SH20 Manukau Harbour Crossing Project

Appendix 17: Geotechnical Appraisal Report

CER 06/023

State Highway 20
Manukau Harbour Crossing Project

Appendix 17:Geotechnical Appraisal Report

May 2006

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Date: 19 May 2006
Reference: 1-81074.xx
Status: Final

Appendix 17:Geotechnical Appraisal Report

NOTE:

Report annotated September 2006 to refer to project updates described in August 2006 Section 92 Response Reports.

Refer to notes on following page

Document Acceptance

Action	Name	Signed	Date
Prepared by	Aaron George	pp. Wendy Nicholas for Aaron George	19/05/06
Reviewed by	Glyn East	pp	19/05/06
Approved by	Keryn Kliskey		19/05/06

File Path: k:\transit\projects\pa2232-manukau harbour crossing scheme-rxu\planning\aee\aee chapters\c00 appendices\mhc_appendix 17 geotechnical appraisal report_final_180506.doc

SH20 Manukau Harbour Crossing Project
Annotation Notes

Reference in text	Note
1	**Proposed form of interchange revised August 2006 to "quarter diamond" configuration. Refer to August 2006 Interchange Report and s.92 Response Report to Auckland City Council.**
2	**Temporary reclamations no longer proposed. Coastal Permit application for temporary reclamation at Onehunga Harbour Road withdrawn August 2006.**
3	**Extent and area of proposed reclamation revised. Refer August 2006 s.92 Response Report to Auckland Regional Council.**
4	**Coastal Permit applications for replacement of Old Mangere Bridge were lodged in May 2006 but withdrawn in August 2006 to enable further consideration of design options. General information relating to the proposed replacement bridge as described within this AEE remains relevant. New consent applications will be lodged at a later date as appropriate. The concept design for the replacement bridge will be confirmed at that time.**
5	**The proposed designation no longer includes the Manukau Cruising Club lease area (refer August 2006 s.92 Response Report to Auckland City Council). The building, carparking area and boat ramp are no longer directly affected by the works.**
6	**Stormwater management proposals revised. Refer August 2006 s.92 Response Report to Auckland Regional Council.**

SH20 Manukau Harbour Crossing Project
Annotation Notes

Background

Transit's proposals for the Manukau Harbour Crossing Project were submitted to Auckland City Council, Manukau City Council and the Auckland Regional Council in May 2006.

All three Councils requested further information from Transit, and this information was provided in August 2006. The requests for further information were made in accordance with Section 92 of the Resource Management Act 1991.

Preparation of this additional information has resulted in some revisions to the original proposals, and these are reflected in supplementary documentation dated 28 August 2006. The key revisions made are summarised below.

Key Revisions

- The proposed form of the motorway interchange at Gloucester Park has been revised from a "diamond" to a "quarter diamond" configuration.
- The extent of reclamation proposed within the Manukau Harbour has been reduced – only one area of reclamation is now proposed, this being along Onehunga Harbour Road and Orpheus Drive, east of the Manukau Cruising Club.
- The Manukau Cruising Club and associated parking area is no longer affected by the proposed works.
- Coastal Permit applications relating to demolition of the old Mangere Bridge and replacement with a new pedestrian and cycle bridge have been withdrawn to enable further consideration of design options.
- Stormwater management proposals have been refined to offer an improved degree of treatment prior to discharge to the receiving environment.

Notification Documentation

The documents submitted with the consent applications and Notices of Requirement in May 2006, along with the more recent information prepared in response to requests from the Councils for further information are available in full for viewing as part of the public notification process.

To avoid confusion, the May 2006 documentation has been annotated where appropriate to refer to the recent revisions summarised above and described in the August 2006 reports.

Reports Referred to in Annotations – Full Titles

Title	*Date*	*Status / revision*
August 2006 Interchange Report		
Report: SH20 Manukau Harbour Crossing Project - Gloucester Park Interchange: Further Consideration of Alternatives	28 August 2006	Rev A Final
s.92 Response Report to Auckland City Council		
Report: Response to Auckland City Council Requests for Further Information under Section 92 of the Resource Management Act 1991	28 August 2006	Final
s.92 Response Report to ARC		
Report: Response to Auckland Regional Council Request for Further Information under Section 92 of the Resource Management Act 1991	28 August 2006	Final

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Executive Summary

The SH20 Manukau Harbour Crossing Project (the Project) forms part of Transit's Western Ring Route, aimed at providing an alternative strategic route to SH1 through Auckland.

The project objective includes provision of a high standard strategic connection between Walmsley Road and Queenstown Road and also to improve the connection between the South Western and Onehunga-Pakuranga corridors.

The findings presented in this report are drawn from the Geotechnical Factual Report (Geotechnical Services Report Ref, GS 04/05) and Geotechnical Interpretive Report (Geotechnical Services Report Ref, GS 04/06).

The findings of the geotechnical assessment indicate that:

- It should be possible to mitigate or avoid most hazards with appropriate design and construction methods.
- Long-term settlement is to be expected on the existing alignment within the Hopua tuff ring floor due to the 3m thick layer of historic fill that has been placed across the compressible marine mud over the last 60 years approximately. Further settlement that would be generated by the proposed works will be mitigated by the use of polystyrene fill for ramp construction.
- Risks remain from unforeseen ground conditions but the presence of the existing motorway that has preformed to expectation for 30 years indicates that this risk is low.
- Some risk exists with the possible liquefaction for the proposed driven piles for the Tararata Creek crossing where less dense sands are present. Construction of this bridge should ensure that the piles are driven into the weakly cemented Kaawa Foundation bedrock.
- An additional area of potential risk is associated with the pile length that the eastern abutment of the new Rimu Road Bridge where depth of pile foundations will need to be confirmed at the detailed design phase.

Included in this report is a summary of the foundation conditions for the structures along the alignment.

1 Introduction

This report presents the findings of a review of information from previous and current investigation assessments and presents the geology, geotechnical hazards/issues, geotechnical constraints, and design parameters of the project.

The Project will widen SH20 between Queenstown Road and Walmsley Road Interchanges from four lanes to six lanes, with bus priority on shoulder lanes where practical. Eight lanes will be provided between the Rimu Road and Gloucester Park interchanges. Mangere Bridge will be duplicated to the east (i.e. a second bridge will be built) to provide four traffic lanes and a shoulder lane for bus priority in each direction. Pedestrian and cyclist usage will continue to be provided along the line of the Old Mangere Bridge by way of a replacement structure (Mangere Footbridge) and also under the Mangere Bridge.

The existing Gloucester Park split interchange will be upgraded to a grade separated ~~diamond~~ arrangement connected to Neilson Street. The Project will require alterations to local streets (Rimu Road, Mahunga Drive, Neilson Street, Gloucester Park Road and Orpheus Drive) and modification to access arrangements to surrounding properties affected by the upgraded interchange at Gloucester Park Road. Foreshore reclamation will be undertaken to accommodate a realignment of Orpheus Drive.

The Rimu Road/Mahunga Drive Bridge will be replaced to allow motorway widening. Further south at Tararata Creek a new off ramp bridge and widened motorway bridge will be required.

At the Queenstown Road Bridge, additional retaining walls and abutments will be required. The Beachcroft Avenue and Hastie Avenue footbridges will also need to be replaced to allow motorway widening.

The findings presented in this report are drawn from the Geotechnical Factual Report (Geotechnical Services Report Ref, GS 04/05) and Geotechnical Interpretive Report (Geotechnical Services Report Ref, GS 04/06). A summary of the earthworks quantities is presented in Volume 2 Appendix 18 Erosion and Sediment Control Plan, while a detailed description of the bridge options is presented in Volume 2 Appendix 3 Bridge and Structures Report.

2 Geology and Soils

The broad corridor route covering the project traverses diverse geological conditions including both Waitemata Group (Miocene) and Kaawa Formation (Pliocene) “bedrock” and weathered derivatives. Overlying the “bedrock” units are Tauranga Group Alluvium (Pleistocene), volcanic craters and associated deposits including ash and basalt, marine sediments, and historic off shore reclamation (see Figure 1). The harbour foreshores at each end of the 650m duplicate Mangere Bridge crossing are delineated by volcanics. Tuff from the Gloucester Park explosion crater and basalt flows from One Tree Hill form the northern shore, while a basalt flow from Mangere Mountain forms the southern shore. The harbour bed between the two shorelines overlies marine sediments and alluvium soils, which in turn are underlain by Waitemata Group “bedrock”.

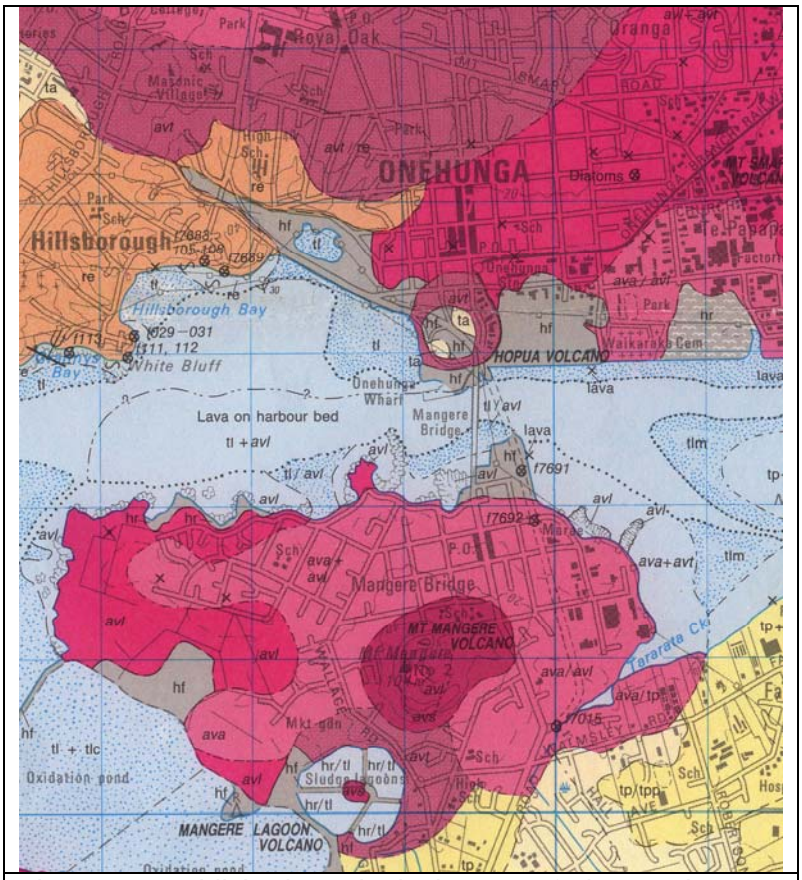

Figure 1: Published geological map of the study area (Kermode 1992) [1]. Waitemata Group (re), Volcanic tuff (avt), Volcanic ash (ava), Volcanic scoria (avs), Puketoka Formation (tp), Undifferentiated alluvium (ta), Fill (hf).

3 Proposed Alignment

For the proposed alignment there are a number of localised geotechnical constraints that will require mitigation by specific construction or design.

Of significance will be the deep soft and compressible marine mud infilled Gloucester Park explosion crater, which will be crossed over a length of some 700 metres. Because of potential settlement issues there will need to be restrictions in the embankment and approach fill heights for the Gloucester Park Interchange.

The realignment of Orpheus Drive will require a reclamation embankment to be built over the marine mud foreshore.

There are inherent geotechnical risks associated with the proposed retreat cuts of the current cut batter slopes at Queenstown Road (potential bedding and structural discontinuities) and Walmsley Road (weakly cemented sands). These cuts have private properties built on or above the slopes that could be adversely affected if slope failures were to occur.

Potential earthquake induced liquefaction of the upper, less dense sands around Walmsley Road may also exist.

Other geological hazards were mitigated during the original 1970's construction of the motorway. These included the removal (by suction dredging) of the marine mud under the Mangere Bridge southern approaches.

None of the constraints or issues outlined above are considered to be fatal to the project, but they will require specific construction techniques that will be more costly than typically required for projects of this type.

On a regional scale lower probability hazards include both seismo-tectonic and volcanic hazards. The Auckland Region lies in one of the lowest earthquake activity regions of New Zealand. No active faults are present within the alignment although near source fault induced seismicity still governs the critical earthquake hazard in Auckland. The design magnitude and accelerations applied during analyses are relatively low. Seismic activity could cause liquefaction in loose sand in the Walmsley Road area but the presence of such material is not prevalent elsewhere.

Volcanic hazards are less predictable. As with the entire Auckland infrastructure, there is up to a 5% probability that an eruption will occur within the next 50 years, although opinions differ whether this probability implies a single centre event or clusters. The impact on the project will vary depending on the location, volume and nature of the volcanic event. Current seismic monitoring should give some warning of a volcanic event.

4 Geotechnical Design Conditions

4.1 Earthworks Conditions

The earthworks conditions and mitigation issues can be divided into 6 sections, which can be summarised as follows:

South of Tararata Creek (RP10/0.54-0.7): This section of the alignment is sited on the alluvial soils of the Manukau lowland adjacent to the rubbly basalt flow from Mangere Mountain. The soils are a veneer of ash over loose/medium dense sandy alluvium merging into Kaawa Formation cemented sands at a depth of some 25 metres. The loose/medium dense upper sands are likely to have liquefaction potential under earthquake conditions.

The construction over this section requires a new south bound off ramp and a widened Tararata Creek Bridge. The new off ramp will require a low height (<3 metres) vertical cutting into the natural slope below Kingfisher Place. To avoid the risk to houses above this sandy slope, a "top down" constructed "post and plank" cantilever pile retaining wall is proposed, such that the excavation can be carried out after the slope has been retained.

Relatively deep piles are required. The Tararata Creek bridge piles will be taken down to the cemented Kaawa sand to avoid founding on potentially liquefiable sands. Driven piles are the most suitable foundation type but these may require partial pre-boring to penetrate the upper soils.

Tararata Creek to Duplicate Mangere Bridge Southern Abutment (RP 10/0.7-2.5): This section of the alignment is formed in shallow cut within the rubbly basalt from the extremities of the Mangere Mountain basalt flow. Further excavation on the eastern side will be required in the remnant 2 to 3 metre height of the flow to achieve the formation width. Hastie Avenue Footbridge (RP 20/1.5) and Rimu Road Bridge (RP10/2) will require replacement. These bridges will be founded on the basalt rock.

Duplicate Mangere Bridge and Mangere Footbridge (RP 10/2.5-3.2): The piers and abutments of the Duplicate Bridge will be founded on groups of bored piles with enlarged bases (bells). The proposed Mangere Footbridge is likely to be founded on single piles. Piles for all these structures are expected to be founded within the Waitemata Group "bedrock" at some 30 metres below sea level. The associated separate fender structure may be a series of single piles or groups of piles and may not need to be founded on the bedrock. Both the northern and southern approach fill embankments and the abutments for the Duplicate Bridge are already present having been constructed at the time of the existing bridge, although the approach at this stage is for the southern abutment to be demolished and re-built. The southern approach is likely to require fill, some local widening and a low height MSE wall.

Duplicate Mangere Bridge to Gloucester Park Interchange (RP 10/3.2-4.0): This section of the alignment crosses the soft, compressible marine mud infilled explosion crater of Gloucester Park on a low height fill embankment. As with the current motorway some long-term settlement must be expected even with low height embankments over this section of the alignment. More than the usual shape correction construction must be expected.

In contrast to the low height embankment required for the motorway, the south facing ramps for the Gloucester Park Interchange will be built on embankments that rise to some 5 metres in height, and will require the use of light-weight polystyrene fill to alleviate stability and adverse long term consolidation settlement. The typical construction in such circumstances of preloading with wick drains is unlikely to be suitable due to the close proximity of the adjacent existing motorway lanes, which result in a high likelihood of adverse settlement effects. Likewise it would not be feasible to put these ramps on structures (such as piled slabs) due to the depth (40-60m) of soft material. Significant constraints are likely with respect to the constructability of piles, and the serviceability of the piles under seismic loading.

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Gloucester Park Interchange (RP 10/4.0-4.2): This section will be built on the weakly cemented tuff ring of the Gloucester Park explosion crater, which overlies a 3 to 6 metres thick basalt flow(s) from One Tree Hill at a depth of some 6 metres from the ground surface. Firm alluvium over Waitemata Group "bedrock" underlies the basalt at a depth of 15 metres.

Construction for this interchange will require a new motorway bridge, and embankment ramps to form a full ~~diamond~~ interchange on a relatively restricted footprint. The foundation conditions are suitable for the bridge abutments and ramp sides to be constructed with MSE walls. Shallow piles founded on the basalt are proposed to support the piers of the bridge.

Of further significance in this section is the requirement to realign Orpheus Drive and reclaim further foreshore out to a width of approximately 20-40 metres over a 200 metre length. This reclamation will require some 4m of fill to be placed over foundation soils consisting of a veneer of marine mud over tuff. Current assessment has indicated that this mud is relatively thin (0.0 to 1.5 metres, typically 0.5 metres thick) and it may be removed as part of the construction. If off site disposal is to be avoided the mud could be reconstituted with cement to form mudcrete and utilised as filling on the project. While the mud may contain certain heavy metals, the mudcrete will encapsulate it and help to prevent further dispersal.

Gloucester Park Interchange to Queenstown Road Interchange (RP 10/4.2-5.2): This section of the motorway will be constructed largely at grade over the reclamation fill formed for the existing motorway. Some 2 metres of fill overlie firm alluvial soils in turn overlying Waitemata Group "bedrock". A replacement Beachcroft Road Footbridge (RP 10/4.9) will be founded on bored pile foundations.

The alignment will require a substantial retreat excavation of the batter below the Queenstown Road off ramp within Waitemata Group rock. This rock has structural discontinuities. To avoid the risk to private properties above this slope a "top down" constructed "post and plank" cantilever pile retaining wall is proposed such that the excavation can be carried out after the slope has been retained. Part of the wall will be utilised to support the existing Mechanically Stabilised Earth (MSE) abutment of the Queenstown Road Underpass (RP 10/5.2). North of the bridge the existing sidling fill will require local widening on the southbound side. An MSE wall is proposed for this purpose.

As noted in the Volume 2 Appendix 18 Erosion and Sediment Control Plan, there will be a deficiency of fill for the overall project. Rubble basalt borrow will be obtained south of Rimu Road and some Waitemata Group soft rock from the cutting adjacent to Queenstown Off Ramp but insufficient for the construction. Unless soils can be won from other construction projects, a quarry source will be required. This may suit the Gloucester Park Interchange MSE wall construction, where the dominant fill volume will be required; as such walls require a granular type of fill for optimum performance.

4.2 Summary of Structures

A summary of the foundations and structures on this project is presented in Table 1 below.

Table 1: Foundation and Structure Summary

Station	Feature	Structure Earthworks	Proposed Foundation Construction
620-765m	New eastbound off ramp to Walmsley Road	Cutting up to 4m into variable strength ash and alluvium	"Top down" constructed "post and plank" concrete cantilever pile retaining walls
765-860m	New Walmsley Road off ramp bridge and widening of Tararata Creek Bridge	3 Spans, 2 lanes; foundation to penetrate through alluvium into cemented Kaawa Formation very weak sandstone	Driven piles which will require partial pre-boring to penetrate the upper soils
1064-1480m	New eastbound lanes	3 lanes; Cutting into soft to firm fill material overlying insitu rubbly basalt and ash.	Cutting the mound to grade
1500m	New Hastie Avenue footbridge	2 span across the motorway with ramps on either side	Footing pad founded on basalt rock
2080m	New Rimu Road Bridge.	3 spans, 3 lanes; foundation to penetrate through fill and tuff	Pile belled on basalt rock. N.B. Basalt may be <1.5m thick under the eastern abutment and may require piles founded in the Kaawa bedrock at or about 17m.
2280-2400m	New eastbound motorway and new Rimu Road off ramp	Motorway – 3 lanes; underlain by stiff to very stiff fill and volcanic tuff from Mangere Mt. Offramp – 1 lane; underlain by stiff fill and volcanic tuff	MSE wall founded on existing southern abutment
2640-3140m	New Duplicate Bridge.	Multispan, supported by pile groups.	Bored piles with enlarged bases founded within the very weak to weak Waitemata Group "bedrock".
	Mangere Footbridge to replace "Old Mangere Bridge"	Multispan, supported by single piles and with an associated separate fender structure also supported on single piles.	Bored piles with enlarged bases founded within the very weak to weak Waitemata Group "bedrock".
3380-3800m	~~Gloucester Park Interchange - south facing ramps~~	~~Polystyrene blocks faced with concrete panels.~~	~~<5m embankments on lightweight polystyrene fill over insitu soil fill and 32m of compressible marine mud.~~
	Gloucester Park Interchange - north facing ramps	MSE Walls to support new ~~onramps and~~ offramp~~s~~	Embankments will be built on the weakly cemented tuff ring
	Gloucester Park Interchange - Bridge	Abutments to be constructed with MSE walls Bridge to be supported by shallow cylinder piles	This section will be built on weakly cemented tuff ring Piles will be founded on basalt
3140-3700m	Orpheus Drive Realignment	Reclaim further foreshore out a width of approximately	4m of fill over foundation soils of marine mud over basalt/tuff.

and approach to embankments

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Station	Feature	Structure Earthworks	Proposed Foundation Construction
		20-40m over a 200m length	Marine mud (nominal 1.5m) to be removed
4820m	New Beachcroft Avenue footbridge	4 spans, bored piles with ramps.	Piles will be founded in very weak to weak sandstone/siltstone “bedrock”
4840-5200m	South of Queenstown Road bridge	Retreat excavation of the batter below the Queenstown Road offramp	”Top down concrete soldier” pile retaining wall to support excavation of both: • Waitemata Group Rock with structural discontinuities, and • Waitemata Group weathered soils adjacent to Queenstown Road overbridge.
5200m	Queenstown Road bridge	New lanes encroaching abutment along the northbound lane.	”Top down concrete soldier” pile retaining wall to support the existing MSE abutment will be founded in Waitemata Group very weak to weak sandstone and mudstone “bedrock”
5220-5620m	SH20 southbound lane, North of Queenstown Road	Embankment fill up to 3.5m high with MSE support, inclined toe	MSE wall will be underlain by stiff fill over Waitemata Group soil.

5 Geotechnical Constraints

In summary the findings of the geotechnical assessment indicate that it should be possible to mitigate or avoid most hazards with appropriate design and construction methods. Long-term settlement is to be expected on the alignment within the Hopua tuff ring floor due to the 3m thick layer of historic existing fill that has been placed across the compressible marine mud over the last 60 years approximately. Further settlement that would be generated by the proposed works will be mitigated by the use of polystyrene fill for ramp construction. Risks remain from unforeseen ground conditions but the presence of the existing motorway that has preformed to expectation for 30 years indicates that this risk is low.

Some risk exists with the possible liquefaction for the proposed driven piles at the Tararata Creek Bridge where less dense sands are present. Construction of this bridge should ensure that the piles are driven into the weakly cemented Kaawa Foundation bedrock.

An additional area of potential risk is associated with the pile length at the eastern abutment of the new Rimu Road Bridge where foundation conditions will need to be confirmed at the design phase.

6 Limitations

The ground conditions described in this report are professional opinion based on a desk top review, field inspection and site investigations at discreet locations along the route alignment. Variation in the ground conditions to those described may occur.