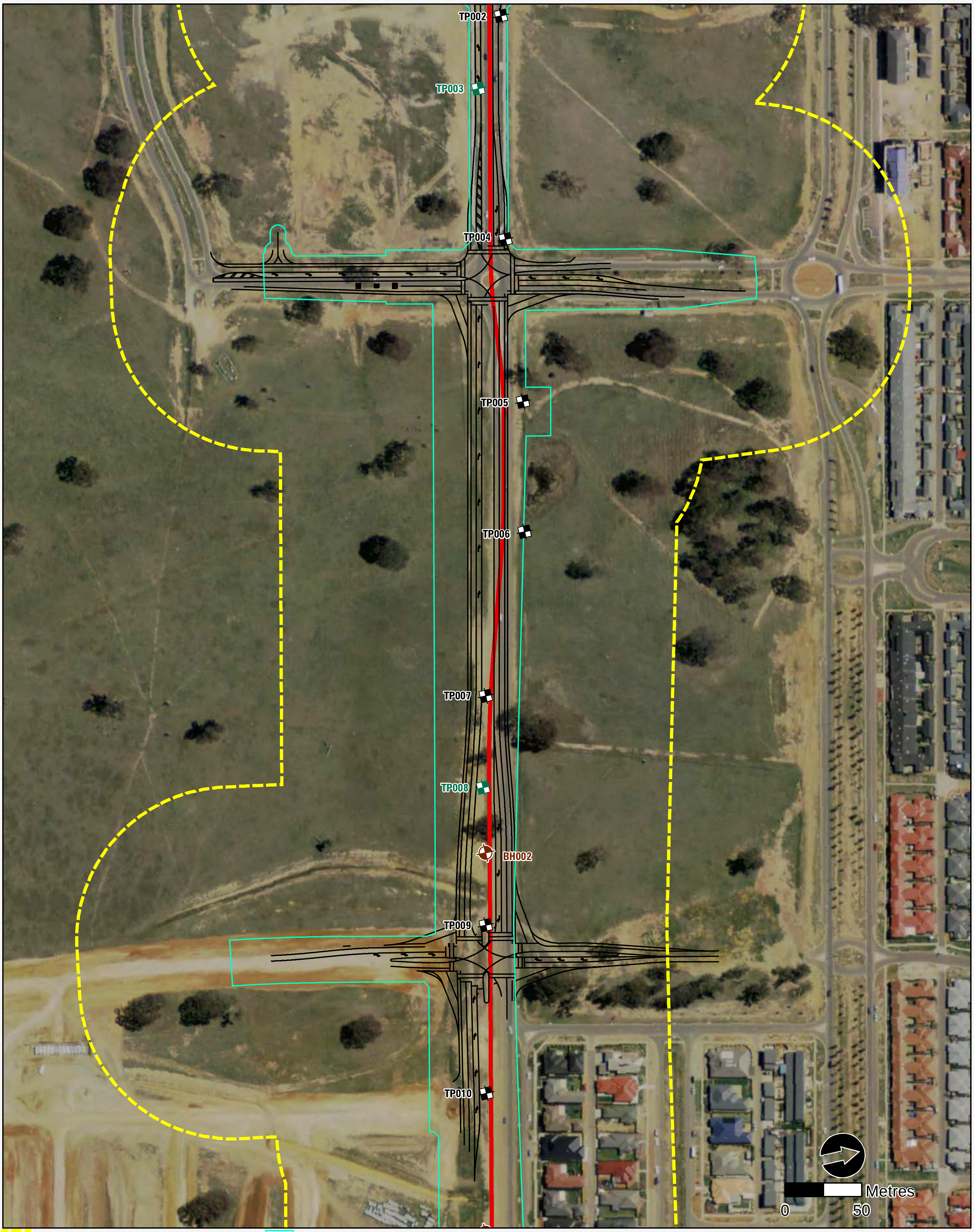
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



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Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 2 of 27

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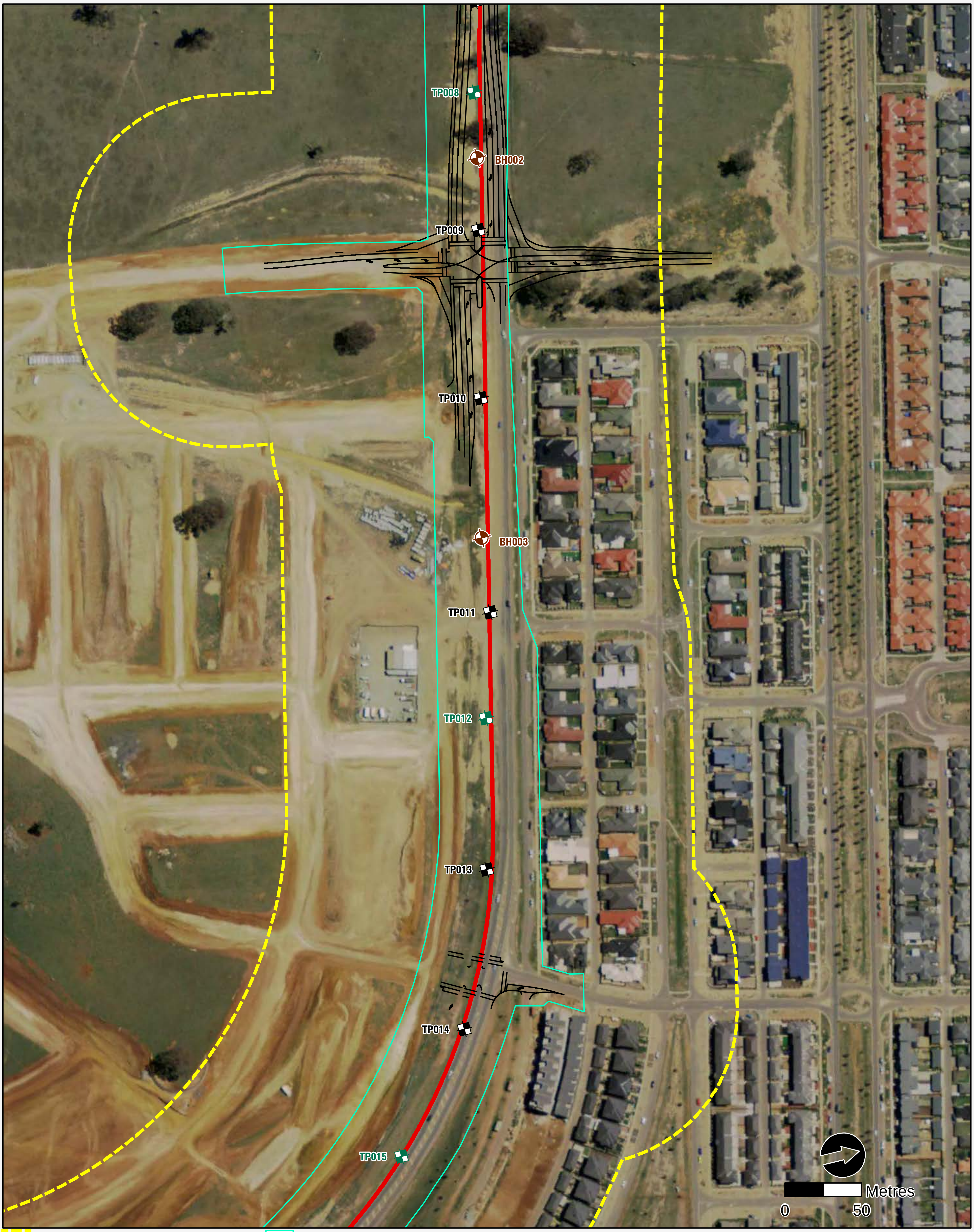
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 3 of 27

\\Apsydfil03\proj\A\Arup\2207509A_Canberra_Light_Rail_TA\10_GIS\Projects\Maps\2207509A_GIS_025_A4.mxd // SafianK // 17/09/2014

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

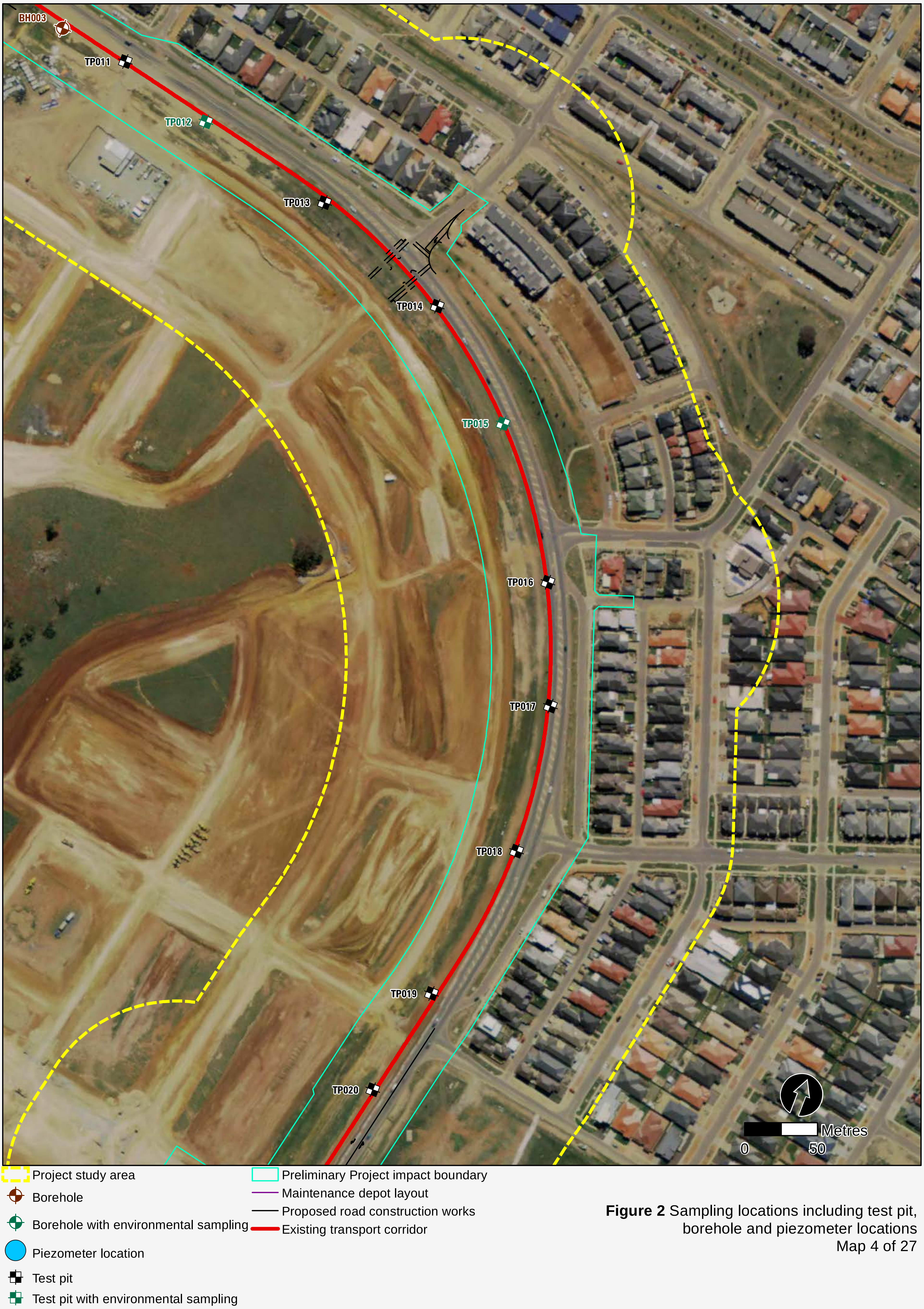

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 4 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 5 of 27

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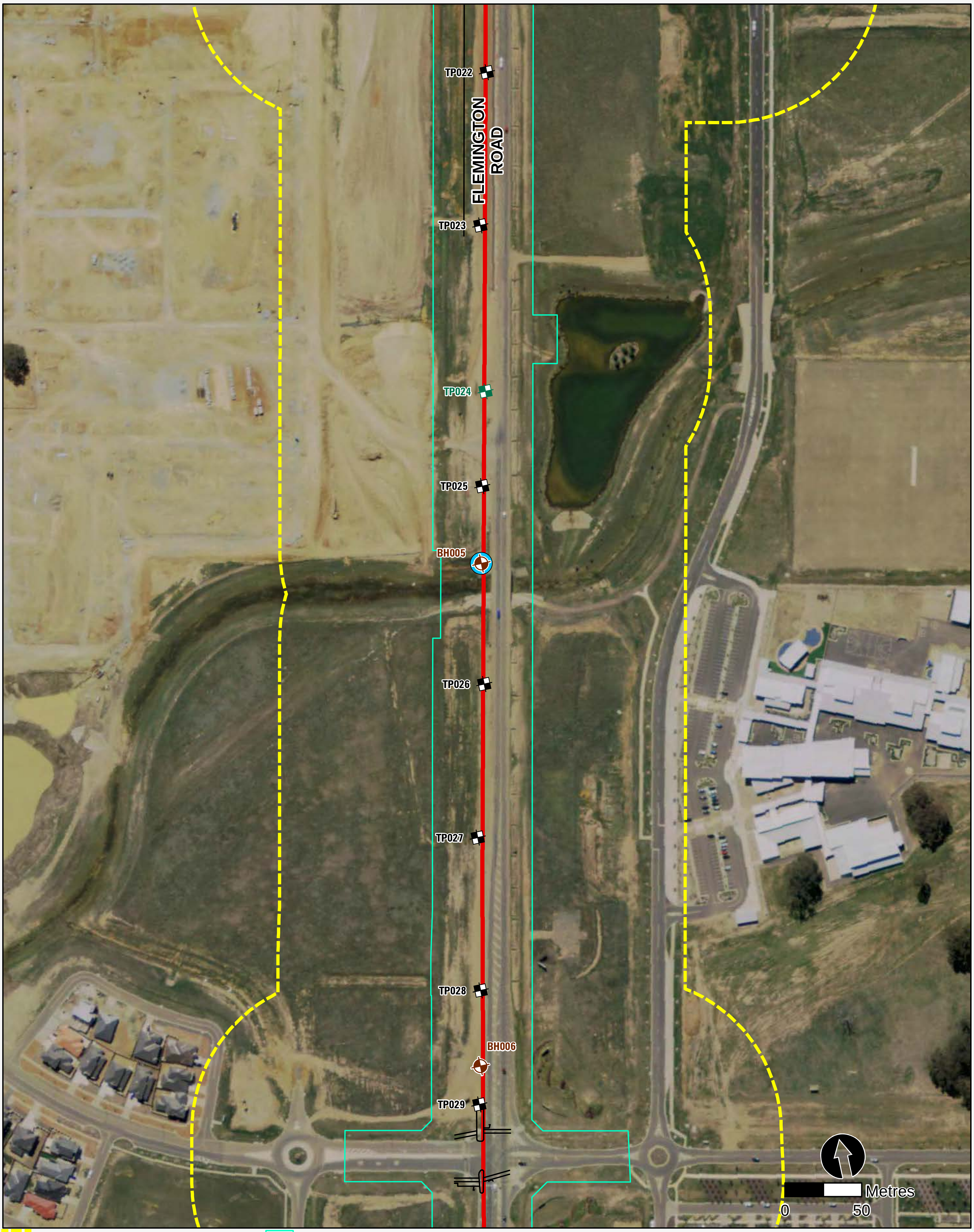
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 6 of 27

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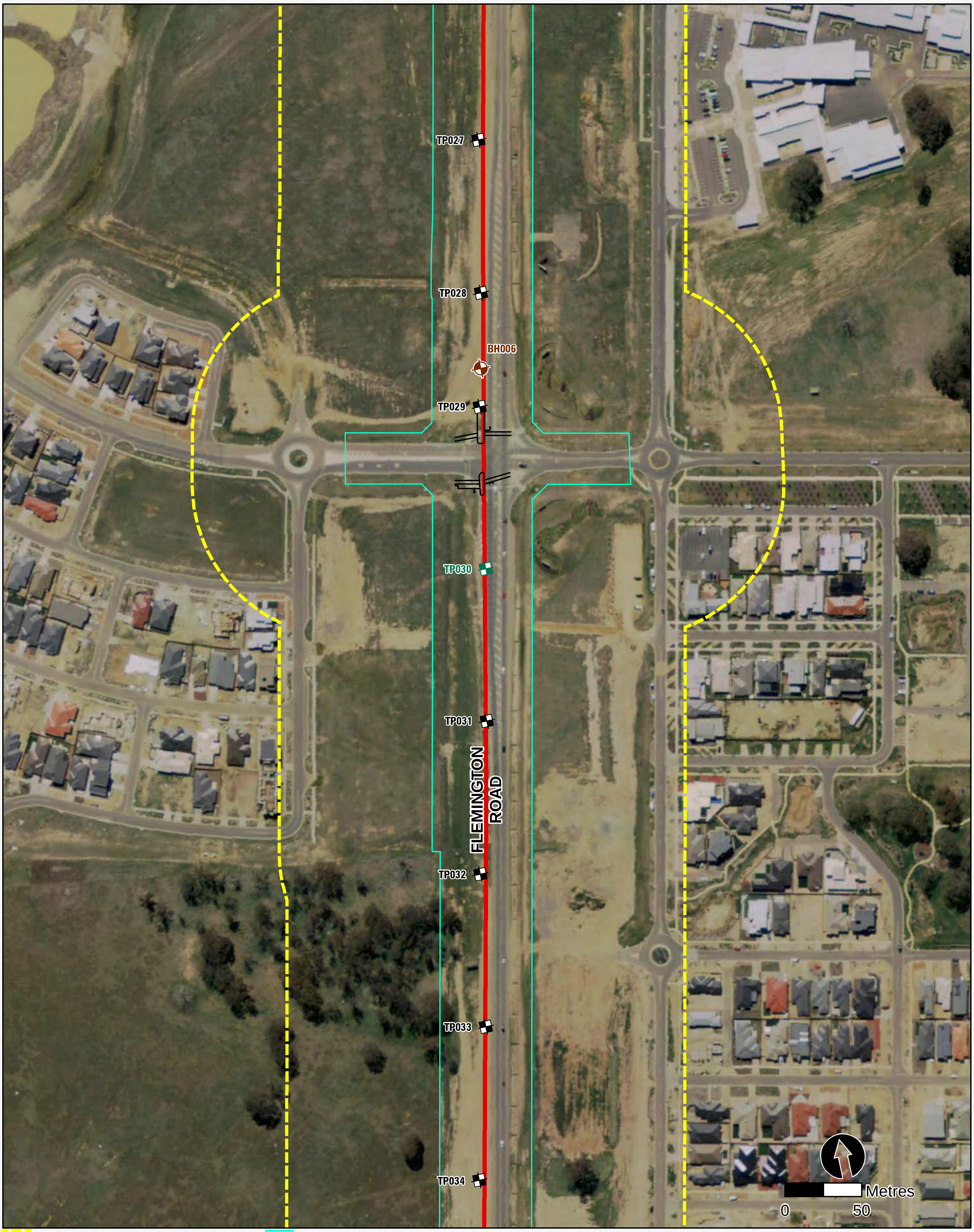
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 7 of 27

\\Apsydfil03\proj\A\Arup\2207509A_Canberra_Light_Rail_TA\10_GIS\Projects\Maps\2207509A_GIS_025_A4.mxd // SafianK // 17/09/2014

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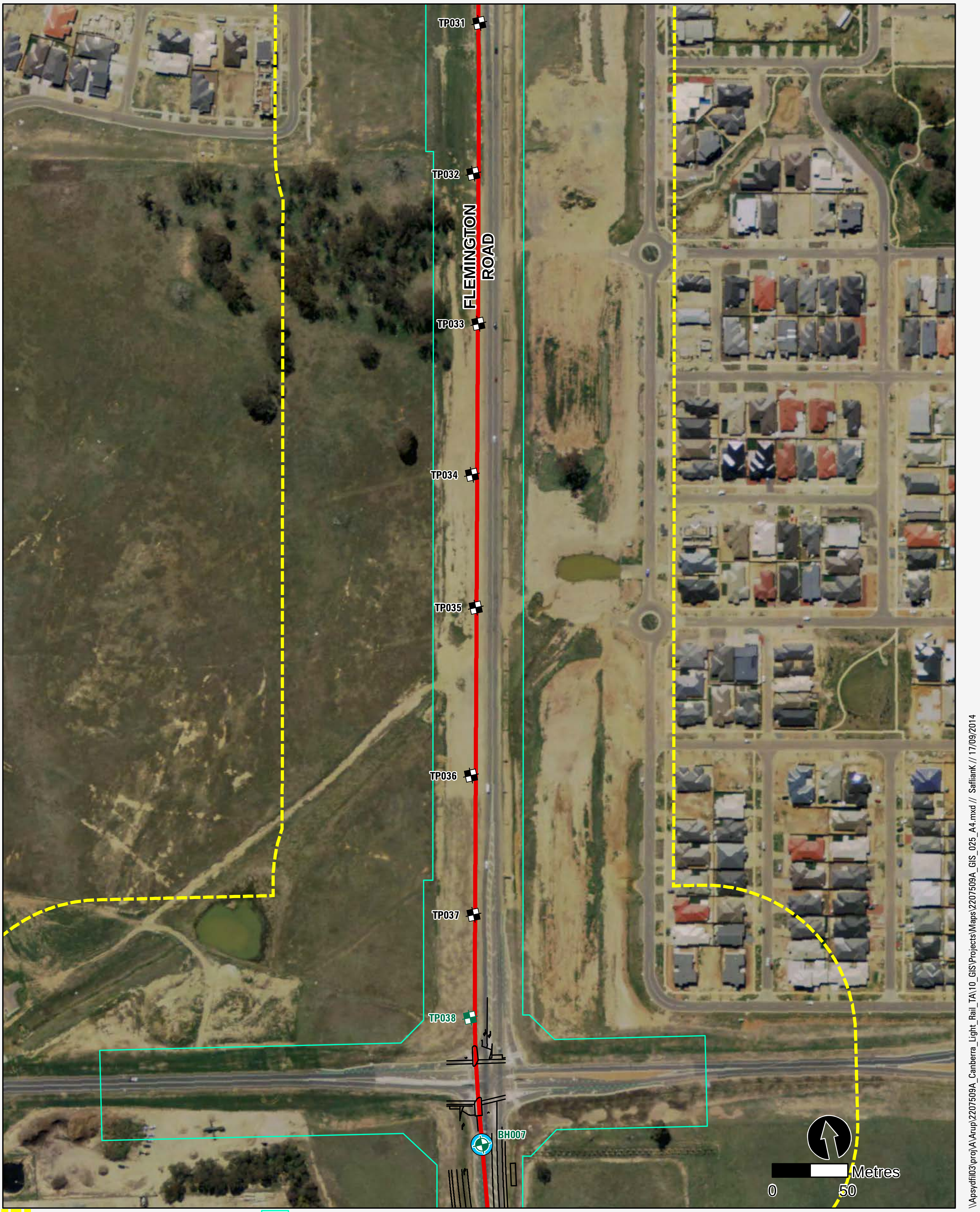
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 8 of 27

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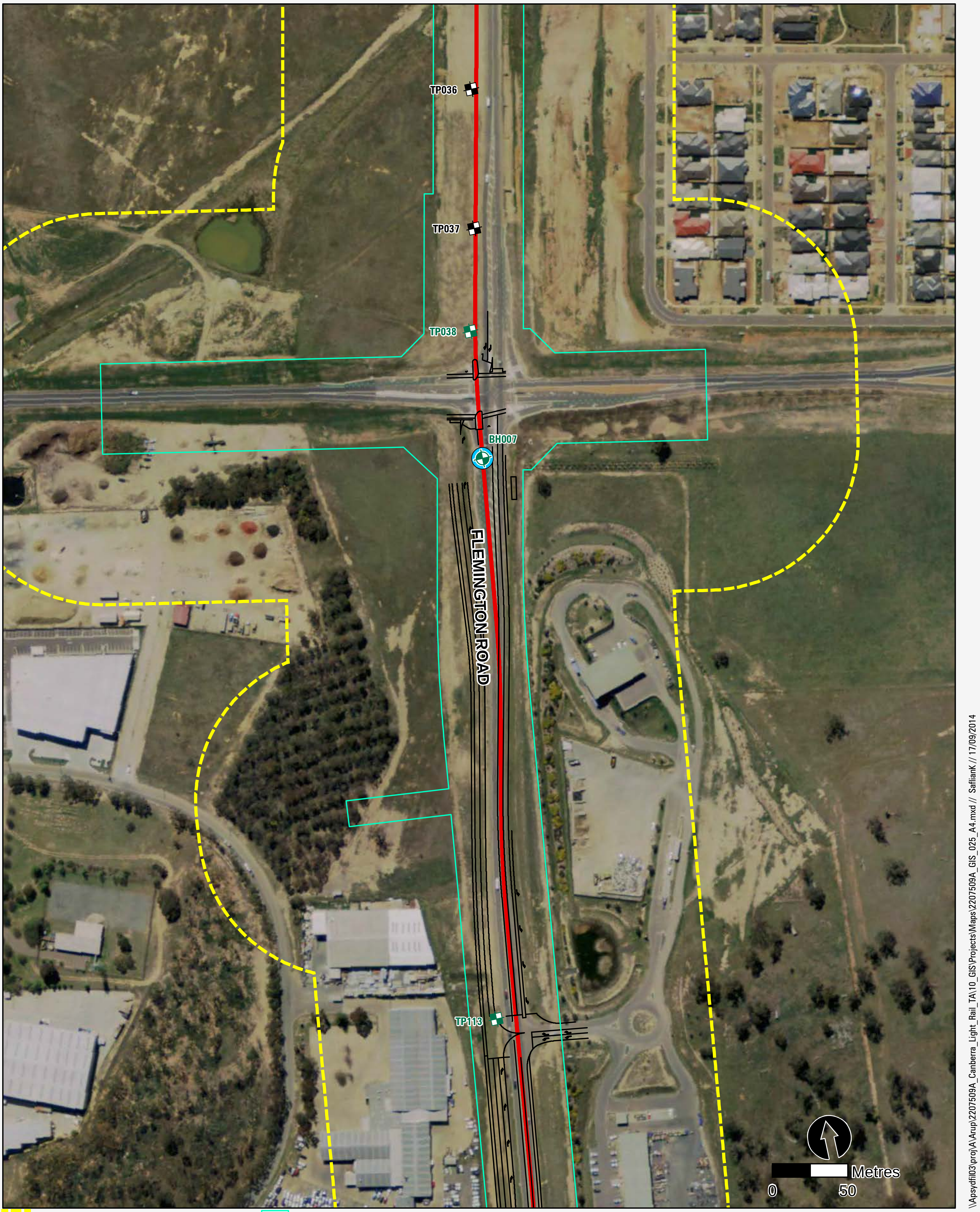
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 9 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

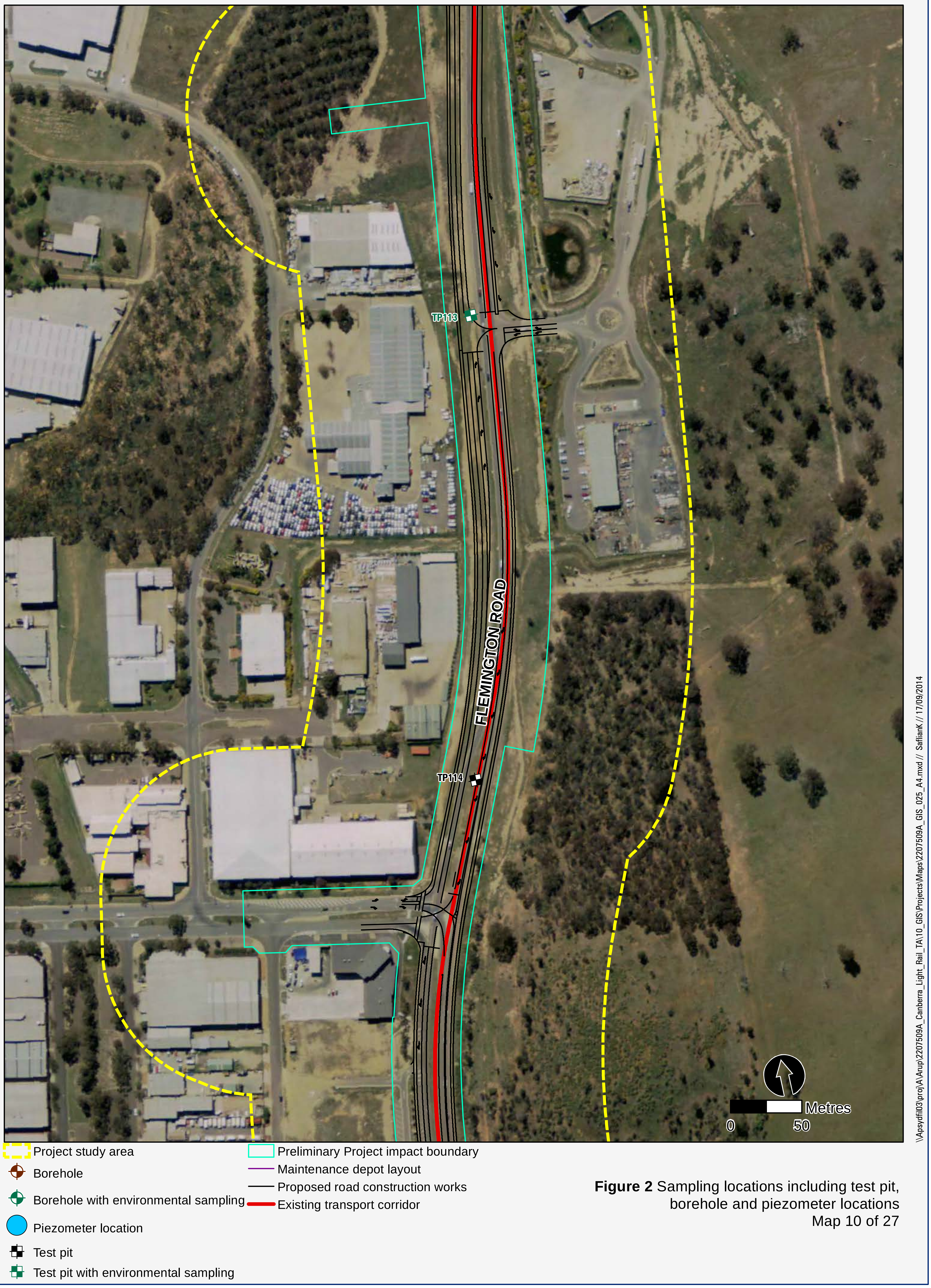

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 10 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 11 of 27

\\Apsydfil03\proj\A\Arup\2207509A_Canberra_Light_Rail_TA\10_GIS\Projects\Maps\2207509A_GIS_025_A4.mxd // SafianK // 17/09/2014

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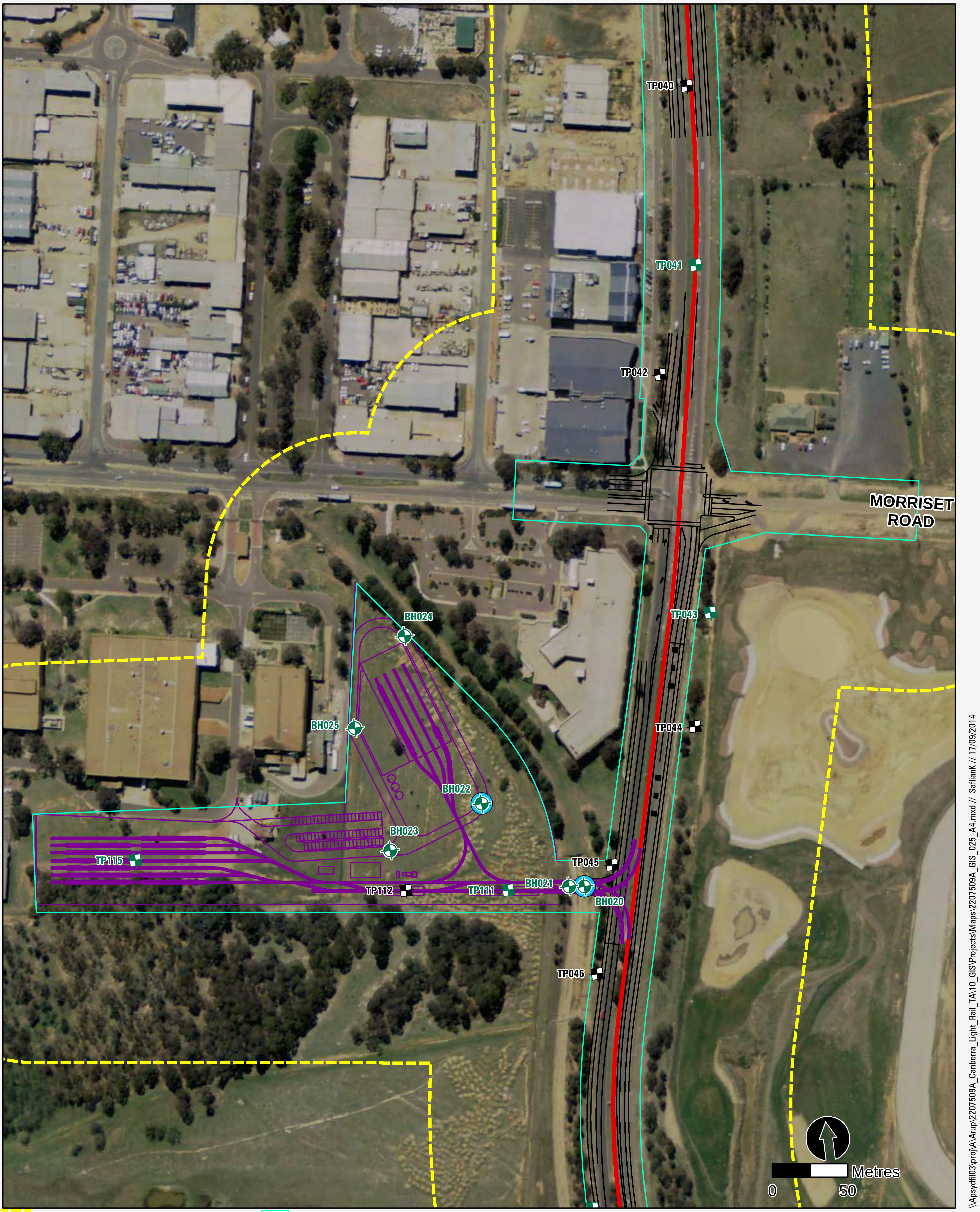
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 12 of 27

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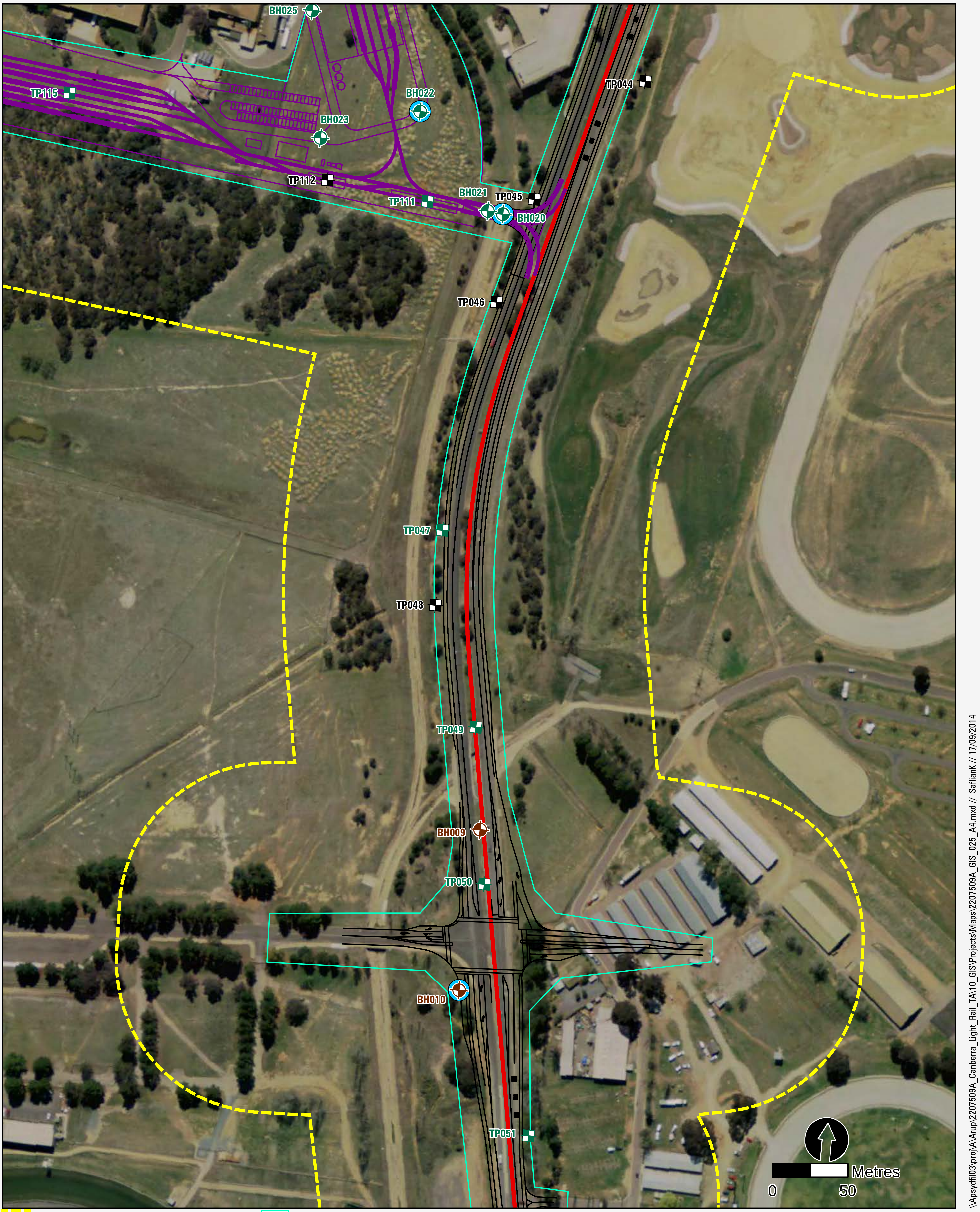
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 13 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

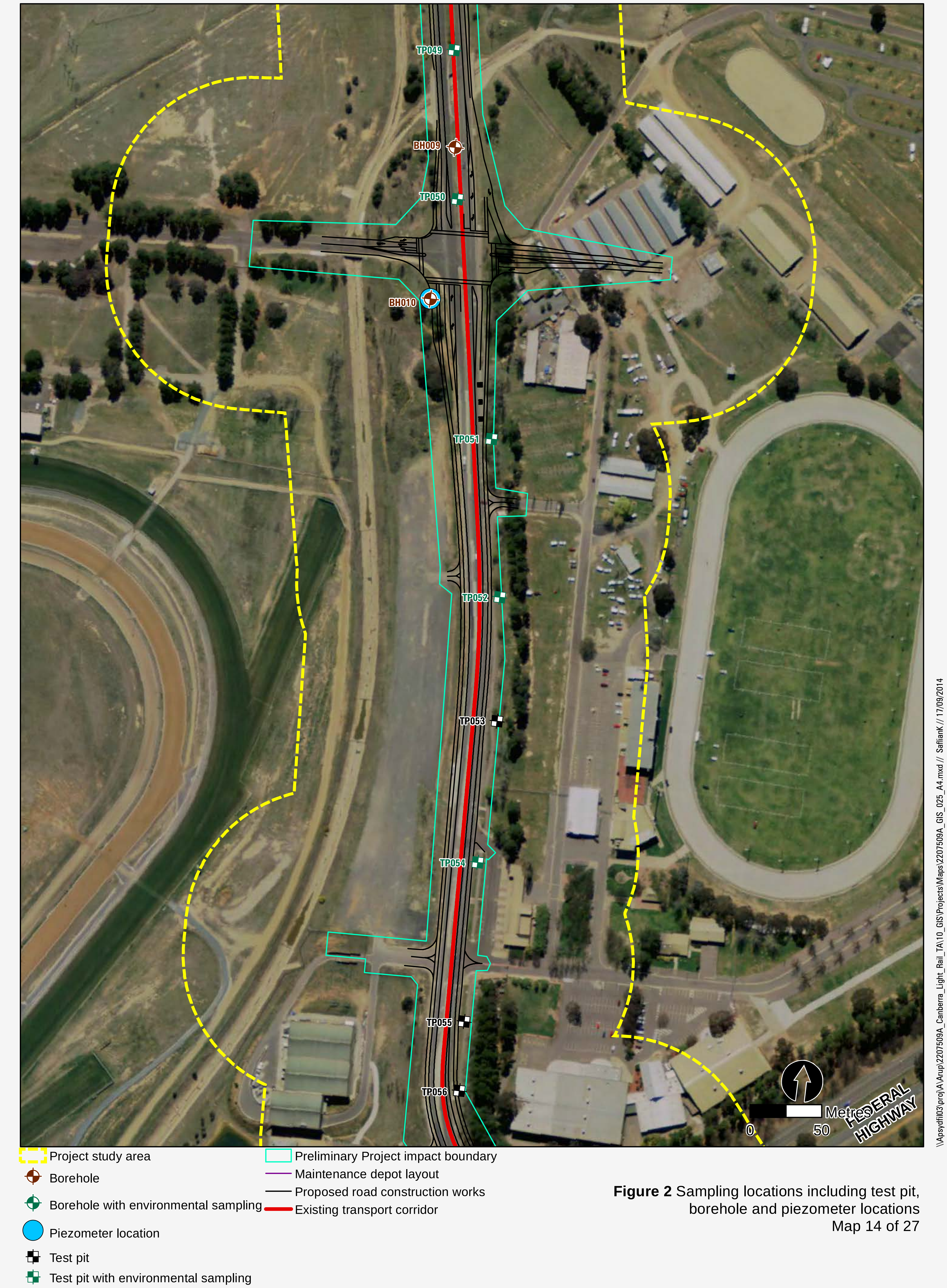

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 14 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 15 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

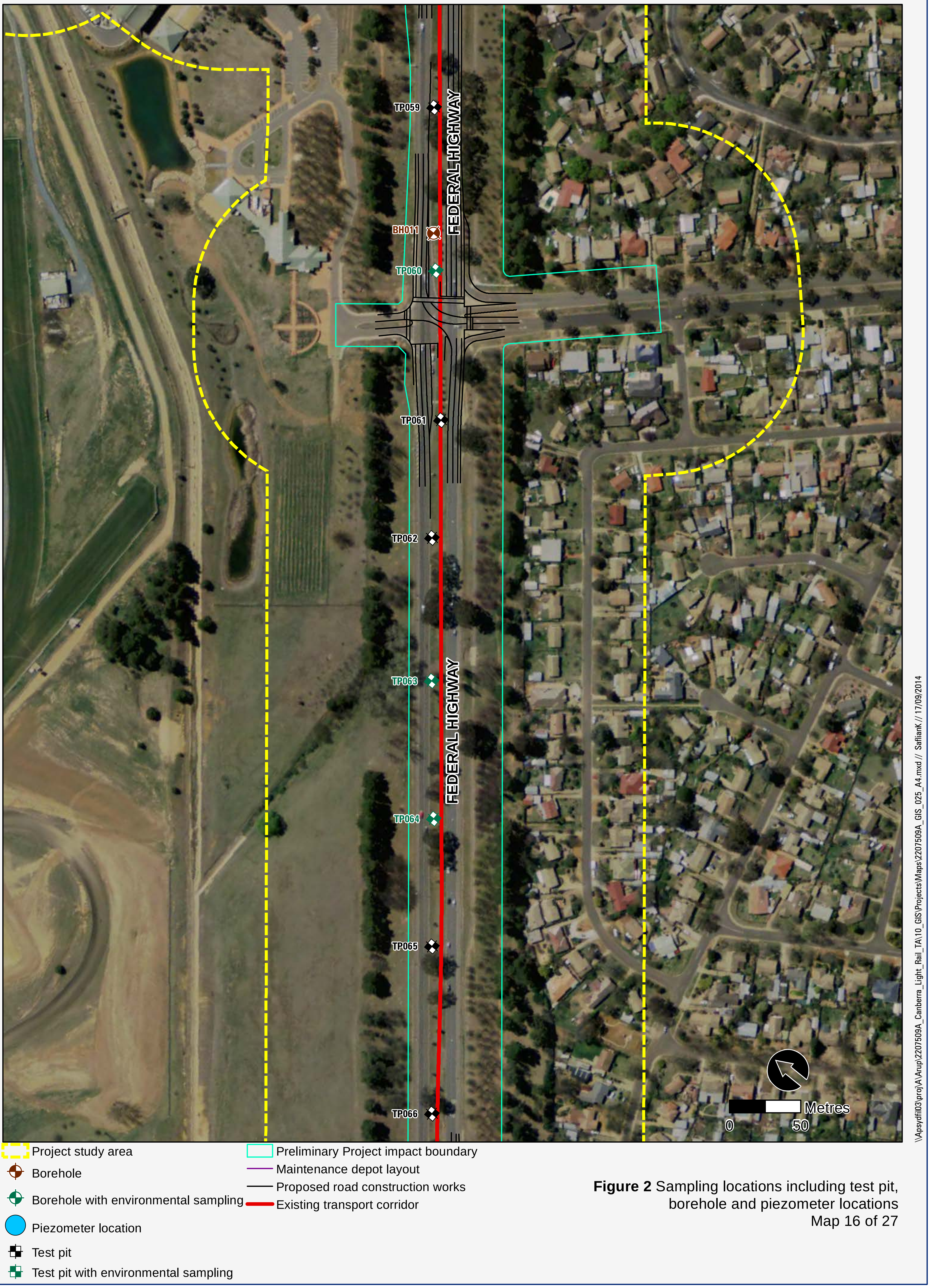

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 16 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 17 of 27

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CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT

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Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 18 of 27

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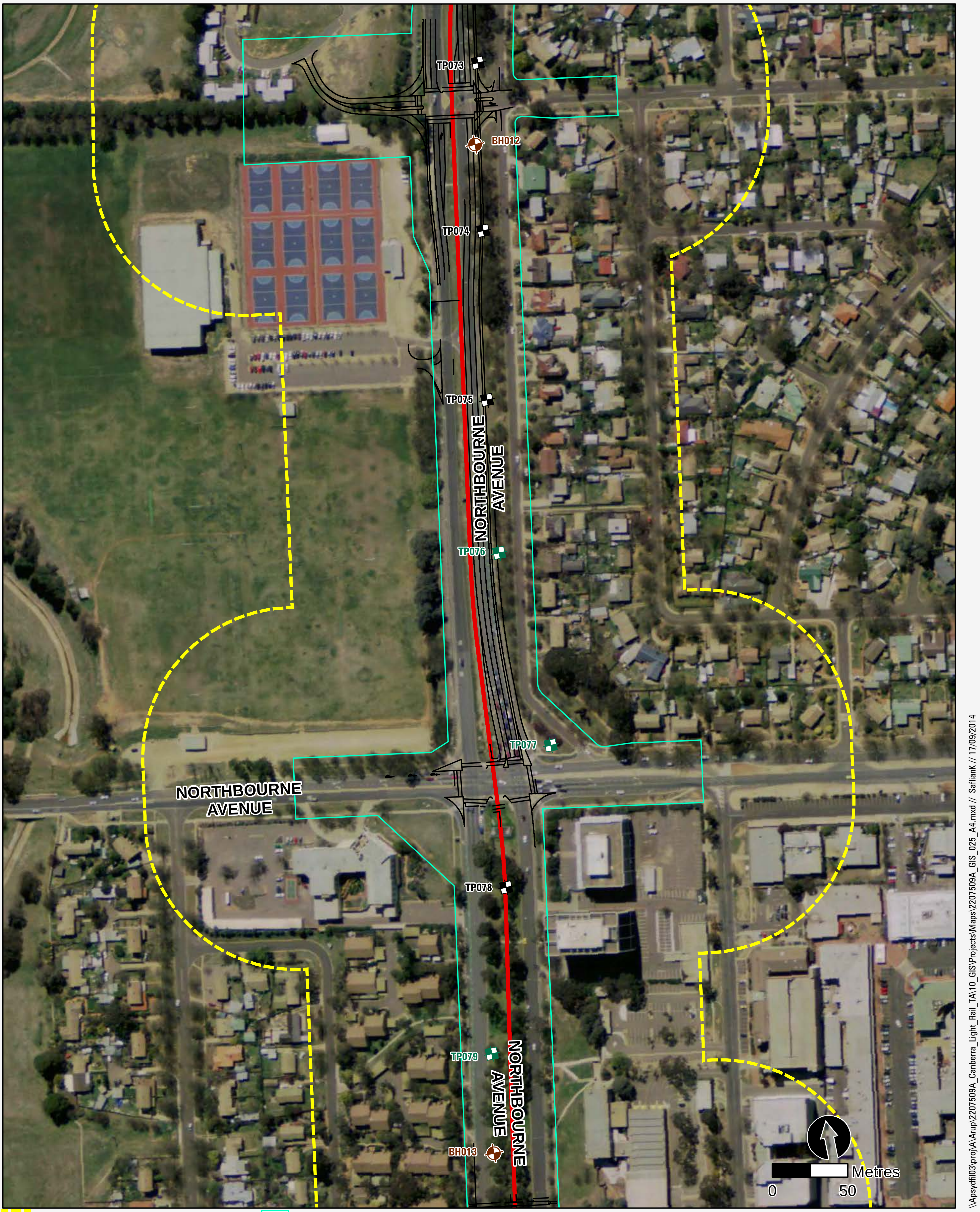
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 19 of 27

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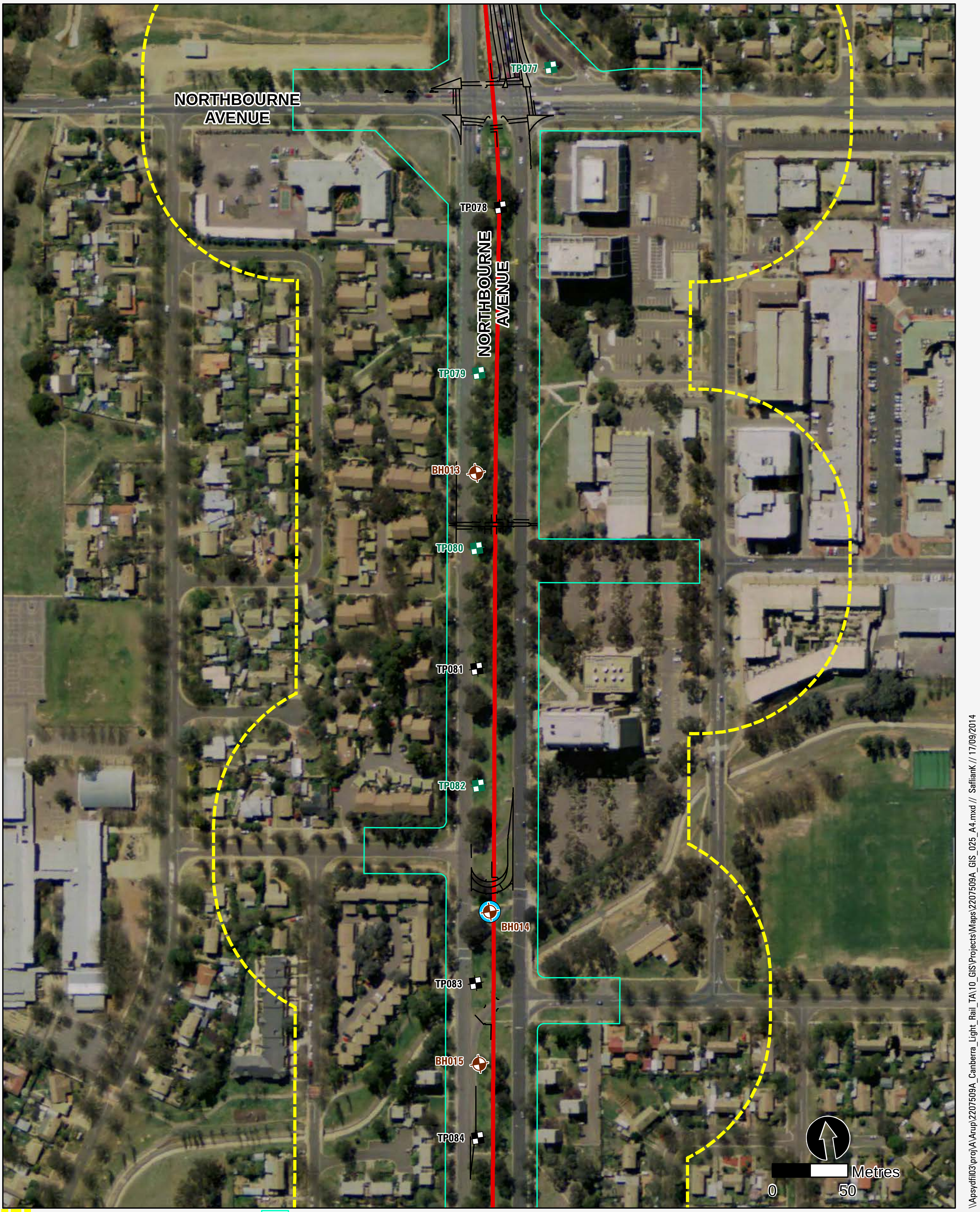
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 20 of 27

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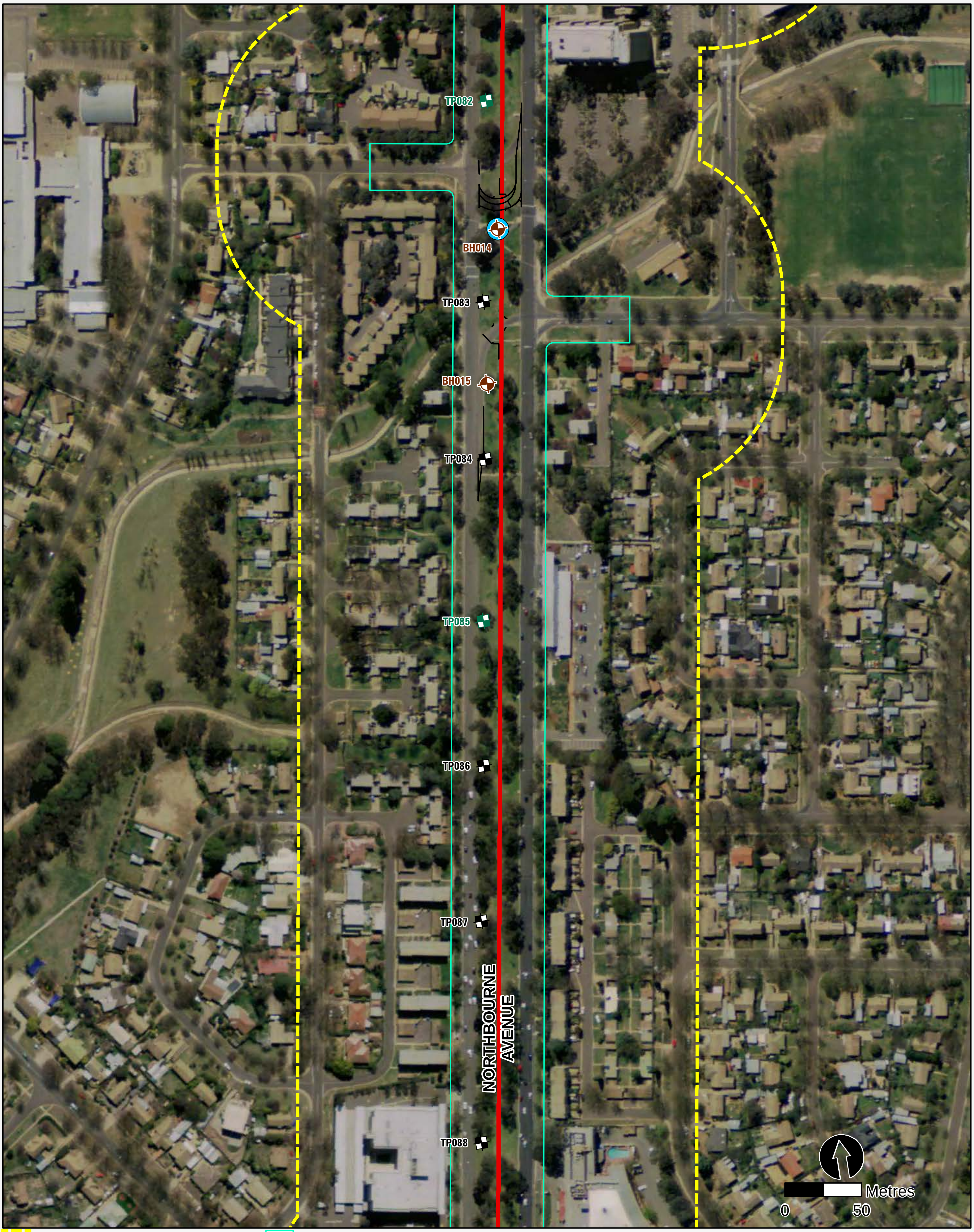
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 21 of 27

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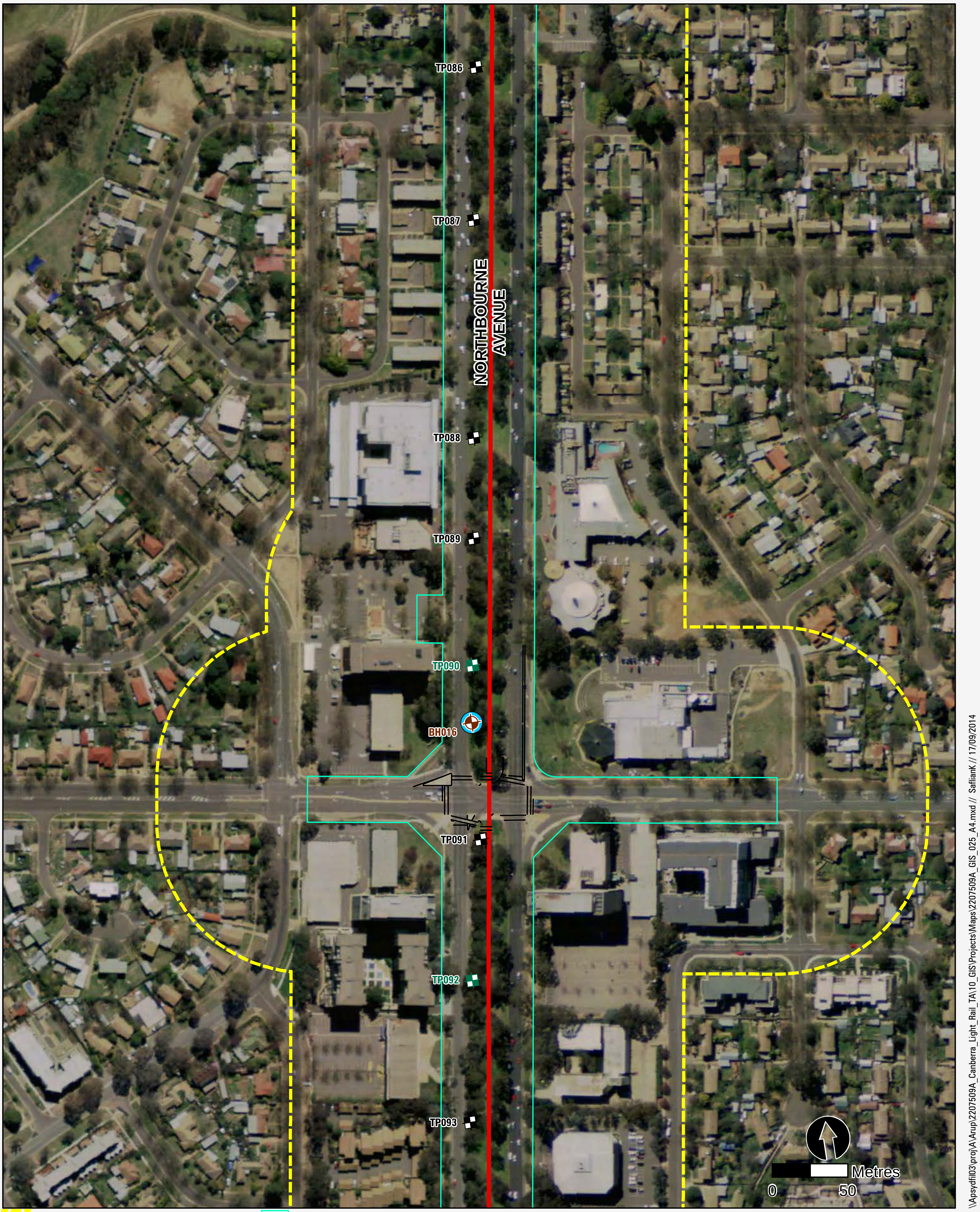
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 22 of 27

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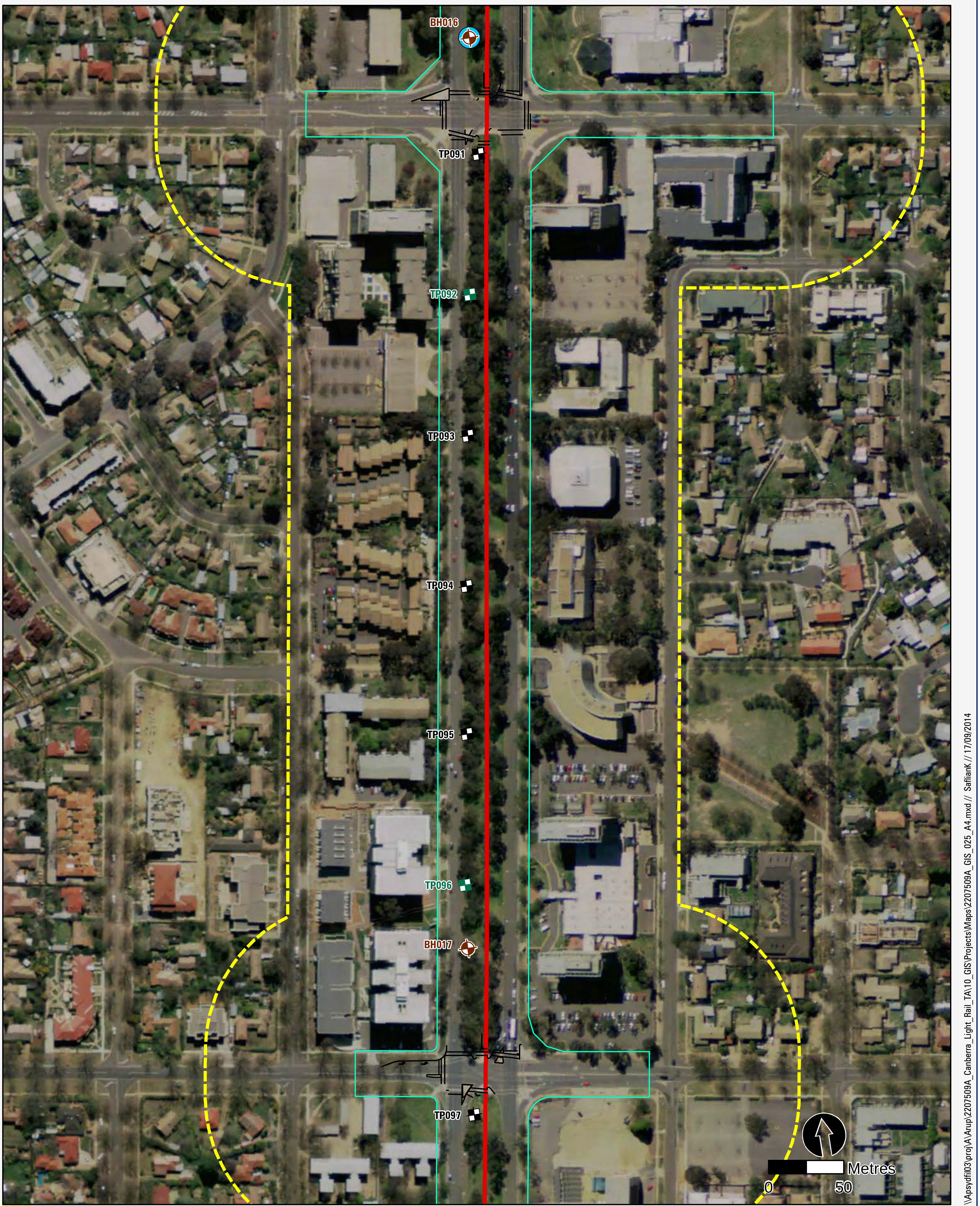
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 23 of 27

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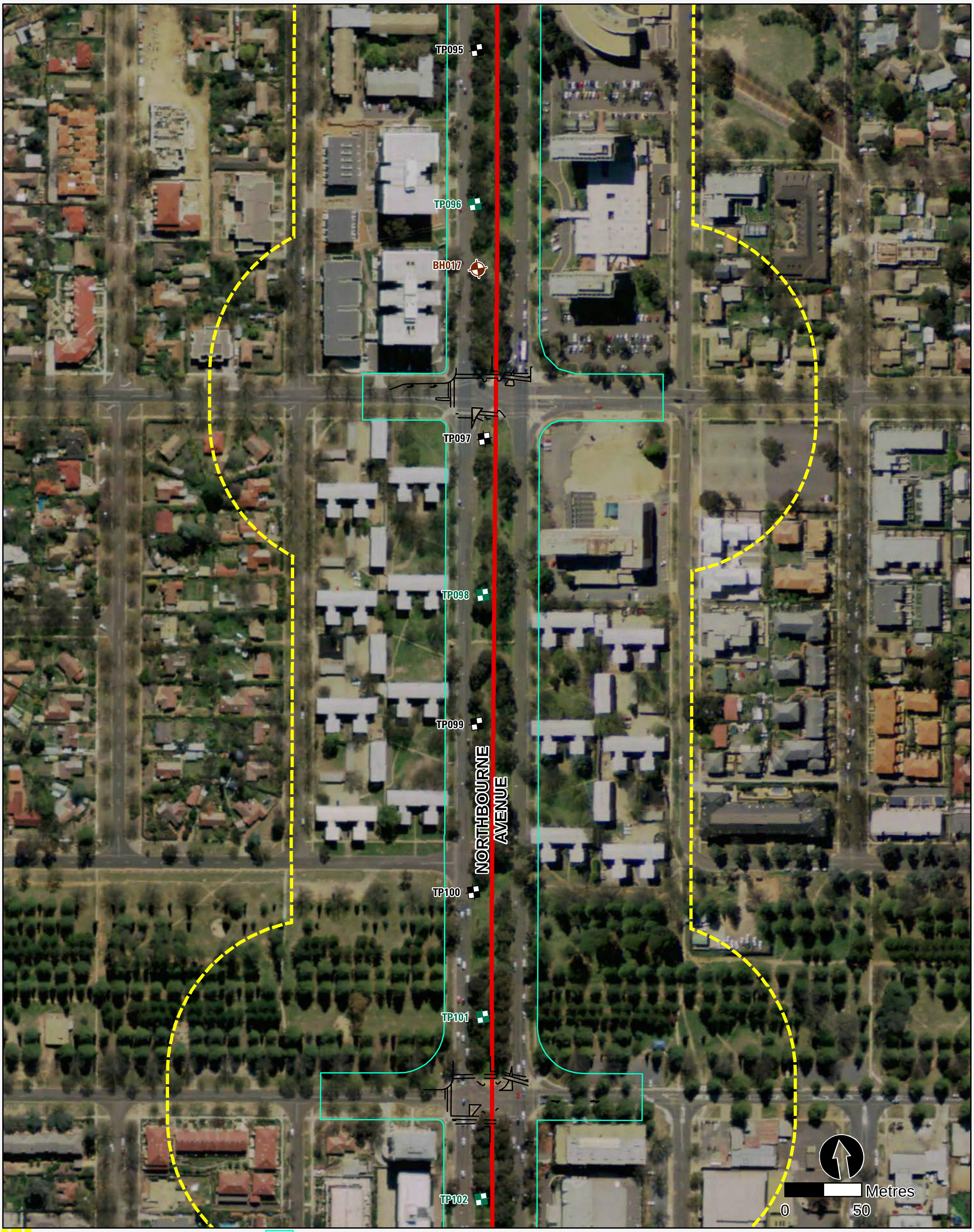
CAPITAL METRO
CANBERRA'S LIGHT RAIL PROJECT



Project study area
Borehole
Borehole with environmental sampling
Piezometer location
Test pit
Test pit with environmental sampling
Preliminary Project impact boundary
Maintenance depot layout
Proposed road construction works
Existing transport corridor

Figure 2 Sampling locations including test pit, borehole and piezometer locations
Map 24 of 27