MELBOURNE METRO RAIL PROJECT ENVIRONMENT EFFECTS STATEMENT INQUIRY AND ADVISORY COMMITTEE

MMRA TECHNICAL NOTE

TECHNICAL NOTE NUMBER:	037
DATE:	19 August 2016
PRECINCT:	All Precincts
EES/MAP BOOK REFERENCE:	EES Chapters 17, 18 and 19; Technical Appendix N – Surface Water; Technical Appendix O – Groundwater; Technical Appendix P – Ground Movement and Land Stability
SUBJECT:	Surface Water and Groundwater Response to Sections 11.1 and 12 of the 'Preliminary Matters and Further Information' Request.

NOTE:

1. This Technical Note has been prepared with assistance from AJM and responds to the matters identified in Sections 11.1 and 12 of the 'Preliminary and Further Information' request made by the IAC on 25 July 2016 (**Request**).

2. For ease of reference, this Technical Note adopts the topic headings set out in the Request and reproduces the relevant 'references' and 'requests' prior to setting out MMRA's response.

11.1 Treating collected groundwater inflows recovered from tunnels

(i) Reference

Section 17.8.2 on the EES Main Report on p17.19, states:

During operation of Melbourne Metro, a very small volume of groundwater may infiltrate the tunnels and station boxes and may require collection and disposal. It is probable that most of this water would evaporate within the tunnels, but if disposal to waterways is required, collected water would be treated via an interceptor and hydrocarbon separator to remove

contaminants prior to discharge to the stormwater system in accordance with an EPA and Melbourne water approved management and disposal plan.

(ii) Request

The IAC requests further information on:

56. how dissolved inorganics (and organics) could be treated in this collected water, and how the high water quality standards normally required to dispose of such fluids to surface waters will be achieved. This particularly applies to already identified zones where shallow tunnelling is likely to encounter contaminated sub-surface conditions.

MMRA Response:

3. Discharge of tunnel drainage water (including any groundwater) during operation is addressed by Environmental Performance Requirement (EPR) AE6, which requires that such water be discharged to sewer unless otherwise agreed to by the EPA and Melbourne Water.

4. Groundwater inflow will be very limited during operation because the tunnels and underground structures will be designed as tanked structures, as set out in section 6.2 of the EES. It is expected that groundwater inflow will generally evaporate.

5. Any unevaporated groundwater inflow would be captured in the drainage system. The outflows from the drainage system (which includes surface water, firefighting and very small volumes of groundwater drainage) will be monitored in accordance with trade waste discharge requirements for disposal to sewer. If any significant concentrations are detected, then appropriate water treatment would be undertaken following discussions with the appropriate authorities.

12.1 Arden Station – diaphragm wall and groundwater inflows/grouting

(i) Reference

Section 18.10.1 of the EES Main Report at p18-26 notes:

> *Construction of Arden station would be expected to include the use of a diaphragm wall retaining structure with toe grouting beneath the wall. This method would prevent groundwater inflows through the excavation walls during construction, but may still allow some inflow through the base of the excavation.*

(ii) Request

The IAC requests advice on:

60. when toe grouting would be initiated with the construction process and the extent to which targeted soils would be grouted.

MMRA Response:

6. If required, toe grouting would be initiated prior to excavation work commencing or in conjunction with excavation. In both cases, the toe grouting would occur before the excavation extended below the watertable.

7. The ultimate extent and location of grouting would be determined by the PPP Contractor through detailed design based on further investigations and modelling of the proposed construction methods.

8. This process is set out in EPR GW2 and GW3, which require further updated modelling prior to construction, and a Groundwater Management Plan to detail groundwater management approaches during construction, including mitigation measures and contingency measures.

12.2 Aquifer impact mitigation bore locations

(i) Reference

Section 18.12: Precinct 5: CBD North Station, Section 18.12.1: Construction, p18-29 notes:

> *Mitigation measures such as grouting of the cavern during construction would be implemented to limit inflows and drawdown in the surrounding aquifer. In addition to this, temporary injection or discharge bores may be used to control the hydraulic gradient and prevent the off-site migration of contaminants.*

Section 18.12: Precinct 5: CBD North Station, Section 18.12.1: Construction, p18-29 notes:

> *The former industrial site at 539-553 Swanston Street (CARMS 64057) presents the highest risk of contaminant migration to neighbouring properties because drawdown at this Groundwater Quality Restricted Use Zone is predicted to be several metres. Over a construction period of two and half years, this level of drawdown would draw the containment plume towards the south. The presence of volatile components in this contaminant plume also raises the risk of vapour intrusion into existing underground structures in the area. Appropriate mitigation measures such as extraction of contaminated groundwater or the use of recharge bores to reverse hydraulic gradients away from the station are being assessed in order to minimise impacts from contaminant migration in this area.*

Section 18.13: Precinct 6: CBD South Station, Section 18.13.1: Construction, p18-32, notes:

> *Two of the five existing recharge wells between the CBD South and Domain station precincts would be within the predicted unmitigated drawdown radius associated with construction activities at CBD South station. These wells inject water into the Moray Street Gravels to maintain groundwater pressures in the overlying Coode Island Silt and prevent ground settlement.*

(ii) Request

The IAC requests advice on:

61. *the proposed location of temporary injection, extraction or discharge water bores for groundwater control*

62. *what the dewatering control infrastructure would look like at surface or street-level*

63. *a map showing where these bores are located and their proposed founding detail*

64. *details of bore water flow rates and pressure heads at which the incumbent CityLink Authority injection wells typically operate*

65. *with respect to the provision of temporary aquifer recharge, whether discussion has occurred with the CityLink Authority to explore using the existing aquifer recharge bores and if so, the outcome of those discussions.*

MMRA Response:

Request 61

9. The locations of temporary groundwater injection wells remain to be finalised. A number of considerations are involved in determining both their location and extent. These include the nature and thickness of the target aquifer, proximity to a mains water supply and power supply as well as access for maintenance requirements which would all need to be taken into account in order to suitably locate the mitigation bores in the final design.

10. Similarly for groundwater extraction wells to manage contamination issues, further detailed assessment would be required to confirm the physical extent and properties of movement of the groundwater issue being managed as well as the construction methodology proposed.

11. Specifically for CBD North, appropriate mitigation measures such as extraction of contaminated groundwater or the use of recharge bores to reverse hydraulic gradients away from the station are being investigated in order to minimise impacts from contaminant migration in this area. However, if a temporary recharge scheme is required at CBD North, this would be determined at detailed design stage. The specific location of temporary injection, extraction or discharge water bores for groundwater control at this location have therefore not been determined.

12. At CBD South, a number of groundwater injection wells would be required. The *Regional Groundwater Numerical Modelling EES Summary Report - July 2016 Update* (see Technical Note 023) includes diagrams of potential injection bore locations at CBD South (Figure 19).

13. These locations have been selected for conceptual design purposes to assess the feasibility of the mitigation method. Ultimately, the exact location will be decided upon by the PPP Contractor and will be subject to further investigation and modelling to confirm that the system, including bore locations, will achieve the EPR.

14. This process is set out in EPR GW2 and GW3, which require further modelling prior to construction, and a Groundwater Management Plan to detail groundwater management approaches during construction including mitigation measures such as temporary recharge.

Request 62

15. All services and controls for this type of infrastructure are typically located underground. At the street level, the infrastructure typically consists of an access manhole cover or gatic cover. These systems are usually remotely controlled and monitored and are only accessed for maintenance purposes.

Request 63

16. As stated above, the location of temporary mitigation bores at CBD North has not been determined.

17. A map showing the conceptual location of the injection wells at CBD South is shown in the *Regional Groundwater Numerical Modelling EES Summary Report - July 2016 Update* on page 42 (Figure 19).

18. Although the figures for CBD South referenced above indicate potential locations of bores, these are conceptual only and the ultimate location of any mitigation bores will be decided by the contractor during detailed design after further investigations.

19. The target injection aquifer (founding) at CBD South will be the Moray Street Gravels. The effectiveness of injecting into these deposits has been assessed in the groundwater model and is demonstrated in practice with the Transurban injection wells. At CBD North, the target aquifer would be the Melbourne Formation. The depth of these bores would need to be decided by the PPP contractor based on further investigations and final locations.

Request 64

20. Transurban has provided long term average injection rates for their injection bores and these have been used in the groundwater model for calibration. These are shown in Section 7 of the *Regional Groundwater Numerical Modelling EES Summary Report - July 2016 Update* at page 28. The injection rates of these bores are between 0.25 L/s and 2 L/s (average of 1 L/s). No pressure head data was provided.

Request 65

21. Discussion has been undertaken with Transurban regarding the provision of data only. There has been no discussion with Transurban to explore the

use of its existing aquifer injection bores. Such discussion has not been considered necessary because:

a. the Transurban bores are not considered to be in appropriate locations for the purposes of the Melbourne Metro injection requirements; and

b. The Melbourne Metro Concept Design incorporates dedicated temporary injection bores designed for the specific purposes of the Melbourne Metro. One of the purposes of these bores is to prevent any significant impact on the Transurban injection bores.

12.3 TBMs handling variance at paleo-valleys

(i) Reference

Section 18.6: Risk Assessment, p18-14. The IAC is not clear how Tunnel Boring Machines (TBMs) could cater for any potential significant variance in geology around the locations of the Jolimont Valley sediments (i.e. from CBD South Station and heading into the Yarra River Crossing and onto the other side of the Yarra).

(ii) Request

The IAC requests:

66. clarification on how any potentially significant variance in geology would be managed by the TBM.

MMRA Response:

22. The Concept Design proposes use of a pressurised, closed-face TBM, where required, to assist in minimising face loss (ground loss into and around the TBM). The TBM key operational parameters (e.g. applied face pressure, cutter head torque and revolution speed, thrust ram loads and excavated material) will be estimated in advance based on anticipated geological and groundwater conditions. As the TBM excavation advances, excavated volumes will be monitored comparing theoretical volume and density with the actual volume and density excavated. Any excessive over excavation will be identified through real time monitoring, which will enable the TBM operational parameters and controls to be adjusted accordingly. Applied face pressures and rate of excavation advance can be quickly adjusted to limit face loss and control excessive groundwater inflows.

23. In addition, settlement monitoring results would be analysed to calibrate face loss assumptions used in the settlement analysis to measure consistency with the predicted ground settlement model, and updated as required. These measures and processes would typically be set out in the Groundwater Management Plan and Ground Movement Management Plan, required by EPR GW3 and GM3.

12.4 Additional site investigations reference

(i) Reference

Section 18.6: Risk Assessment, p18-14 and Section 19.6: Risk Assessment, p19-16 notes that rock structure, particularly vertical to sub-vertical rock features (i.e., joints or other defects) is expected to have a large effect on the potential for 'over-break' and groundwater inflow with the construction of the CBD Station caverns and inter-connecting space between the CBD Stations (where tunnelling by TBM is currently not proposed).

(ii) Request

The IAC requests advice on any additional site investigations, either conducted or proposed, since the issue of the EES and any supporting documents, with respect to:

67. *updated estimates of hydraulic parameters for aquifers*

68. *targeting those alignment areas either with significant investigation gaps, or where investigation anomalies have shown up (i.e., current lack of investigation data directly at the locations of Domain and Parkville Stations, groundwater wells showing lower total dissolved solids results compared to surrounding data points, etc)*

69. *better definition and checks for steeply dipping fracture zones or defects that may result in anisotropic aquifer depressurisation patterns (to date it seems the data-bank is derived from mostly vertical investigation core holes, which will have a higher chance of missing such defects)*

70. *follow-up to the peer review comments provided by Mr Middlemis – Hydrogeologic (21 April 2016) with respect to:*

    - aquifer confinement vs. unconfined behaviour

    - refinement of aquifer specific storage parameters

    - transient model calibration for aquifer behaviour

    - evaluation of amelioration mechanisms, like in-situ grouting and temporary recharge wells

    - if any, further investigations (ie, inclined investigation core holes, early mapping of early works/excavations, etc) are proposed in order to determine the impact of rock structure and fabric on excavation conditions.

MMRA Response:

Request 67

24. The results of further work relating to hydraulic parameters for aquifers that has been undertaken since the issue of the EES are detailed in the *Interpreted Hydrogeological Setting EES Summary Report - July 2016 Update* (see Technical Note 023). The additional investigation undertaken since

the release of the EES, including installation of groundwater monitoring wells, is detailed in Section 4 of that report. The results of all hydraulic testing are included in Appendix C of that report (bores labelled as GA15-BH035 to GA15-BH103, GA15-BH117 to GA15-BH119 and GA15-BH125 onwards have been included since the issue of the EES). The interpretation of hydraulic testing is included in Section 5 of that report.

Request 68

25. Further boreholes have been drilled at Parkville and Domain stations.

26. Five additional boreholes (GA15-BH089, GA15-BH090, GA15-BH095, GA15-BH097 and GA15-BH243) have been drilled at Parkville, to make a total of seven bores in this area. All new bores at Parkville have been tested for groundwater quality as well as hydraulic tests such as packer tests and/or slug tests.

27. Three additional boreholes have been drilled at Domain, to make a total of 14 bores in this area. At Domain, one new bore was tested for groundwater quality, all three were slug tested and two were packer tested. A pumping test has also been undertaken at Domain.

28. For the results of hydraulic and of groundwater quality testing, refer to Appendices C and E of the *Interpreted Hydrogeological Setting EES Summary Report - July 2016 Update*.

Request 69

29. Further work has been undertaken to better define the structural geology of the CBD South area and the impacts of structural features on the hydraulic conductivity of the rock mass. This has included one 350 m long Directionally Cored Borehole (horizontal borehole). The further understanding gained from these investigations is detailed in Section 6 (Directionally Cored Borehole specifically described in Section 6.5) and Section 7.0 of the *Interpreted Hydrogeological Setting EES Summary Report - July 2016 Update*.

Request 70

30. Response to request regarding peer review comments:

    a. *aquifer confinement vs. unconfined behaviour:* The nature of the groundwater model is that it replicates unconfined or confined behaviour explicitly depending on water levels and model layer configuration. We believe this comment relates to the storage parameters, as discussed below.

    b. *refinement of aquifer specific storage parameters:* This relates to the discussion on page 8 of Mr Middlemis' review regarding storage parameters and the sensitivity of the model to specific storage in particular. Based on Mr Middlemis' comments, a number of additional scenarios were run to test the sensitivity

of the model to specific storage. The results of these scenarios are discussed in Sections 8.2.1.5 and 8.2.1.7 of the *Regional Groundwater Numerical Modelling EES Summary Report - July 2016 Update*. The results of the sensitivity testing indicated that the groundwater inflows and drawdowns predicted by the model were not sensitive to the specified changes in specific storage. The model was also tested for sensitivity to changes in specific yield and it was found that the specific yield of the Melbourne Formation is likely to have a significant effect on groundwater inflows and drawdown. This is discussed in Sections 8.2.1.6 and 8.2.1.7 of the *Regional Groundwater Numerical Modelling EES Summary Report - July 2016 Update*.

c. *transient model calibration for aquifer behaviour:* This relates to point 8 in the table on page 6 of Mr Middlemis' review pointing out that only steady state calibration of the groundwater model has been undertaken and not transient calibration. No transient calibration has been undertaken since the issue of the EES as steady state is considered adequate for the conceptual design stage. This is in agreement with Mr Middlemis' review.

d. *evaluation of amelioration mechanisms, like in-situ grouting and temporary recharge wells:* A range of scenarios involving mitigation measures have been undertaken during the further modelling completed since the issue of the EES. These are detailed in Section 8 of the *Regional Groundwater Numerical Modelling EES Summary Report - July 2016 Update.*

e. *if any, further investigations (i.e., inclined investigation core holes, early mapping of early works/excavations, etc) are proposed in order to determine the impact of rock structure and fabric on excavation conditions:* This point does not correspond to any comments in Mr Middlemis' review. However, we note that the *Interpreted Hydrogeological Setting EES Summary Report - July 2016* includes the results and interpretation from a Directionally Cored Borehole drilled specifically to assess the rock structure. The results are discussed in Section 6.5 of the *Interpreted Hydrogeological Setting EES Summary Report - July 2016 update.* Further monitoring and geological mapping during construction of the project will be determined by the PPP Contractor, as it is standard practice to assess geological conditions and the impact of rock structure and fabric on excavations. The monitoring and calibration of predictive models based on results would typically be set out in the Groundwater Management Plan and Ground Movement Management Plan, required by EPR GW3 and GM3.

CORRESPONDENCE:

No correspondence.

ATTACHMENTS:

No attachments.