Reference number:	
Advice from:	Stephen Hancock
Date of response :	4 September 2017
This advice is in response to request:	As set out in WEST GATE TUNNEL PROJECT: Provision of Expert Advice to Inquiry and Advisory Committee – dated 29 June 2017 – Scope of Task 12: Following the completion of expert evidence, provide a brief final report to the IAC no later than the end of Week 4 of the Hearing which complies with the PPV Practice Note-Expert Evidence and sets out: a. Any changes of opinion since your Interim Report (if any) and the reason for that change of opinion; and b. Your opinion on the latest version of the proponents proposed approval document (if any) and any other party's suggested changes to the approval document.

List of Abbreviations used in this document and in the report supporting it

CIS	Coode Island Silts
CEMP	Construction Environmental Management Plan
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
EES	Environmental Effects Statement
EMF	Environmental management Framework
EPA	Environmental Protection Authority
EPB TBM	Earth Pressure Balance Tunnel Boring Machine
EPR	Environmental Performance Requirements
GMP	Groundwater management Plan
GQRUZ	Ground water Quality Restricted Use Zone
IREA	Independent Reviewer and Environmental Auditor
MMRP	Melbourne Metropolitan Rail Project
NYMS	North Yarra Main Sewer
OEMP	Operations Environmental Management Plan
PASS	Potential Acid Sulphate Soil
PIW	Prescribed Industrial Waste
SWTS	South western Trunk Sewer
WDA	Western Distributor Authority
WTP	Westgate Tunnel Project

1 Change of Opinion

In the Interim Report on:

Groundwater

Ground Movement

Contamination and Waste Management

Dated 11 August 2017, at paragraph 3 it is stated "*this interim report has the objective of informing the IAC of such sensitive issues as may, in the technical opinion of the advisors, arise in respect to the elements named in the title above".* Further at Paragraph 9 the statement is made that "*the writer has not had access at the time of preparing this Interim Report to the primary data sets"*

The data sets were requested at the Directions Hearing but only came available after the completion of the Interim Report. The consequence of this has been that the Interim Report did not set out firm opinions on the adequacy of the Proponents Project documentation specifically, but sought only to comment generally on where, the writer's opinion, there could be issues which would need to be addressed as the CEMP and final designs were developed within the EPRs set out in the documentation as it stood to manage and mitigate any potentially adverse reactions of the construction and operation of the WTP. To this extent then there has been no change of opinion since no comprehensive opinion was ever expressed in the Interim Report.

2. Approval Documents

Since the completion of the Interim Report, the data requested at the Directions Hearing has

been received and reviewed; the evidence in chief of the WDA experts on Groundwater, Ground Movement and on Contamination and Waste Management has been heard and tested in cross examination. In addition, a number of Project Notes have been tabled.

The above documents specifically address the issues raised at the Hearing and raised regarding areas of sensitivity in the Interim Report. These now form a sound foundation upon which the writer can form an opinion as to the adequacy of the EES documentation as a basis for project environmental approval and ultimately as a basis for the development of final designs achievable through a CEMP and an OEMP consistent with the EPRs as set down in the documentation.

The writer's final opinion is that, while the geological formations as described and evaluated in the EES documentation as being those which underlie and or through which the project will be developed will vary in characteristics, in some cases not fully defined definitively as yet, the project can be expected to be constructible and operable much as presented in the EES Documents without creating unacceptable risks in environmental terms on groundwater, ground movement or in creating or aggravating existing contamination risks.

The above opinion is then supported by the writer's final report which is attached hereto.

Stephen Hancock – Technical Advisor

Approval Documents

(i) Question

What is your opinion on the latest version of the Proponent's proposed approval documents (if any) and any other party's suggested changes to the approval documents (if you have seen those changes by the time you write this report)?

Please include a list of your recommended changes to the proposed approval documents (if any) including any changes to the EPRs or changes to the design plans (in so far as such changes fall within the IAC's terms of reference)?

(ii) Response

The attached report sets out my opinions and they are summarised in the conclusions thereto

Westgate Tunnel Project

Independent Advisory Committee

Final Report on :

Groundwater
Ground Movement
Contamination, Waste and Spoil Management

Prepared by Stephen Hancock - Technical Advisor

4th September 2017

Introduction

1. This report has been prepared as the support document to Expert Advice provided by the writer. It has been informed by not only the EES Documentation made public before the hearings commenced but by the responses received to requests made at the Directions Hearing on July 14th 2017 and by various Technical Notes subsequently circulated and by the evidence in chief of the WDA experts and their extensions on this presented at the hearing. These additions to the documentation publically circulated have allowed the writer to confirm opinions relevant to the environ mental effects arising in relation to Groundwater, Ground Movement and Waste and Contaminated Soil Management. These are then presented herewith.

2. The West Gate Tunnel Project will involve the deep excavation and construction of a sequence of engineering features related to new and expanded road infrastructure both above and below ground surface between the western edge of the CBD and the Kororoit Creek Road intersection with the Westgate Freeway to the south west of Melbourne.

3. This interim report has been prepared at the request of the IAC in accordance with the Terms of Reference issued by the Minister dated 26/5/2017 and a brief issued on 29 June 2017 entitled "*West Gate Tunnel Project: Provision of Expert Advice to Inquiry and Advisory Committee*"

4. This document requires at Task 6 *"Provide an interim report to the IAC to be tabled at the commencement of the Hearing on 14 August 2017 which sets out within your area of expertise:*
   a) The matters required by the PPV practice note - Expert Evidence including all facts, matters and assumptions upon which you have proceeded
   b) The key issues, including whether the key issues you have identified prior to the circulation of have changed and if so how;
   *c) Your expert view raised by paragraph 13(e) (i0- (Iv) of the Terms of Reference * in so far as they relate to the key issues you have identified;*
   d) Any areas in which you consider that there is insufficient information having regard to the current and future stages of the project (eg detailed design);
   e) Recommended changes to the approval documentation (if any)"

   *(the TOR requirements under 13(e) (i)-(Iv) requires "*consideration and where relevant investigation of:*
      i. the magnitude and significance of adverse and beneficial environmental effects,

ii. *the adequacy of the proposed environmental management framework including the environmental requirements and environmental management measures contained within the EES, with reference to applicable legislation and policy;*
iii. *The adequacy of WAA No S0100269 ;*
iv. *The adequacy of the impact assessment and whether the proposed environmental performance requirements are capable of being met"*

5. Thus this final report has the objective of informing the IAC of such sensitive issues which may, in the opinion of this Technical Advisor arise in respect to the elements named in the title above.

Material Considered

6. EES documentation has been released by the Western Distributor Authority which covers the full scope of possible environmental effects required by the Minister for Planning to be considered. The full scoping requirements are set out in the document entitled *Scoping Requirements for Western Distributor Project - April 2016 by DEDJTR.* Amongst many others in Table 1 of that document, it requires that "Evaluation Objectives" should include - "Land Stability, Hydrology and Water quality and Waste Management" issues arising from both the construction and operation of this project.

7. In respect to the elements of relevance to this report, the following EES and other documents have been read in detail and their findings considered as to completeness and reliability in respect to this p technical report:
   a) West Gate Tunnel Project - Environmental Effects Statement -Main Report - Volume 1 including the Executive Summary; Section 4 -Assessment Framework; Section 5 - Project Description
   b) Volume 3 including Section 19 Effects on Physical Environment.
   c) Technical Reports B Contaminated Soil and Spoil Management
   d) Technical Report. C Groundwater
   e) Technical Report. D-E Ground movement and Surface Water
   f) EES Map Book and the Development and Urban Plans and
   g) The "*EPA Submission on the West Gate Tunnel Project Environmental Effects Statement " dated10 July 2017"*
   h) Western Distributor Project Geotechnical, Soil Contamination and Hydrologeological Investigation Factual Report, by Golder Associates Pty Ltd
      - Western Distributor- Tunnel - Report Volume 2 Chapter 1, RN 1521107-2001-R-Rev1,
      - Western Distributor – RFT – Additional Investigations – Report, RN 1521107-181-R-Rev2,
      - Western Distributor - Tunnel – report, RN 1521107-182-R- Rev1,
      - Conceptual Geological Long Section- West Gate Tunnel, dated 2015/05/05, marked preliminary
   i) Evidence in Chief and presentations of ;
      - Trevor O'Shannessy of Golder Associates Pty Ltd - Ground Movement , tab 4 in "Experts Report on behalf of WDA Vol 1 of 1, and document no 43
      - Andrew Kalitsis of Golder Associates Pty Ltd – Contaminated Soil and Spoil Management, tab 5 in "Experts Report on behalf of WDA Vol 1 of 1and document 44;
      - Jonathan Medd of Golder Associates Pty Ltd- Groundwater, tab 5 in "Experts Report on behalf of WDA Vol 1 of 1and document 45;
      - John Heilig of Heilig and Partners Pty Ltd on Vibration and regenerated noise(tunnel)

   j) Project note numbers 14, 27, 31, 33,34 and 51 supplied in response to information requests issued at the Directions Hearing 26 July 2017

k) "Engineering Geology of Melbourne", Ed. Peck w.a. Neilson J.L.,Olds R.J. and Seddon K.D. published by AA Balkema press 1992
l) EPA documents, including State Environment Protection policies and Guidelines relating to Major Construction Sites; Land (pub.no.854), Potentially Contaminated Land, Acid Sulphate Soil and Rock (pub.no 655.1, Soil hazard categorisation and management,
m) References on Acid Sulphate Soils - Laboratory Methods Guidelines- Version 2.1- June 2004, published by Dept. Natural resources. Mines and Energy Indooroopilly Queensland – authors - Ahern CR and Sullivan LA.

8. All these documents have been used to identify and evaluate the key issues arising from the West Gate Tunnel Project in relation to groundwater, ground movement and contaminant waste and spoil management.

9. The comments that derive from these analyses has also included consideration of past deep excavation programs in which the writer had direct firsthand experience. These have included the Brooklyn Trunk Sewer tunnel; the Brooklyn Pumping Station inflow management and dewatering; the South West Trunk Sewer (SWTS) tunnel from Brooklyn Pumping Station to the Hopper Crossing Pumping Station; the City Link tunnels and the Arts Centre (Hamer Hall) Construction and the planning for the Metro Rail Project.

10. All of the above involved excavations in some or all of the materials which will be intersected by the various engineering excavations involved in the West Gate Tunnel Project.

11. In addition the writer has researched the Melbourne Main Sewer replacement project as it was the first use of an earth pressure balance tunneling boring machine in Victoria and this technique is proposed for use in the WTP tunnel excavations.

12. Finally, the land surrounding the project for industrial uses and for concomitant waste disposal over at least the past 100 years is recognised.

13. Thus, comments presented herewith on the risk profiles and management approaches put forward in the EES documents and in the statements of evidence by the experts from the WDA are informed by the writers long experience of groundwater management and of industrial waste clean up and contaminant management and on the fate and movement of contamination in the natural environment.

Risk identification, assessment and mitigation

14. The development of the West Gate Tunnel Project as presented within the project documentation and the evidence submitted has been pursued through an iterative and inclusive process of route and risk identification, physical parameter assessment and evaluation. This process was guided by an initial Environmental Management Framework (EMF) which led on the identification of Environmental Performance Requirements (EPR) and thence to identifying mitigation measures of relevance to mitigating unacceptable risk levels to be addressed in the Construction Environmental Management Plan (CEMP. This plan will then be implemented through final design and construction procedures. This latter process is stated in the project documentation as being ongoing.

15. These procedures are seen by the writer as having been thoroughly pursued and are consistent with the policies and legal responsibilities applying to any such development proposal as the West Gate Tunnel Project.

16. Specifically, the risk identification processes pursued are seen to have been thorough in the investigations undertaken, as have been the assessment and modelling exercises. Similarly, the mitigation approaches outlined to date are appropriate and the intention to use active and ongoing monitoring including repeated model verification to ensure the ability to foresee the outcome of monitoring trends is applauded.

17. It is to be expected that present risk levels are likely to have been conservatively estimated and that more serious risks are only likely to emerge from instances where statistically evaluated risk parameter ranges are materially exceeded or where unforeseen constraints render mitigation initiative effects being less than expected.

18. The writer is conscious of the impacts which can occur due to departures from statistically evaluated risk scenarios and hence has focused on these in considering the project documentation. It should be added however that, despite the potential for unforeseen conditions to arise, he is confident that mitigation measures are available which can, at a cost and with time, ensure that such occurrences can be mitigated to meet the project EPRs.

Groundwater

19. It is inevitable that excavations for the West Gate Tunnel project, be they
    - the15.6m diameter road tunnels;
    - the 3.0m diameter cross drives between the road tunnels;
    - the dive and portal structures associated with entry and exit engineering;
    - the necessary realignment of the North Yarra Main Sewer,
    - the drilling of bored piles for the bridges and overhead structures,
    - the construction of earth embankment will impact upon the shallow groundwater regimes.
20. This is because the water table (upper level of saturation within the underlying geological sequence) is frequently at quite shallow depths below the surface. Indeed, it is at the surface near features such as the Stony Creek Backwash Swamp; at Moonee Ponds Creek and along Kororoit Creek to the west.

21. The EES documents present a rigorous evaluation of the hydrogeology of the project area and of sufficient contiguous land surrounding the project. The investigation program has been comprehensive in defining the geology, the hydrological conditions and parameters of the geological units potentially impacted by the construction and or operation of the project. It has been equally diligent in identifying the potential sources and range of contamination risks which could be encountered.

22. Risk assessment (RA) evaluations allowed the definition of the EPRs (EES Main Report Volume 1, Page 8-21 Table 8-6) necessary to meet EPA policy and guidelines and the identification of environmental management techniques which could be used to mitigate the magnitude of any impacts to achieve acceptable outcomes within the overall Environmental Management Framework (EMF) for the project.

23. The above evaluation processes are stated in the project EES documentation to be ongoing as detailed designs are generated and as Construction Environmental Management Plans are developed for each stage of the project. It is expected that the mitigation measures outlined will be implemented within the CEMP based on needs identified by further investigations where necessary and using trigger monitoring results as the bases for initiating or intensifying the application of the various mitigating measures.

Hydrogeology

24. The extensive investigations throughout the project area have revealed that the Maribyrnong River is a stream which has been displaced to the eastern edge of its original valley by the outpouring of Newer Volcanic lava flows from the north. It is evident from the Conceptual Long Geological Section that the original valley was centred on a stream course about 2 - 2.3km to the west of its present position at an elevation of about - 35mahd.

25. The geological sequence which was exposed by erosion within the original (palaeo)valley included the poorly sorted silty sands and gravels of the Brighton Group (Tpb) which underlie the Newer Volcanics (Tnv) This erosion also exposed the silty clay marls of the upper sequence of the Fyansford Formation (Tmn1) which is underlain by the upper deeply weathered Older Volcanics (Tvo1) on the eastern side with the fresh deeper Older Volcanics (Tvo2) to the west below the Fyansford Fm. Some Werribee Fm (Tew) remnants are recorded in the Geological Section (Figure 14 of Technical Report D-E) but this is stated to be stiff to very stiff clays and lignite.

26. The consequence of this sequence is that the road tunnels will penetrate initially the deeply weathered upper Older Volcanic (Tvo1) sequence south west of the Northern Portal and then as it traverses south west it will traverse into the Fyansford Fm (Tmn) in the floor and the Brighton Group (Tpb) in the roof before traversing into some Sub Basaltic alluvium within the palaeovalley of the Maribyrnong River and thence through the extremely altered(palagonite)lower sequence of the Newer Volcanics (Tvn2) with both tunnels then passing through the slightly weathered to fresh basalt of the upper Newer Volcanic (Tvn1) sequence to arrive at the southern portals.

27. The lithology of the various sequences is especially well described in Section 7.1.1 of Technical Report D on Ground Movement (pages 47 – 53 as well as in Technical Report C in Table 8 (pages 39 and 40) and in Section 7.2.4 where the hydrogeological settings is presented along with the hydrological evaluations derived from the extensive testing undertaken. The degree to which the evaluations can be relied upon is however dependent on the reliability of the data derived and this includes factors including:
    - Core loss during drilling
    - The measured impacts of pumping tests
    - The data available from Slug displacement testing and Lugeon (Packer) testing.

28. For the most part, the writer's evaluation of these factors from study of the core logs and photography indicate that data inadequacies are rare. However, certain sensitive areas exist which will require close attention, planning and further investigation. Indeed, in Project Note 33 and in the evidence presented by Medd on Groundwater it was clearly stated that further investigation to establish a Groundwater Management plan for implementation within the CEMP is proposed. It is the writer's opinion that the following sensitive areas should be considered closely in these plans.

:

- In general when the EPB TBM is excavating through face comprised of mixed lithologies. such as to the east of Williamstown Road extending beneath the Stony Creek valley.9 See BH 148 – 151 and 159and 160 for concerning core loss issues and possibly hard large boulders in the face.
- Where the tunnel invert during construction is within 5 – 10 m of any sedimentary formation immediately underlain by the Werribee Formation, especially where the tunnels traverse out of the Older Volcanics in the invert to strike the base of the Newer Volcanics in the obvert beneath the deepest section of the Stony Creek alluvium and Coode Island Silt.
- In that section of tunneling where the eastbound tunnel is rising towards the southern portal beneath the Stony Creek valley and alluvium, see BH 112 and 129

Risk profiles and Risk Mitigation

29. The risks to groundwater within the project area as set out in the EES documentation relate to groundwater extractions that may be involved in the project engineering. In particular, it is the risk that the impacts could have on groundwater availability and it's quality to meet such beneficial uses as apply. In addition, there are potentially risks relating to the mobilisation of existing contaminated groundwater and/ or the generation of new sources of contamination such as through the oxidation of potentially acid sulphate soils.

30. The above risks are all are rated in the risk matrices presented. Those assessments are, as they stand, are agreed by the writer. The means of mitigating those risks are also seen to be comprehensive and well considered.

31. The probability of actual occurrence of material risks is considered by the writer to be unlikely since it is stated in Project Note 33 that the EPB TBM is proposed to be operated in closed mode using either paste of air throughout most of the tunneling. Further, any risks will be mitigated based on the monitoring of ground water inflows to water level stabilizing bores. This monitoring will be included amongst other issues in the Groundwater Management Plan (GMP) being presently prepared as part of the CEMP.

32. Thus it is accepted by the writer that the mitigation of risks to the groundwater environment will take place and that time has been allowed to implement these measures within the tunneling schedule. Notably, in Project Note 33 and in the presentation accompanying Medd's evidence it is clear that the EPB TBM operation has the capability at all times to effectively seal off any unprotected ground opening by slurry injection and or by the use of ground strengthening grout injection. The writer accepts that these contingencies largely allay any residual concerns over impact on groundwater likely to arise from the tunnel engineering, albeit some issues will remain as to the management of entrained contaminated groundwater within the tunnel spoil as this was evidenced in the presence of PFAS in the discharge water pumped from the Newer Volcanics well (TUBH 900) to the west of Williamstown road.

33. These latter aspects are considered below.

PORT, CITY LINK AND CITY CONNECTION

34. The engineering involved in the project development to the east of the Northern Portals of the road tunnels will in relation to groundwater environmental issues involve minor shortterm risks.

35. Pile construction for the bridges across the Maribyrnong River and Moonee Ponds Creek and for the elevated road and Veloway structures are only likely to involve the removal of minor volumes of saturated Yarra Delta sediments as poured in-situ piles are established to depth within steel subsurface formwork. The engineering processes involved are well established and the need for the use of construction materials resistant to saline water and other electrolytically inducible corrosion processes should be well understood and covered by the CEMP.

ROAD TUNNELS, PORTALS AND THE HYDE STREET OFF RAMPS
GEOLOGICAL ENVIRONMENTS

36. The geology of this segment of the project includes, close to the Maribyrnong River and the Stony Creek Backwash Swamp, some fill and Yarra Delta sediments. The latter is evident in the bore logs inspected and includes:
    a) Fill and made ground including a wide range of material mostly above or close to the water table;
    b) Alluvium - silty and clayey especially along Stony Creek deriving from Newer Volcanics erosion, close to the water table;
    c) Coode Island Silt (Qhi) - clayey silt with sands towards the edges and at depth with shell and carbonaceous bands (BH 112 and 129), below water table except near the North Portal andnear the NYMS and variously
    d) Weathered Older Volcanics near eastern end of the tunnel.

37. Near the Spotswood Golf Course and the Donald McLean Reserve, the landscape is underlain at shallow depth by Newer Volcanics with some minor shallow alluvium as described above near Stony Creek, However, a deeper channel extends to depths over 10m bgl in BH 129 directly beneath the creek. The tunnel will traverse at relatively shallow depths below this feature in extremely broken (Core Loss 46.4% between 10.5 and 18m) Newer Volcanics. Any use of compressed air as the balancing medium across the east bound tunnel stretch near Stony Creek would seem inadvisable

38. Risks to groundwater from construction and operation in the project area could include:

a) Depressurization of sand lenses within the Coode Island Silt such as to exacerbate consolidation and surface settlement in hydraulically contiguous areas
b) Dewatering of Coode Island Silt (CIS) such as to give rise to acid generation within the formation and acidic drainage from excavations into or interconnected to the CIS,
c) Mobilization of contamination from adjacent landfills and from contaminated sites especially close to the Northern Portal and the Southern Portals.
d) Impacts on groundwater dependent ecosystems in Stony Creek and in the associated Backwash Swamp
e) Impacts on water flows and on the water table beneath public open space areas such as the Yarraville Reserve and those abutting Stony Creek.

RISK MITIGATION

39. A range of risk mitigation techniques are proposed and have been confirmed as to being included for potential application within the CEMP and GMP to be applied and these include:

- Around the Northern Portal and North Yarra Main Sewer realignment works
  a) The construction of secant walls to depths sufficient to largely prevent groundwater inflows.
  b) Jet mix grouting of soft sediment to reduce permeability and to increase material resistance to groundwater up-flow across the base of excavations.
  c) The application of pipe jacking technologies in soft sediments as part of the NYMS realignment works to minimise inflow opportunity
  d) Pressure grouting of rock formations to increase strength as necessary.
  e) The injection of water into any significant aquifers to offset water table depression and hence the development of hydraulic gradients which might cause significant contamination movement.

- In the Road Tunnels and Cross Tunnelling

a) The use of EPB TBM technology in closed mode.
b) The use of pipe jacking and or micro-boring of pre-grouted material in cross tunnel construction.
c) The expeditious reinforced cement lining of the bored tunnel perimeter immediately behind the EPB TBM.
d) The expeditious grouting of any annular space between the bored tunnel profile and the circular lining segments.

RESIDUAL RISKS

40. The above techniques will be applied as part of the GMP of the CEMP in advance of construction or as dictated by close construction monitoring as set out in Technical note 33.

41. Around the Portal areas and the NYMS realignment implementation the efficacy of mitigation works will be able to be tested before extensive construction works begins. It is accepted by the writer that the residual risk profiles around the portal areas will be mitigated to levels acceptable within the EPR. These are dictated by the regulatory regimes applying within the Cut Paw Paw Groundwater Management Precinct.

42. It is noted that near the Portal area leakage of groundwater from shallow aquifers into the NYMS as it exists at present has caused the water table to decline to depths below sea level (> -7mahd) along Whitehall Street (Figure17, P59, Volume C). When this sewer is abandoned and backfilled as the realigned sewer takes the load it is to be expected that water tables in this area will then largely normalize. As this occurs, some acid waters known to be present will be flushed towards the surface which could have adverse effects upon vegetation, especially trees in Hanmer Reserve. This danger is considered by the writer to be slight as the water table gradients and flow lines will be towards abandoned NYMS and the lithology of the Coode Island Silt as I t saturates again will be neutralizing of any significant acidity.

43. Some contaminated water from former landfills and gasworks close to Whitehall Street may also have been drawn towards the sewer by the long term leakage of the abandoned NYMS, but this too will be subject to at least dilution if not also by attenuation as it passes through reactive and carbonaceous sediments. The outcome under any circumstances should be detectable by groundwater quality monitoring in the area which it is proposed will extend beyond the period of construction activities under the GMP.

44. The major road tunnelling will traverse a wide variety of geological materials in which the need for effective proposed mitigation works mayl not be able to be tested in advance. Rather, implementation will be reactive to the further knowledge of the materials gathered through additional investigations and /or monitoring data trends and validated model predictions generated coincidental with tunneling progress and experience as set out in Technical notes 27,28 and 33.

45. The risk mitigation in tunnel progressing is dependent upon the EPB TBM being operated as proposed in closed mode to counteract the hydrostatic pressure differential which apply across the cutting face and the unsealed segment of the tunnel perimeter as it proceeds. The writer is now confident that within a carefully implemented and informed CEMP even to more extreme characteristics of the formations surrounding and in front of the cut face can be controlled though mitigation works including grout injection for ground strengthening. Similarly, grouting of the annular spaces around the tunnel and for strengthening cross tunnel material stabilization should be achievable. Further, where grouting from in- tunnel must be limited due to weakness of overlying materials to the necessary pressures which would need to be applied, this will be known in advance from the packer testing done to date. Alternative mitigation could then involve localized grouting from the surface. The writer is now confident that the use of the EPB TBM under the management of a comprehensive and diligently applied GMP and CEMP will effectively achieve the tunnel construction outcome sought

46. Large tunnel boring machines have been in use for several decades elsewhere in the world and the technologies have been progressively improving. The use of a EPB TBM with the capability to penetrate and progressively seal off a 15.6 m diameter tunnel while cutting mixed material face remains however a new technology within Victoria at least. Similarly, the construction of the cross tunnels between the two road tunnels and the NYMS realignment involve technologies which, though not of a magnitude that is unusual, remain challenging in some of the geological environments. That said, the same mitigation techniques are available and are seen to be appropriate. The writer believes that the issues which may arise have been recognized by the WDA in the extent of the investigations and evaluations which have been undertaken and in allowing for a period of experience in the initial time table for the works. Similarly, the responses in the Technical Notes (14,27,28,33 and 51) make it clear that the many issues raised by the IAC at the Directions Hearing have been considered and are to be addressed in the CEMP

47. The above gives the writer confidence that, in so far as is possible, the tunneling and excavation projects will proceed without undue delays. That said, with even the best GWP and CEMP management and oversight, it is in the nature of complex sub-surface projects that unforeseen occurrences are manifest. The writer remains confident however that the project impacts on the groundwater environment will be acceptable within the EPRs applying to the project.

48. Risks associated with contaminated groundwater inflows, the initiation of acid groundwater generation by dewatering, excessive groundwater extraction and groundwater beneficial use degradation are agreed as being low to non-existent. This is because the speed of tunnel penetration and tunnel line sealing as presented, when taken with ground pressure balancing, should render inflows small and locally short lived, especially as the bulk of the hydraulic testing indicates the formations to have limited hydraulic conductivity . This is indicated by the geometric mean statistics presented in Tables 10 and 11 (p56) of Technical report C.

49. Groundwater beneficial use degradation risks are, in the opinion of the writer, correctly assessed as being minor. To start with the beneficial uses of the natural groundwater are limited by the salinity naturally being in the Category C -D Range (Total Dissolved Solids 3,000 - 14,000mg/L) leaving the

only significant use as support to groundwater dependant ecosystems which are acclimated to these brackish to saline waters.

50. Some occurrence of low salinity groundwaters are recorded beneath public open space where garden watering has probably been practiced but no evidence of any use of groundwater extraction bores exist within or close to the project area albeit that many investigation and contamination monitoring bores may exist, all of which may not be accurately plotted as to location within the various government groundwater data bases.

51. Anthropogenic use of any of the naturally occurring groundwater within the shallower sequences which extend down to the buried surface of the Maribyrnong River palaeovalley are also limited by the threat of extensive groundwater contamination and by the declared Groundwater Quality Restricted Use Zones as are shown on figures 20 and 21 (p66 and 79 of Technical report Volume C).

52. Groundwater has been and is still used by industry and at some public recreation sites from the Werribee Fm. (Tew) . This deep sand aquifer underlies the Fyansford Fm.(Tmn) and the OlderVolcanics(Tov) is recognised within the Cut Paw Paw Groundwater Management Area as the only aquifer with significant extraction potential. It appears to be hydraulically isolated from the shallower contaminant prone aquifers. It is the aquifer for which an aquifer volumetric limit (CAP) has been set for extractions. Since no water is expected to be extracted from this aquifer and it seems most unlikely that the EPB TBM, carefully managed, could interfere with this aquifer. Thus, it is not considered by the writer to be at risk from the WTP as proposed.

Ground movement

53. Ground movement consequential on major engineering and excavation works such as those associated with the WTP derive simplistically from the stresses created by
    a) surface loadings on pre-existing sediments, including fill - compression
    b) The removal of water from intergranular spaces (porosity) in which location they can provide buoyancy or support for sedimentary structures. - consolidation
    c) Plastic creep of strata horizontally and vertically towards excavated void spaces in the ground, until gravitational and hydrostatic balance is re-established - void closure
    d) Mobilization of pre-existing failure plains such as faults or planes of instability in steep slopes - slope instability.

54. In each case the impact is mostly settlement of surface levels to greater or lesser extent which is dependent upon proximity to the area of applied geotechnical stress, the geotechnical intensity and area over which the stresses are applied and the geotechnical parameters of the underlying materials and strata. In some cases, loadings on weak compressible material can result in perimeter surface uplift due to volume displacement.

55. The WTP is being constructed over a wide variety of geological strata which are well known within the context of civil engineering works around Melbourne *(Peck et al 1992, Engineering Geology of Melbourne, Balkema, Rotterdam*). In addition, past land uses have created anthropogenic features such as quarries, pits and embankments which have been variously filled as landfills compacted only to the extent of self- weight compaction or consolidation, or to engineering standards demanded for use as industrial land or public open space (Figures 9-1,39-41, Technical Report D-E)

56. The risks involved in the construction and operation of the engineering features of the WTP relate to the geotechnical properties of the natural formations subject to stresses relating to road, bridge, tunnel and embankment construction; and the degree to which these stresses translate or directly impact upon anthropogenic structures and buildings (domestic, public and heritage) and infrastructure (drains, sewers, pipelines, power conduits) built on and or within them.

57. All the above aspects are addressed comprehensively in the EES documentation albeit that it does not address every single building within the project precinct. What it does do is to identify the risks and where and how risks can be addressed and mitigated by engineering and management procedures. The geotechnical documentation is very voluminous and comprehensive and is well summarized in Appendix B as Preliminary Engineering Parameters (Table ,Volume D-E). Notably, the statistical averages are consistent with the data value ranges (> 1 order of magnitude in all cases).Thus, the thorough and targeted testing program undertaken provides confidence to the conclusions drawn in Section 11 (p99-101 0f Technical Report D-E).

Risk Profiles and Risk Mitigation

58. Risk profiles in the EES documentation are presented in relation to three segments of the project namely:
    a) Port, Citylink and City Connections- Section 8
    b) Tunnels - Section 7
    c) Westgate Freeway - Section 6

59. Each of these segments was assessed in relation to the potential for ground movement consequential on the necessary engineering and earth moving requirements of the WTP. The risks were determined rigorously by analyses based upon geotechnical evaluations undertaken on a large number of investigation boreholes, laboratory evaluations and testing of the geological materials found, as we las on the occurrence of existing structures (landfills, filled ground, sewers, pipe and other subsurface infrastructure) beneath or adjacent to the project areas which might give rise subsidence of geotechnical issues in the engineering.

60. Table 10 (p35, Technical Report D-E) presents summaries of the major geological units identified by the investigations and includes qualitative descriptions of their geotechnical character and these descriptions alone suggest that there are only a few areas where there is potential for ground movement likely to give rise to significant damage or degradation of buildings or infrastructure. Further, where potential for ground movement exists which might impact structures, mitigation measures are set out as means of meeting the EPRs set out in each of the above project segments (Port, Citylink and City Connections - Table 14, Tunnels - p 95; West Gate Freeway - Table 13, p85 and Table 11,p45) These will be applied by Project co to direct the use of mitigation measures such as those set out in Table 3 - Summary of ground movement engineering control measures with the design (p15)

61. Specific area models have been developed using the geotechnical parameters determined by the testing programs. These conservatively evaluate the extent and magnitude of vertical displacement movements along the tunnel alignment. The evaluations take into account variations in strata thicknesses and void loss ratios of 0.5 and 1% to determine initial indications of cumulative ground movement This work was then extended to evaluate whether the movements represent the development of slopes or elastic strain sufficient to cause structural damage to buildings, infrastructure or to rigid pipelines (Appendix B of Technical Report D including sub Appendixes C-F).

PORT, CITYLINK AND CITY CONNECTION

62. This segment of the WTP extends from the Northern Portal area across the Maribyrnong River and across the Yarra delta area to the south west edge of Melbourne City. It is underlain by alluvial and estuarine sediments such as the compressible Coode Island Silt (Qhi). The area has also been subject to significant filling of swamp areas and former stream channels and meanders using a variety of materials including construction and industrial waste as well as dredge spoils. Water tables are mostly very shallow.

63. The weak and compressible materials are subject to ground movement under further loading and hence nearly all of the structures in this area will need to be supported by bored piles sunk to depth. It is possible that some embankments will be required in places and here ground strengthening in advance or the use of light weight material to lessen the applied loads is likely to be proposed at

specific sites in accordance with the environmental performance requirements and the CEMP when finalized.

64. Further specific site evaluations may be undertaken in this area to define optimum final designs for the various structures across this segment and especially for the Maribyrnong River bridge and the ramps which will service McKenzie Road and the port access and in relation to the new bridge proposed to cross Moonee Ponds Creek and the ramps associated with that structure.

65. The writer is conscious of the fact that extensive experience now exists in the construction of infrastructure across the Yarra delta area and that the issues have been addressed sufficiently to give confidence that with additional investigations specific to the critical above ground structures that the conclusions drawn in the EES documentation are supported.

66. The most sensitive area of construction will be around the North Portal where the construction of this facility plus the excavation works associated with the NYMS realignment, and the initiation of tunneling. Loadings arising from waste rock and tunnel spoil and waste water management will create local loadings. These are not expected to interact with any adjacent operations as the wastes from the tunnelling and other works to the west of the Maribyrnong will be carried by conveyor to the waste receival area to the south south east at 221 Whitehall Street.

67. Most significantly, the complex interactions of the various engineering elements have been investigated and evaluated at least sufficiently for ground movements around the WTP engineering elements to be modelled as to magnitude. These give the writer confidence that as final designs and the CEMP are completed to meet the EPR, that where necessary mitigation measures, such as those outlined in the EES Documentation on Ground Movement and on Groundwater (see above) will achieve minimal ground movement minim and that the results will not create unacceptable impairment of structures and infrastructure within the project boundary.

TUNNELS AND PORTALS

68. The tunnels and the North Portal and South Portal areas have already benefitted from the data gathering and modelling pursued. The magnitude of the ground movements that eventuate will be an outcome of the extent to which the mitigation technologies outlined in the EES documentation are effective when deployed and the degree to which the use of the use of the EPB TBM is effective in minimizing groundwater inflow and over excavation.

69. The writer is now confident that planning is in place to minimize delays in tunneling progress such as might derive from the need to achieve full permeation grouting. Rather, the intention is to use grouting along the tunnel alignment only to achieve ground strengthening at locations where the necessary. Elsewhere, jet grouting is proposed around surface excavations to reduce the potential for upflow within structures protected by secant piling. These approaches are much more achievable and can be readily reinforced as a bac up if necessary.

70. The documentation does not give guidance as to the nature of the grouts which may be used or indeed of the constituents of the paste which may be used in closed face operations of the TBM. It is to be expected that these issues will be addressed in the CEMP by experts in these specific fields. The documentation and the evidence of the various experts commenting upon the environmental issues associated with the tunnel construction and operations presume that the operation of the TBM will minimise most all of the issues which can afflict more conventional tunnelling approaches. The writer is confident that this presumption is rationally valid and consistent with the full and better advices received in the Technical Notes cited herein before.

71. It is noted by the writer that the extremely varied materials are too be penetrated by the TBM, including mixed formations, boulders material, etc. It is also noted that in some cases drill and blast driving of cross drives may be necessary. These types of variation in construction practice will entail delays on occasions as may the need for clearing large boulders from the face on occasions. The

writer is however not of the opinion that delays from these causes is likely to aggravate conditions leading to ground movement so longas mitigation measures are taken to ensure that significant groundwater inflows or sediment slurry inflows are not permitted to occur. Certainly, the EPB TBM and other mitigation measure have been identified to ensure that such occurences can be minimized. As a consequence, the writer is satisfied that the CEMP and final designs will be effective in minimizing ground movements to levels acceptable within the EPRs during tunnel construction.

72. The construction of the two southern portals have the potential to give rise to serious issues of ground movement in respect to impacts on the linear infrastructure of the West Gate Freeway fill, jet fuel pipelines, HV Power lines, upon Williamstown Road and its associated drainage infrastructure and on the Freight Rail line and on adjacent properties. In the writer's opinion, these facilities are unlikely to be seriously affected as it is inherent in preliminary modelling that a conservative approach is taken and this is confirmed by the model parameters applied and which indicate very limited ground movement

73. It is noted that all the Portals are large structures and that they will be open to potential inflows of groundwater for up to a year before being entirely sealed. Mitigation measures such as grouting will minimize the inflow but at the southern eastbound Portal, but, based on past experiences, it is possible that even small groundwater inflow from sand bands in the Coode Island Silts (Qhp) could give rise to wider area consolidation of the formation due to pressure declines. These might destabilize and contribute to the fill in base of the Westgate Freeway which is immediately adjacent to the site. This possibility seems unlikely as the lithology of the Stony Creek alluvium does not seem to include the Coode Island Silt near the Eastbound Portal excavation. The writer believes such an issue, should it become apparent in the site monitoring, could be easily off set by locally recharging the sand beds to offset any drainage depressurization.

74. The writer is of the opinion that all of the above have been prudently addressed and will be subject to close monitoring and to updated and verified model predictions as the excavations proceed. As a consequence. The bases for initiating mitigation measures (Bracing struts, grouted ground anchors, rock bolting, cement coatings, etc.) as may be necessary to offset any unacceptable ground movement potential will be available within the CEMP

75. The writer is satisfied that the approach outlined in the EES documents and in the evidence is sound at this location and also notes that the evidence presented by the Golder expert notes in response to Submission 255 and referring to the Newer Volcanics upper sequence (Tvn1) that "the rock mass is likely to be stiffer than the model assumes" (O'Shannessy Evidence tab 4in Expert Report on Behalf of WDA, p 5 dot point 1)

WESTGATE FREEWAY

76. There are few ground movement issues associated with the Westgate Freeway, as most of the length to approximately Chainage 52000 (Figure B1 in Appendix A of Appendix A -Technical Report D) is underlain by the Newer Volcanics upper sequence(Tvn1) which is a strong formation, or by fill compacted to engineering standards.

77. Beyond 52000m, the Westgate Freeway is bordered initially on both sides by alluvium which is a lateral equivalent of the Coode Island Silt (Qhp) or by the the Coode Island Silt to the north and east along the north side of the Freeway through the Donald McLean Reserve on the southside and the Spotswood Golf Course and the Hyde Street Reserve on the northside.

78. The above area is where the Hyde Street off and on ramps will be constructed parallel to the Freeway. The final design of these ramps is yet to be determined but it seems likely that they will involve some above ground embankment development and a considerable amount of piled foundations.

79. The presence of reactive soils across the Newer Volcanics (Tvn) which are subject to severe expansion and contraction during wet and dry periods is an issue in the public mind (Submissions

Numbers 182, 273, 283, 342, 344, 391,442 and 478). The community is concerned that the WTP elements will impact upon water table levels and this in turn upon soil moisture variations and or changes in soil water demand by deeper rooted vegetation.

80. In the writer's opinion, presently indicated impacts of the project both during construction and when in operational mode, plus the depths to water table and the actual vegetative water demands upon water table make these concerns unsustainable. This opinion aside, it would be prudent for the WDA to identify sensitive areas and to ensure that monitoring of water table and of soil moisture variations is carried out to establish a reliable data base sufficient to direct remedial action should there be any deleterious variations associated with the project implementation.

81. The writer considers it advisable that dilapidation surveys be conducted on properties not only close to the project boundaries, but also in sensitive areas further removed, if water table interactions interactions could give rise to losses in soil moisture and soil cracking accompanied by property damage. Such an area could be adjacent to the tunnel alignment where it swings north east north of the Westgate Freeway and the Stony Creek floodway where low lying properties occur adjacent to the golf course boundary.

82. Having studied the EES documents and the supporting reports in detail the writer is of the opinion that WTP constructions is unlikely to be a source of significant ground movement because informed designs developed within the CEMP will reflect high standards of construction integrity through adherence to the EPRs and consequent upon the close oversight of that plan by the regulatory authorities and by the Independent Review and Environmental Auditor.

Residual Risks

83. The only risks which initially appeared not to have been sufficiently considered related to ground movement due to any inadequacy of the EPB TBM to perform in preventing groundwater/sediment slurry inflows, and issues of ground movement arising due to failures in tunnel sealing consequent upon.ineffective grouting.

84. The writer notes that, the EPB TBM will mostly operate in closed mode thereby minimizing the potential for inflows and that the pre-fabricated cement lining segments include comprehensive joint sealing materials and forms which are inherently compressed by the tunnel boring machine operation. Further, the annular grouting is not intended to be a seal, but rather is a ground strength supplementing action. The above facts support to EES documentation position that the potential for ground movement (subsidence) due to void loss above and around the of the tunnel will be much as is predicted by the modelling done to date.

85. The writer initially raised concerns in his Interim Report (11th July 2017) as to whether there was potential for vibrations generated by the EPB TBM to exacerbate consolidation rates in poorly consolidated materials such as might occur within the stream channel of Stony Creek. Such an occurrence could give rise to subsidence of overlying structures such as the Westgate Freeway and the Hyde street off and on ramps.

86. The above issue is no longer considered by the writer to be a concern. He is now satisfied, after reading the evidence of Dr. John Heilig (Tab 12 in Expert Reports on behalf of WDA) AND Technical Note 28, that such densification is unlikely. This is both because the material present appears not to be lithologically prone to such effects and because the TBM will be operating in closed mode using paste across the most sensitive area and the vibration levels are not likely to propagate to sensitive areas at sufficiently high intensities to give rise to densification. It is further noted that Dr Heilig states "*the EPRs for the West Gate Tunnel project restrict continuous vibration values to less than 20% of the BS 7385 report minimum vibration values*". Which he indicates is less than 20% of the vibration levels that might give rise to the densification of "susceptible soils ".

87. The writer has no doubt that the WTP t will experience perturbing events during construction, but equally has no doubt that they can be resolved by the implementation of mitigating engineering

solutions retroactively. The work done to date and involved in the development of detailed designs within the CEMP is aimed at avoiding the occurrence of unforeseen events by being prepared in advance. This approach should ensure that, if they do occur, their impact will be minimal and able to be expeditiously addressed without the potential for them to aggravate ground movements issues.

Waste and Spoil Management

88. Protection of the environment in relation to waste and spoil management subdivide into several issues which are inter-related. These are:
    a) Solid wastes
    b) Liquid wastes and for each of these
    c) Logistics and
    d) Management options

89. Solid wastes include all those material excavated from the four dive and portal constructions; from the NYMS realignment work, the drilling of piled foundations; and generated by the EPB TBM as it progressively creates the two major tunnels, as well as from the cross tunnels constructed every 120m or so.

90. In total, the solid waste involved in the WTP development is stated to be about 2.11Mcum in-situ. Included in this volume is 85Kcum of possibly acid sulphate soils (PASS) 3Kcum of Class A Prescribed Industrial waste (PIW); 14Kcum Class B PIW and 156Kcum Class C PIW (Table 4, Sect. 6.0 of Appendix D in Technical Report B Part 2)

91. Liquid waste includes all the water drained from those excavations extending below water table and or draining from the solid industrial waste. Much of the water will be brackish groundwaters but some will be groundwaters contaminated from former industrial activities within the area. Water will also enter the Whitehall Street waste accumulation areas from incident rainfall and this too could be contaminated, should it come into contact with the solid waste.

92. The logistics proposed for handling waste involves stock piling the waste initially at the former Pivot Fertilizer site at 221Whitehall Street, Yarraville. This site will need to be licensed in advance of waste receival by the EPA.

93. Management of waste will centre around the northern portal site as most of the wastes will derive from the TBM. These will be delivered to 221 Whitehall Street by closed belt conveyors.

94. Potentially contaminated waste will be stock piled for classification within covered buildings (Technical Note 31). Other wastes will derive from the excavations associated with the dive structures and the realignment of the NYMS and from other work sites. These will also be delivered to the 221 Whitehall Street site by truck for categorization and potentially for treatment (especially PASS) or for reuse as is practicable (Technical Note 51 and in Document 44 by Kalitsis)

Contamination Evaluations - Soil and Spoil

95. Evaluations of the presence and types of soil and spoil contamination that the WTP will confront in construction and in which environment it would have to operate has been intensively evaluated by a rigorous investigation program involving the following elements:
    a) Establishing existing conditions deriving from the past known and suspected uses of the land within the project boundary and proximal to it from existing public records.
    b) Evaluating the stratigraphic units subject to disturbance or excavation for their geochemical characteristics and or potential to give rise to contamination or corrosive attack on the materials that might be used in construction.

c) Sampling the materials present in the project area for the presence, forms and concentrations of contaminants or contaminant generation potential
d) Focused sampling for contamination in areas of known or likely contamination deriving from past land uses both within and proximal to the project boundaries especially where significant sensitivity exists as a consequence of the magnitude of the in - ground engineering works to be developed (eg Portal and tunnel areas).
e) Relating contamination characteristics to the stratigraphic units subject to disturbance.
f) Defining contamination into categories whereby options for disposal or reuse in environmentally acceptable ways can be considered within the applicable EPRs and regulatory policies.
g) Estimating conservatively the volumes of all categories of waste that will need to be managed as the WTP progresses.

96. All of the above is presented in Appendixes B-E within the Technical Report B Part 2 and in . It is seen as a very comprehensive evaluation. This work provides a guide for further evaluations within the CEMP to more specifically pre-plan in so far as is practicable the arrival of contaminated soils and spoil at the accumulation area and the necessary management of those materials.

Waste Management Accumulation, Reuse Options and Disposal Logistics

97. With the character of the wastes deriving progressively from tunneling and road construction already classified to an indicative extent in-situ, according to Kalitsis the WDA expert in this field, it is already known that a large proportion of the earthworks and tunneling spoil is suitable for reuse as cover materials in landfill rehabilitation or that it may be at least chemically suitable for reuses such as in embankments, cut and cover excavation back fill, road sub base or other purposes provided that engineering properties requirements are met. The latter is to be a priority for contaminated soils and spoil management.

98. Spoil and waste reuse plans will be finalized within a Waste Environmental Management Plan consistent with the EPA Waste Heirarchy policy (EPA Best Practice -Environmental Guidelines for Major Construction Sites within the CEMP. All the options are then subject to oversight and audit by the Independent Review and Environmental Auditor whose assessments will be guided by the WTP EPRs (Table 8.6 in EES Main report Vol 1 at page 8-21)

99. Reuse options and logistics are yet to be finalized, but the options for off- site disposal of waste and spoils as Clean Fill has been researched and landfill licensed capacity has been confirmed as being sufficient to meet the demands of both the WTP and the concurrent MMRP (Kalitsis evidence - Document 44, slide 1

100. Category A and B Industrial Waste and Actual Acid Sulphate Soils (EPA Pub 655.1 Acid Sulphate Soil and Rock) will be either reused within the project at locations or at sites where they will be safely emtombed in permanent landscaping features from which adverse exposure within the environment will be minimal (Technical Notes 31 and 51) or alternatively treated on site before being removed for disposal or reuse as may be determined by their characteristics

101. Similar logistical requirements will arise at the southern portal sites and at the various works management areas associated with the widening of the Westgate Freeway from the southern portal sites out to the M80 interchange and on to Kororoit Creek Road; in the areas where the Hyde Street ramps are to be constructed and between the northern portals, the port, City Link and the city connections. These will however be much less complex logistics than those adjacent to the Northern Portal area because the volumes of solid waste reporting to these areas are so much less as is set out below:
a) Westgate Freeway - 469 Kcum
b) Tunnels and Portals - 1,504 Kcum
c) Port, Citylink and City Connections. - 137 Kcum

102. The above volumes are all described as “bank” volumes which means they are volumes in place, not volumes when disaggregated by excavation. A “swell” factor of at least 30% needs to be added to

evaluate trucking logistics. An average density for weight evaluations in truck loads would then be about 1.7 t/cum loose.

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103. The presence of contaminated fill and natural strata within and adjacent to the project area makes it essential that all waste soils and spoil reporting to the accumulation area will need to be at least confirmed as to its category before it can be removed from the site.

104. Specifically, categorization will involve at least the following:
    a) Acid Sulphate Soil status – except for some tunnel spoil where the material comes from a strata and / or depth which are known not to have potential for acid generation potential (eg Tvn 1 and 2, Tovi and 2; Tpb at least,)
    b) Industrial Waste Classification or Fill designation - except where the spoil derives from a depth well below and away from sources of industrial contamination or former landfill.

105. These category confirmations will involve a rigorous sampling regime to be implemented along with a rapid turn-around analytical service. The CEMP will need to incorporate agreed a minimum sizes for bulk sampling and statistical protocols to fairly represent the material as waste for disposal or reuse..

Contaminated Water Management

106. The EES documentation recognises that contaminated waters do exist within the project area boundaries (((Section 6.2, p41 and 7.2.6, p65 – 74, Technical Report C) and that groundwater will flow into the excavations (Section 7.1, p49 , Technical Report C) to the extent that engineering of the site or the balance pressures exerted by the TBM cannot preclude such inflows. There is certainly potential for this water to contaminate otherwise uncontaminated spoil if the contamination concentrations are sufficient and if the inflows are significant or prolonged. Under any circumstances, the contaminated water will report at the Spoil and soil accumulation areas where it will become part of the overall water drainage requiring disposal.

107. Section 2.5 of Technical Report C - Groundwater at page 19 notes that disposal and beneficial use options need to be detailed within the Groundwater Management Plan with the options being determined by discussions with the EPA and Melbourne Water. Disposal options are further considered at Section 6.4.3, p 44 and at Section 7.6.5 at p119 and 120.

108. As with solid waste and spoil management, the need for treatment and offsite disposal have been evaluated as to acceptability and capacity and these are confirmed. Notably, both the operation of the EPB TBM, especially as it will be in closed mode and using paste much of the time, will minimize the magnitude of water arriving at 221 Whitehall Street. Further, the use of injection bores and other barriers to contaminated water movement should markedly reduce the extent to which waters contained within the spoil and wastes are contaminated. However, it has been revealed that the tunnel alignment and the work related to the NYMS realignment may encounter water contaminated by past industrial use and some acidic waters. No firm suggestions are made as to how disposal will be achieved other than it is to be decided based on water quality monitoring and should be addressed in the CEMP and in the Operational Environmental Management Plan (OEMP).

109. It is proposed that there will be a comprehensive water treatment facility at 221 Whitehall Street. This is to ensure that any water released from the site to sewer meet the requirements of a Trade Waste Agreement to be finalized with Melbourne Water and or with the EPA for releases to stormwater or locally to the Maribyrnong. In addition, WDA experts considered some reuse of water which is suitable as a component in cement mixes and or for re-injection to the groundwater to minimize the potential for contamination movement in areas where such potential might exist were groundwater hydraulic gradients permitting.

110. For reinjection to be effective, whatever the source of the water, treatment would be necessary to remove entrained solids, gas and bacterial contamination. Without this pretreatment, inflows to wells, irrespective of the strata being recharged, would become clogged in time and hence their

effectiveness significantly reduced as a contamination mitigation measure and as a source of reliable monitoring data for the triggering of various mitigation measures. These aspects need to be considered in the CEMP and OEMP.

Conclusions on Groundwater, Ground Movement and Contamination, Waste and Spoil Management

111. The writer is of the view that, as with most of the WDA project, the risk profiles have been conservatively defined. It follows then that the mitigation measures, when coupled with contemporaneous monitoring as a guide to their implementation, will be found to be effective in minimizing the issues inherent in the management of tunnel spoils and contaminated soils and water.

112. In particular, the development of the CEMP and OEMP will be informed by an excellent data base arising from the investigations, evaluations and modelling projections done as well as by the collection of further data where the present data may be anomalous or not quite sufficient (eg where substantial core loss during drilling obscures possible anomalies).

113. Finally, the system of CEMP oversight and auditing that will apply for the project should ensure that the EPRs developed for the project will be met.

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