Before the Board of Inquiry
Waterview Connection Project

in the matter of: the Resource Management Act 1991

and

in the matter of: a Board of Inquiry appointed under s 149J of the Resource Management Act 1991 to decide notices of requirement and resource consent applications by the NZ Transport Agency for the Waterview Connection Project

Statement of evidence of Timothy Fisher (Stormwater) on behalf of the **NZ Transport Agency**

Dated: 12 November 2010

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STATEMENT OF EVIDENCE OF TIMOTHY FISHER ON BEHALF OF THE NZ TRANSPORT AGENCY

INTRODUCTION

1 My full name is Dr Timothy Simon Richmond Fisher. I am a Director and Senior Water Engineer at Tonkin & Taylor (T&T). I am a Member of the Institute of Professional Engineers New Zealand and am a Chartered Professional Engineer.

2 I have a Bachelor of Civil Engineering (1st Class Honours) and Masters of Civil Engineering (Distinction) from the University of Canterbury and a PhD in Civil Engineering from the University of British Columbia, Canada, specialising in environmental hydraulics.

3 My 15 years experience in water engineering includes working on a wide range of river, water, wastewater, stormwater, flooding, mining, water resources and coastal engineering projects.

4 I have specialist skills in the design and assessment of stormwater projects and in stream diversions, which are key aspects of the Waterview Connection Project. Recent examples of projects I have been involved in include:

4.1 Northern Gateway Toll Road (SH1) where I was stormwater team leader and stormwater treatment designer for the 7.5km motorway, awarded Innovate Gold Award[1] and The Arthur Mead Award (Merit);[2]

4.2 Manukau Harbour Crossing (SH20) design of stormwater treatment for resource consents;

4.3 Transmission Gully peer review of hydrological, hydraulic, sediment and harbour modelling reports;

4.4 ARC TP10 pond review where I was project director for the new guideline report on stormwater treatment ponds;

4.5 Mangakotukutuku Stream diversion (1.4km length) for Solid Energy, which included aquatic habitat features as well as flood conveyance, and which won Arthur Mead Environmental Award and Innovate Silver Award; and

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[1] Innovate is awarded by Association of Consulting Engineers (ACENZ) for projects that show excellence in technical skills, interaction with the client and other project team members, and some level of innovation. There are three levels of award: Gold, Silver and Award of Merit.

[2] The Arthur Mead Award for the Environment and Sustainability is awarded by the Institute of Professional Engineers New Zealand (IPENZ) for projects that best exemplify sustainable management of resources and care for and consideration of environmental values.

4.6 Consenting for the Stevensons Quarry Drury stream diversion (1.1km length) which involves aquatic habitat features and flood conveyance.

5 My evidence is given in support of notices of requirement and applications for resource consents lodged with the Environmental Protection Authority (*EPA*) by the NZ Transport Agency *(NZTA*) on 20 August 2010 in relation to the Waterview Connection Project (*Project*). The Project comprises works previously investigated and developed as two separate projects, being:

5.1 The State Highway 16 (*SH16*) Causeway Project; and

5.2 The State Highway 20 (*SH20*) Waterview Connection Project.

6 I am familiar with the area that the Project covers, and the State highway and roading network in the vicinity of the Project.

7 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2006), and agree to comply with it. In preparing my evidence, I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

8 My evidence will deal with the following:

8.1 Executive Summary;

8.2 Background and role;

8.3 Summary of Assessment of Stormwater Effects – CMA;

8.4 Summary of Assessment of Stormwater Effects – Other Sectors;

8.5 Summary of Assessment of Streamworks Effects;

8.6 Post-lodgement events;

8.7 Comments on submissions; and

8.8 Proposed Stormwater and Streamworks conditions.

EXECUTIVE SUMMARY

9 Stormwater and streamworks design and mitigation measures have been developed for the Project and are described in my evidence

and the Technical Report No. G15 Assessment of Stormwater and Streamworks.

10 Stormwater treatment has been provided to meet the requirements of the PARP:ALW for all of the new motorway areas. In addition, improved environmental outcomes will be achieved by the stormwater treatment of existing motorway areas that currently only have minimal treatment. A higher than usual level of treatment of 80% TSS removal is proposed for areas of the Project that discharge to the CMA. By these measures the effects from stormwater discharges on the receiving environment have been minimised. The effects of residual stormwater contaminants, including cumulative effects, on freshwater and marine ecology are covered by Mr Sides and Dr De Luca, respectively.

11 The effects of stormwater discharge from the Project during the construction phase will also be mitigated by treatment devices selected and designed using the BPO approach.

12 Streamworks are proposed for Oakley Creek in Alan Wood Reserve including a SH20 bridge, realignments and rehabilitation. The proposed stream realignments and rehabilitations will have a positive effect on the environment as natural channel form will replace the existing manmade basalt rock wall channel. The ecological effects due to the channel shortening will be offset with mitigation as described by Mr Sides. No adverse effects are anticipated to the stream bed morphology, flow hydraulics or sediment.

13 The Project will reduce the flood storage of Oakley Creek available within the Project area. However, the streamworks proposed will lower flood levels and flood extents in the Project area. This is achieved by channel design and the preservation of flood plain storage than would otherwise have been lost to already consented development (i.e. the Goldstar property). The only potentially adverse effect is the increase in peak flood flows and increase in flood water level upstream of the Bollard Avenue Culverts, which increases the 100 year ARI water level at a basement garage for one property. As mitigation NZTA will offer to relocate any affected electrical fittings in the garage to above the flood level as mitigation for change of flood levels predicted due the Project. In the post lodgement period we have developed designs to reduce the flood water level at this location, but these need to be developed with Auckland Council as part of their catchment planning process.

14 Overall, the number of properties affected by flooding decreases and the number of habitable floors at risk of flooding decrease as a result of the Project works. The Project streamworks will provide a benefit in terms of peak flood levels and extents. The potential downstream effects have been mitigated. Therefore, the effects of

the streamworks on flooding are considered to be adequately directly mitigated and negligible.

BACKGROUND AND ROLE

15 The NZTA retained Tonkin & Taylor as part of a consortia team to assist with investigation, engineering and reporting on the SH20 Waterview Connection component of the Project, including scheme design engineering services.

16 After the SH20 and SH16 projects were merged, I was asked to prepare (with assistance from Aurecon which had been working on the SH16 project) an Assessment of Stormwater and Streamworks (*the Report*) in relation to the Project. The Report was to address stormwater issues and the environmental impacts of the streamworks to the Oakley Creek both during the construction period and once the Project was operational. Peer review of the Report was undertaken by Mr Peter Millais of Beca.

17 My Report was lodged with the EPA in August 2010 as part of the overall Assessment of Environmental Effects (*AEE*) (specifically, Part G, Technical Report G.15).

18 I was also the lead author of the Stormwater and Streamworks Design Philosophy Statement (the Design Philosophy Statement).[3] I was a contributor to the WRR Maioro Street Interchange and Waterview Connection: Oakley Creek Realignment and Rehabilitation Guidelines.[4] Finally, I also helped to develop the scope for the contaminant load modelling undertaken by NIWA.[5]

SUMMARY OF ASSESSMENT OF STORMWATER EFFECTS – CMA

19 In this section of my evidence I will describe the key points of my Report as it relates to stormwater effects of the Project in Sectors 1 to 5, where the discharge of stormwater is directly into the Coastal Marine Area (CMA). Within this section I will address operational and construction effects separately.

20 I am addressing the stormwater effects on the CMA first, because it closely relates to the evidence of Mr Hind, Dr Bell and Dr De Luca (on the SH16 causeway reclamation and construction works, coastal processes and marine ecology respectively). My evidence will subsequently address the stormwater effects of the Project in Sectors 6 to 9 and the streamworks effects in Sector 9, which closely relates to the evidence of Mr Sides on freshwater ecology.

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[3] Technical Report G.27.

[4] Appendix C to Technical Report G.6 Assessment of Freshwater Ecological Effects.

[5] Refer Technical Report G.30.

Summary of Methodology - CMA

21 The methodology is set out in Section 3 of my Report, but in summary the approach taken to stormwater design was to incorporate mitigation measures, such as stormwater treatment, right from the start as these are requirements of the Proposed Auckland Regional Plans: Air Land and Water (*PARP:ALW*). The assessment of effects is therefore of the design that incorporates the mitigation measures.

22 The design of stormwater systems is based on standards and approaches detailed in the Design Philosophy Statement which adopts the following principles for the design:

22.1 The design will incorporate the total stormwater management system (collection and conveyance network; treatment devices; stormwater cross drainage; Oakley Creek bridges and realignments);

22.2 The objective of the stormwater management system is to provide a best practicable option (*BPO*) to avoid, remedy or mitigate more than minor adverse environmental effects, determined through a robust evaluation of options;

22.3 The design should include full consideration of stormwater operational implications throughout the design life; and

22.4 The design should best practicably mimic the existing hydrologic regime and setting, to deliver outcomes that remedy or mitigate adverse environmental effects. The design should also consider any measures to improve current flood issues in the catchment.

23 The existing environment was reviewed to provide context for the design, mitigation and assessment of effects.

24 The rainfall data used in the calculation of the design flows were derived from the 24 hour rainfall depths provided in Auckland Regional Council (ARC) Technical Publication No. 108, Guidelines for Stormwater Runoff Modelling in the Auckland Region (1999) (ARC TP108). The rainfall depths from ARC TP108 were checked against the summary statistics for the National Institute of Water & Atmospheric Research (*NIWA*) Owairaka and Onehunga gauges, and the HIRDS[6] databases, and found to be reasonably consistent with other data sources. Different representative rainfall depths were used for Sectors 1-7 and Sector 9 due to the spatial distribution of rainfall across the Project area.

[6] NIWA High Intensity Rainfall Design System (HIRDS)

25 Predicted climate change effects, including an increase in rainfall intensity, were accounted for in the design because these changes are predicted to occur over the life of the stormwater infrastructure. The ARC TP108 rainfall depths were factored by the recommended increment identified in the MfE (2008) Climate Change Effects and Impacts Assessment for the predicted temperature increase for the Auckland region of up to 2.1°C. This resulted in an increase in 24 hour rainfall depth for the 100 year Average Return Interval (ARI) event of 17%.

26 The hydrological design used the ARC TP108 method, which is the ARC preferred methodology for the Auckland Region. This method was used to determine the water quality volume for the design of stormwater treatment devices.

27 ARC Technical Publication No. 10 Stormwater Management Devices: Design Guidelines Manual (TP10) was used as the basis of design of stormwater treatment devices in accordance with PARP:ALW. A BPO approach was used to select the treatment devices.

Operational Stormwater Effects - CMA

28 An assessment of the effects of the stormwater aspects of the Project during the operation phase was carried out. This assessment included an evaluation of the matters that were taken account of during the design and the BPO selection of solutions (as required by the Resource Management Act 1991 (*RMA*) and the *PARP:ALW* and Proposed Auckland Regional Plans: Coastal (*PARP:C*)). Section 6 of the Report outlines the design process, the proposed solutions and the assessment of effects for the operational phase.

29 The proposed BPO solutions are intended to demonstrate that feasible solutions exist to meet stormwater treatment objectives. It is intended that there be flexibility for contractors to provide innovative or alternative designs to meet or better the performance criteria specified by resource consents, or account for Project design changes.

30 The PARP:ALW requires and ARC TP10 targets removal of 75% Total Suspended Solid (TSS) on a long term average basis. For this Project however, stormwater runoff is being treated to remove more than 75% TSS including from most of the existing motorway surface (which is generally untreated at present). This additional treatment, which will significantly improve the existing stormwater runoff from the SH16 causeway, has been identified as a way of mitigating the effects of coastal reclamation, and the associated loss of biological habitat. For this reason the stormwater treatment devices for the Project that discharge to the CMA (Sectors 1 – 5) have been designed to remove 80% or more TSS on a long term average basis. This level of treatment exceeds the requirements of PARP:ALW and ARC TP10.

31 The proposed BPO solutions for permanent devices[7] include wetlands, bio-filters, swales and cartridge filters. The higher level of treatment will be achieved using conventional treatment devices with design modifications to increase their treatment capacity. For the biofilters and swales their capability has been also been improved by adding alternate treatment mechanisms; for examples the biofilters evolved from swales by the addition of a raingarden component that adds infiltration treatment, and with an organic media a more effective, targeted treatment for heavy metals. The increase in treatment efficiency to 80% is a demanding step for these treatment technologies and ongoing maintenance will be more important than normal for these devices. The treatment devices for each of the Project's discharge locations, are summarised in Table 6.1 of the Report.[8]

32 Table 1 summarises the impervious areas[9] for the existing motorway, the additional impervious areas added for the Project and the total impervious areas for the motorway after the Project.[10] For Sectors 1-5 there are 12.69 ha of additional impervious area which results in a total impervious area of 41.06 ha. Stormwater treatment is currently provided for only 11.6% of the existing impervious motorway surfaces within Sectors 1-5. The Project will significantly increase the area of existing motorway that receives stormwater treatment to 98.2%. The overall extent of stormwater treatment will be 98.7% for Sectors 1-5.

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7 Stormwater treatment devices used during the operational phase of the Project are referred to as "permanent devices". This is to distinguish them from stormwater treatment devices used during the construction phase of the Project, which are referred to as "temporary devices".

8 The Report – pages 50-53.

9 Pervious areas are additional, but are generally small or non-existent for motorway catchments, with the exception of the Sector 9 where the Chris the King school in included in the catchment.

10 Table 1 is a copy of Table 6.24 to the Report, with the addition of a subtotal for Sectors 1-5. It has also been updated, from Table 6.24 in the Report, to reflect additional mitigation proposed post lodgement. This includes for Sector 4 the addition of treatment to Causeway Bridge (refer paragraph 104) and for Section 5 the additional treatment for the SH16 eastbound offramp at Great North Road interchange (refer paragraph 106).

Table 1: Summary of Areas and Percentages with Water Quality Treatment for Operation Phase

Sector	Existing Impervious			Additional Impervious		Total	
	Area (ha)	Percentage currently treated	Percentage proposed treatment	Area (ha)	Percentage proposed treatment	Area (ha)	Percentage proposed treatment
Sector 1	8.05	1.7 %	100 %	3.67	100 %	11.72	100 %
Sector 2	1.45	0 %	100 %	0.72	100 %	2.17	100 %
Sector 3	3.88	0 %	100 %	1.47	100 %	5.35	100 %
Sector 4	8.37	13.7 %	100 %	3.40	100 %	11.77	100 %
Sector 5	6.62	30.3 %	92.1 %	3.43	100 %	10.05	94.8 %
Subtotal Sectors 1-5	28.37	11.6 %	98.2 %	12.69	99.0%	41.06	98.7 %
Sector 6	4.08	0 %	68.7 %	1.06	100%	5.14	75.2 %
Sector 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sector 8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sector 9	1.04	0 %	100 %	8.49	100 %	9.53	100 %
Total Project	**33.49**	**9.87 %**	**94.5 %**	**22.25**	**100 %**	**55.74**	**96.8%**

33 The provision of new stormwater treatment systems for the existing SH16 motorway surfaces has a positive effect on the receiving environment by reducing contaminant loads to the Waitemata Harbour from this existing source. While stormwater treatment is not strictly required for existing impervious surfaces, NZTA have taken the opportunity to provide treatment for these areas where practicable. It makes sense to undertake these improvements as part of the Project because these works are best done at the same time as lane widening (as these existing areas cannot easily be separated from additional impervious areas) and because the betterment this additional stormwater treatment provides will help to mitigate the effects of the Project on the marine environment.

34 Contaminant load modelling undertaken by NIWA[11] demonstrates that total suspended solids, Zinc and Copper loads estimated for 2016 and 2026 (using traffic volumes at those times) are 20%-40% lower for the SH16 sections of the Project with its stormwater improvements compared to the those predicted for the existing motorway in those years.

35 NIWA[12] estimated that in 2016 the annual loads delivered to the Waterview Estuary from the Project motorway area (all Sectors excluding Sector 6) will be 18 tonnes of sediment, 314kg of zinc and 39kg of copper. The annual loads delivered to the Waterview Estuary from the catchment area (inclusive of the Project) are expected to be 455 tonnes of sediment, 944kg of zinc and 124g of copper. These values are less than the existing baseline annual loads from the catchment area (2% less for sediment, 8% less for zinc, and 10% less for copper), which is due to the proposed improvements to stormwater treatment for SH16 for the Project.

[11] Technical Report G.30.

[12] Technical Report G.30.

For 2026, the estimated annual sediment and contaminant loads delivered to the Waterview Inlet from the representative catchment areas are a slight increase on those for 2016 but still remain less than the existing baseline loads.

36 Energy dissipation and erosion control measures are proposed at all treatment device outfalls. Through provision for erosion control measures at all treatment device outfalls, the potential adverse effects on the surrounding environment from erosion or scour at discharge points will be avoided.

37 With treatment and after mixing no conspicuous change to the receiving waters is expected. Similarly, no emission of objectionable odour is expected. Therefore, there are no adverse environmental effects expected due to aesthetic changes or odour from stormwater discharges.

38 Operation and maintenance of stormwater systems will be important to ensure their ongoing performance. This is addressed in the Operational Stormwater Management Plan.[13] Operation and maintenance plans are standard features for stormwater systems and are a normal requirement of stormwater consents. They provide prescriptive instructions to maintenance operators about the activities and frequencies that are required to ensure that stormwater systems operate safely and comply with consent performance conditions.

Construction Stormwater Effects – CMA

39 An assessment of the effects of the stormwater aspects of the Project during the construction phase has also been carried out. This includes the BPO selection of solutions, as required by the RMA and ARC PARP:ALW, and an assessment of the cumulative effects of stormwater discharge from the Project on the environment during the construction phase. Section 7 of the Report outlines the design process, the proposed solutions, and the assessment of effects.

40 Stormwater management during the construction phase is a separate and unique stage in the water management of the motorway. It occurs <u>after</u> earthworks activities have been stabilised in an area and erosion and sediment discharge controls are no longer appropriate, but <u>before</u> operational stormwater controls are in place.[14]

41 The proposed BPO solutions are again intended to demonstrate that feasible solutions exist to meet stormwater treatment objectives. Again it is intended that there be flexibility for contractors to provide

[13] Refer Appendix D to my Report.

[14] Management of the earthworks phase of the Project is described in Technical Report G.22 Erosion and Sediment Control Plan, and in Mr Ridley's evidence.

innovative or alternative designs to meet or better the performance criteria specified by resource consents, or account for Project design changes or alternative construction methodologies.

42 The philosophy for stormwater management during the construction phases is as follows:

42.1 Maintain compliance with existing stormwater 'divert and discharge' consents, specifically those requiring stormwater treatment for sections of SH16 and the Great North Road Interchange.

42.2 Provide stormwater quality treatment for impervious areas where there are potential water quality effects such as from construction yards.[15]

42.3 Provide stormwater conveyance and overland flow paths to protect worksites and neighbouring properties from stormwater flooding.

43 The temporary treatment devices are summarised in Table 7.1 of the Report.[16]

44 Stormwater treatment during construction proposes to achieve 75% TSS removal where practicable. The types of impervious surfaces expected during construction and the treatment approaches for Sectors 1 to 5, are as follows:

44.1 Construction yards are to have runoff treated by construction treatment devices.

44.2 Widening for SH16 is to have stormwater treatment once the lanes become live, as provision of stormwater treatment during construction is not practicable. Instead, erosion and sediment control measures are to remain in place throughout the construction phase.

44.3 For Causeway sections of SH16 where the pavements will be constructed in stages, a series of construction treatment devices for the different stages of construction is proposed.

44.4 For the Waterview Interchange ramps, proposed permanent stormwater treatment devices and reticulation will be constructed simultaneously with the works, and will therefore service these areas once they become live to public traffic. No

[15] The construction yards and the expected activities are summarised in Table 7.2 of the Report. Refer page 107.

[16] Refer page 105 of my Report.

separate devices for the construction phase are proposed for these ramps.

45 Stormwater treatment during construction is proposed using stormwater management measures in accordance with TP10. However, as noted above, for areas of motorway widening (Sectors 1-6), there will be low levels of pollution generation, and there are no viable options for stormwater treatment for the construction period. In these areas the BPO has been to retain erosion and sediment discharge control measures during construction. In all areas the permanent stormwater treatment measures will be in place and operational before the road is opened.

46 Energy dissipation and erosion control measures are proposed at all treatment device outfalls for the construction phase. Through the provision of erosion control measures at all outfalls, the potential adverse effects on the surrounding environment from erosion or scour at discharge points during the construction phase of the Project has been avoided.

47 The effects from overland flowpaths, aesthetics and odour are as per the operational stormwater assessment, which is to say there are no adverse effects anticipated.

48 Operation and maintenance of stormwater systems will be important to ensure their ongoing performance. This is addressed in the Temporary Stormwater Management Plan[17].

SUMMARY OF ASSESSMENT OF STORMWATER EFFECTS – OTHER SECTORS

49 In this section of my evidence I will describe the key points of my Report as it relates to stormwater effects in the remaining Sectors of the Project. Primarily this is Sectors 6 and 9, but Sectors 7 and 8 have tunnel drainage to manage, and Sector 7 has construction stormwater from activities associated with construction of the cut and cover section of tunnel. Again I will address operational and construction effects separately.

Summary of Methodology – Other Sectors

50 The approach to the design of stormwater in Sectors 6 and 9 is similar to that applied for Sectors 1-5 in the CMA. The philosophy as outlined in paragraph 22 above, is unchanged for Sectors 6 and 9. However, the hydrological effects from the motorway on the fresh water receiving environments of Meola Creek and Oakley Creek require special consideration.

[17] Refer Appendix D to my Report.

51 Consideration was given to the Oakley Creek Realignment and Rehabilitation Guidelines.[18] Stormwater designs were developed in conjunction with Project ecologists and landscape designers, to maximise the ecological potential and create linkages to the rehabilitated Oakley Creek[19], and to integrate the stormwater design within the urban design framework.

52 For Sectors 6 and 9 both water quality and water quantity treatment are required. The latter consists of extended stormwater detention to protect the streams in Sectors 6 and 9. For Sector 9 flooding of Oakley Creek is a major issue, so stormwater attenuation is proposed to mitigate any potential flooding effects.

53 The hydrological methods for Sectors 6 and 9 are based on the same techniques as applied to Sectors 1-5. The ARC TP108 method was used, with hydrological modelling undertaken using the HEC HMS[20] model for wetlands to design stormwater attenuation. For the design of streamworks and cross drainage, the catchments were assumed to have land use equivalent to maximum probable development anticipated by the district plans. This creates the highest anticipated imperviousness for the catchment and therefore the greatest runoff.

Operational Stormwater Effects – Other Sectors

54 The approach to the design and assessment of the effects for operational stormwater in Sectors 6 and 9 is similar to that for Sectors 1-5 in the CMA. The main difference is the freshwater receiving environments of Meola and Oakley Creeks, and the flood issues in Oakley Creek catchment which are described in the section that follows on the Assessment of Streamworks Effects.

55 The BPO solutions proposed for Sectors 6 and 9 are stormwater wetlands. Devices for Sectors 6 and 9 are required to provide water quality treatment, as well as extended detention and (in Sector 9 only) attenuation. Therefore, the only viable options are wet ponds and wetlands, of which wetlands are preferred as they provide superior water quality treatment and better habitat and amenity values. The permanent treatment devices are summarised in Table 6.1 of the Report.[21]

56 Stormwater quality treatment of runoff from within Sectors 5 and 9 have been designed to 75% TSS removal, which is the standard level of stormwater treatment required by the *PARP:ALW* and targeted by *ARC TP10*. The higher level of stormwater treatment

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[18] Appendix C in Technical Report G.6 Assessment of Freshwater Ecological Effects.

[19] Refer Section 8.3 of the Report.

[20] Hydrological Modelling System (HEC HMS) by US Army Corps of Engineers

[21] Report, pages 50-53.

proposed for Sectors 1-5, which exceeds PARP:ALW and ARC TP10 requirements, is unnecessary because the receiving environments are unlikely to be adversely affected by stormwater discharge from the Project[22]. Also it is difficult to make wetlands bigger for higher treatment efficiencies because of space constraints caused by existing stormwater and sewer services in Sector 6 and competition with open space requirements in Sector 9 (that is, wetlands designed to achieve 80% TSS in Sector 9, would require considerably more space, reducing the available land for open space).

57 Table 1 above, summarises the impervious areas for the existing motorway, additional for the Project and the total for the motorway after the Project. For Sector 6 there is 1.06 ha of additional impervious area which results in a total impervious area of 5.14 ha. Stormwater treatment will be provided for 100% of the additional impervious area. Stormwater treatment is currently not provided for the existing impervious motorway surfaces within Sector 6. The Project will significantly increase the level of treatment by treating 68.7% of the existing impervious surface area. Overall for Sector 6, stormwater treatment will be provided for 75.2% of the total impervious surface area.

58 Sector 9 is new motorway and stormwater treatment will be provided for 100% of the additional 8.49 ha of impervious surfaces. Stormwater treatment will also be provided for the Christ the King site (due to prior arrangement between the NZTA (then Transit) and the Roman Catholic dioceses of Auckland) and for the Maioro Interchange overbridge and on and off ramps.

59 Stormwater quantity treatment is necessary in Sectors 6 and 9 to mitigate hydrological effects from the increase in impervious area. Extended detention is proposed in both Sectors to mitigate any erosion effects of the discharges on Meola and Oakley creeks, respectively. This is done by storing the first 34.5mm of rainfall within the wetland and releasing it over 24 hours. This is in accordance with the recommended approach in ARC TP10.

60 In Sector 9 the peak discharges from the motorway and Christ the King site will be limited to the predevelopment catchment peak flows for the 2, 10 and 100 year ARI design events, in recognition of the flooding issues in Oakley Creek.[23]

61 The proposed permanent stormwater treatment for Sectors 6 and 9 meets the requirements of the regional plans and ARC TP10 guidance document.

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22 Refer to Technical Report G.6 Assessment of Freshwater Ecological Effects.

23 Refer to Section 8 of the Report.

62 Energy dissipation and erosion control measures are proposed at all treatment device outfalls. Through provision for erosion control measures at all outfalls, the potential adverse effects on the surrounding environment from erosion or scour at discharge points have been avoided.

63 Where the Auckland Council primary stormwater system is affected by the Project works, replacement stormwater systems will be built to convey flows up to the 10 year ARI peak flow, which is the required design standard. Where overland flow paths are affected by the Project works, the proposed alternative flow paths to maintain service will convey flows up to the 100 year ARI peak flow. By these measures any potential effects from overland flow on the environment are minimised.

64 An example of the proposed mitigation for affected overland flow paths is in Sector 9 as the SH20 motorway alignment crosses Oakley Creek and then runs parallel to the creek potentially blocking overland flow. The overland flow from the Hendon Avenue area is collected in stormwater swales and piped under the motorway to Oakley Creek.

65 No adverse effects are expected in Sectors 6 and 9 from the aesthetics changes from discharges or odours as per the operational stormwater for Sectors 1-5.

66 Sectors 7 and 8 of the Project are the tunnel sections of SH20, so no stormwater runoff is generated from the motorway carriageway. However, drainage from the tunnel still needs to be managed for the small amount of groundwater infiltration into the tunnel (approximately 16 m^3/day), rainwater carried into the tunnel by vehicles during rainfall events (estimated at 8 l/s), flows generated by tunnel washdown procedures (small flow and volume), and deluge flows activated during emergencies such as fires.

67 The tunnel drainage collection system consists of grated channels, pits that incorporate flame traps, and a conveyance pipe draining to the tunnel low point. The tunnel collection system has been designed to capture up to 232 L/s and 800m^3 in volume. The tunnel drainage systems are described in the Report, but it should be noted that the design is closely linked to the fire, structural, mechanical and electrical design, as well as the construction method, so there may be changes to the details of the design.[24]

68 The tunnel water is collected in a sump located at the low point. The sump will have oil and grit separators to remove these pollutants.

[24] Changes to the detailed design will not result in changes to the effects of stormwater discharge, as the options for disposal already depend on the level of pollutant.

Depending on the level of water contamination, the flows can be discharged to either the northern portal wetland (normal levels of stormwater pollutants in water), or tanker trucks for offsite treatment and disposal (highly contaminated water). Disposal of contaminated water to sewer may be an option subject to approval from Watercare.

69 The operation and maintenance of the tunnel drainage systems is described in the Operational Stormwater Management Plan.[25] This will need to develop in detail with the design and construction of the tunnel to reflect the final system and its requirements.

Construction Stormwater Effects – Other Sectors

70 The approach to the assessment of effects for construction stormwater in Sectors 6, 7 and 9 is similar to that for Sectors 1-5 in the CMA. The philosophy for stormwater management is as set out in paragraph 42 above with the additional requirement to:

70.1 Provide stormwater quantity treatment such as attenuation where there are potential flood or stream erosion effects, (the surface section of SH20 motorway in the Oakley catchment).

71 Extended detention is required in Sectors 6 and 9 to protect the streams from erosion effects and attenuation in Sector 9 for flooding reasons. The other difference is the treatment of water from concrete batching plants at the northern portal (Sector 5) and southern portal (Sector 9), and the management of treated tunnel construction water in Sectors 7 and 9.

72 For the construction phase, wet ponds have been selected as the BPO over wetlands, because it is not cost effective or practicable to install wetlands for the short duration of the construction phase. The exception is where greater investment in temporary wetlands is warranted such as where these are proposed to provide extra 'polishing' treatment for inflows that include treated water from tunnel and batching plant treatment systems. In these cases wetlands are the BPO because their high organic content can reduce elevated pH. The temporary treatment devices are summarised in Table 7.1 of the Report.[26]

73 For Sector 6, temporary treatment devices will be provided in accordance with the criteria set out for Sectors 1-5 at paragraphs 42 and 44 above. The BPO solutions for Sector 6 are similar to those for Sectors 1-5, as the construction activities are similar. In construction yard 5 the permanent stormwater wetland will be utilised as a temporary wet pond for the construction phase. For the widening of SH16 there will be stormwater treatment once the

[25] Appendix D of the Report.

[26] Page 105 of the Report.

lanes become live, with erosion and sediment control measures remaining in place during construction.

74 Sector 9 is a more critical area for stormwater treatment during the construction phase. In Sector 9 it is proposed to provide stormwater treatment for all impervious areas including construction yards and formed motorway. The main concern in this area is that the large impervious area, if not attenuated, would have the potential to have hydrological/flooding effects on receiving environments. Therefore, for Sector 9, in addition to stormwater quality treatment, it is necessary to provide stormwater quantity treatment with extended detention and attenuation.

75 The attenuation devices proposed have been designed to limit post development peak flows to pre-development levels for the 2 year, 10 year and 20 year ARI rainfall events. The 20 year ARI rainfall criterion has been selected because of the shorter design life of these devices (which will be no more than the construction period of approximately 5-7 years), and it is consistent with the design criteria for extreme events used for other temporary devices such as ponds used for sediment control.

76 For other aspects of the assessment of construction stormwater effects, such as energy dissipation and erosion control measures, aesthetics of the discharge and odour, the assessment is the same for Sectors 6, 7 and 9 as that presented previously for Sectors 1-5, in that is that no adverse environmental effects are expected.

77 In terms of management of overland flowpaths, it is proposed that overland flow paths in Sector 9 be maintained during the construction phase by installation of the proposed permanent drainage swales and culverts at the beginning of the construction period. By these measures any potential effects from overland flow on the environment are minimised.

78 The Project will require the installation and use of two concrete batching plants during the construction phase. The concrete batching plants are required to supply concrete to the tunnel for liner construction and will be located at the northern and southern portals, in construction yards 6 and 10, respectively.

79 The runoff and waste water from these concrete batching plants will require extra treatment due to the high sediment loads and elevated pH. The waste water from the concrete batching plant, e.g. the truck washdown, and the runoff from the plant yard will be treated and stored onsite before either being reused or disposed of after treatment. The storage-treatment-reuse tank will consist of a container modified for the removal of sediment and pH correction. Discharge will be through temporary stormwater wetlands CD5B and

CD9C (used for the construction yards 6 and 10, respectively) for further water quality polishing prior to discharge. [27]

80 A continuous turbidity and pH meter will be located at the discharge point from the Concrete Batching Plant treatment system. Discharges from the concrete batching plant will meet a turbidity and pH discharge standard. This level will initially be set at 50 NTU and pH 7.5. Where the turbidity level is exceeded, or pH is greater than 7.5, further treatment will be required via chemical treatment and/or pH management prior to discharge. Alternatively this stormwater will be discharged to the sewer (if separate approvals with Watercare can be agreed). Full details of the concrete batching plant operations are described in the Concrete Batching and Crushing Plant Management Plan[28].

81 During construction, the tunnels will be dewatered to an erosion and sediment discharge control device consisting of modified containers used for treatment of tunnel water.[29] Tunnel water will be then discharged to CD7B and CD9B for water quality polishing.[30] The daily volume is estimated at 300m^3/day at each portal, and has been allowed for by increasing the permanent storage volume of the wetlands by this amount.

SUMMARY OF ASSESSMENT OF STREAMWORKS AND FLOODING EFFECTS

82 In this section of my evidence I will describe the methodology and key conclusions of my Report as it relates to Streamworks and Flooding Effects.

Summary of Methodology – Streamworks and Flooding

83 The approach to streamworks was developed and is expressed in the Oakley Creek Re-alignment and Rehabilitation Guidelines[31] (the Realignment and Rehabilitation Guidelines), which were developed by Project ecologists, landscape architects and engineers and propose a set of integrated principles for ecological function, landscape values and stream hydraulics. The objects of the Guidelines are:

83.1 To inform concepts for potential stream realignments; and

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27 For details of CD5B and CD9C refer to the Report, Appendix A Drawings 20.1.11-3-D-D-350-113 and 20.1.11-3-D-D-350-113-117, respectively.].

28 Appendix F to the Report.

29 For details refer to Technical Report G.22 Erosion and Sediment Control Plan and the evidence of Mr Ridley.

30 For details on CD7B and CD9B refer to the Report, Appendix A Drawings 20.1.11-3-D-D-350-114 and 20.1.11-3-D-D-350-113-117, respectively.

31 Refer Technical Report G.6, Assessment of Freshwater Ecology Effects, Appendix C.

83.2 To guide the rehabilitation of Oakley Creek in the Hendon Park - Alan Wood Reserve area.

84 The Realignment and Rehabilitation Guidelines have directed the design of motorway crossings of Oakley Creek, realignments of Oakley Creek and the Stoddard Road tributary and stream rehabilitation efforts. In particular, the typologies[32] for stream reaches have been applied to the design of the realigned and rehabilitated reaches of the stream

85 The hydraulic design and assessment of the proposed streamworks was undertaken using Danish Hydraulic Institute (DHI) MIKE software. Initial designs and model runs were undertaken by T&T using a MIKE Flood model with TP108 hydrology.

86 Subsequently, the Oakley Creek Catchment Model (the *Catchment Model*) was used to assess the effects of the proposed streamworks. The Catchment Model was developed by AECOM on behalf of Metrowater as part of a comprehensive catchment study of the Oakley Creek catchment[33]. The objectives of that study were to develop hazard maps and develop catchment wide options for flood management. The Catchment Model uses linked MIKE 11, MIKE 21 and Mike Urban modules. The Catchment Model has been independently reviewed, and calibrated and verified using flow and water level records.

87 Modelling was undertaken to compare flows, velocities and water levels in Oakley Creek with the Project in place, to the existing situation[34]. This was done using the 100 year ARI flood flows inclusive of maximum probable development and climate change. This comparison is the basis for assessing the effect of the Project on flood levels and stream hydraulics.

88 Modelling was also undertaken for a pass forward scenario[35]. This is a flood mitigation option being considered by Auckland Council that increases flows in Oakley Creek to alleviate flooding up stream of Richardson Road. These model runs were used to check that the proposed design has capacity to cope with, and is future proofed for, this potential flood mitigation option.

89 In addition, modelling was undertaken for 2500 year ARI floods and for scenarios involving the partial blockage of the three sets of culverts between Bollard Avenue to Western Rail Line culverts (under New North Road) and the Bollard overflow culvert. These

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32 Table 8.2 of the report.

33 AECOM (2010). Oakley Creek Flood Management – Model Build Report. For Metrowater/ACC

34 Refer Appendix C in my Report.

35 Refer Section 8.5.2 in my Report.

model runs were used to determine the level of flood defences for the tunnel portal areas.

Summary of Assessment - Streamworks

90 The proposed Oakley Creek streamworks for the Project involve:

90.1 SH20 Bridge and cycleway bridge across Oakley Creek, including enabling abutments for the rail corridor, and associated channel works;

90.2 Construction of SH20 motorway in areas of Oakley Creek floodplain;

90.3 Realignment of the creek for three discrete lengths in Alan Wood Reserve;[36]

90.4 Rehabilitation of the creek in four reaches, upstream, downstream and between the proposed realignment sections;[37] and

90.5 Realignment of the Stoddard Road tributary, to be undertaken when necessary for future rail development.

91 A number of options for the SH20 crossing and for the realignments of Oakley Creek were assessed with the proposed approach considered to be the best practicable option[38]. A bridge was selected over the alternate of triple box culverts due to its greater hydraulic efficiency, lower risk of blockage, and environmental benefits.

92 The proposed stream realignments were preferred over other options[39] because it was most in keeping with the values established in the Realignment and Rehabilitation Guidelines. The realignments also provided the best integrated solution with the preferred location of the Valonia Wetland (TD9B) [40][41] and the dual use of the Goldstar property (25 Valonia Street) as sports field and its retention for flood storage.

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[36] Stream realignments A, B & C as depicted in Figure 8.1 (page 146) and in Appendix A Drawing 20.1.11-3-D-D-330-211 of my Report.

[37] Stream rehabilitations A, B, C & D as depicted in Figure 8.1 (page 146) and in Appendix A Drawing 20.1.11-3-D-D-330-211 of my Report.

[38] Refer Section 8.2 (page 154) in my Report for detailed considerations.

[39] Refer Section 8.2.1 (page 154) in my Report for details of alternate stream realignment options.

[40] For detail of TD9B refer to my Report, Appendix A Drawings 20.1.11-3-D-D-300-118.

[41] Refer Section 6.10.2 (page 88) in my reports for options considered for TD9B

93 The proposed steam realignments and rehabilitations are based on a naturalised channel. Features of the proposed design include:

93.1 A low or normal flow channel which meanders in plan within the stream banks;

93.2 In-stream heterogeneity via riffle-run-pool, riffle sequences and complexity via rock placement;

93.3 Cross sectional profile that resembles a natural staged channel, including a permanent flow channel, with stream banks based on the two year event;

93.4 Bed material consisting of cobbles. Infilling of naturally occurring silts into deeper pool areas is expected;

93.5 Floodplains and berms to hold the 100 year ARI flood flow;

93.6 Planting of stream banks and floodplain to provide stream shading to reduce in-stream macrophytes, improve stream hydraulics, enhance aquatic habitat and contribute to slope stabilisation; and

93.7 Visual and physical public access to the stream.

94 The length of existing stream affected by the works (included rehabilitation) is 1450m. [42] The final stream length is 1318m a shortening of 132m.[43] The length realigned due to the Project is 870m. The ecological effects of constructing the streamworks and the offset mitigation for the loss of stream length are considered in the evidence of Mr Sides.

95 The proposed stream realignments and rehabilitations will have a positive effect on the environment as the naturalistic channel form will replace the existing manmade basalt rock wall channel. The Project streamworks will have net ecological, environmental and recreational benefits by providing greater access to the stream, better ecological habitats, and more vegetation than currently exists in these reaches.[44] No adverse effects are anticipated to the stream bed morphology, flow hydraulics or sediment.

Summary of Assessment - Flooding

96 The proposed changes to Oakley Creek floodplain due to the Project involve:

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[42] Refer to Figure 8.1 (page 147) of my Report.

[43] Note Mr Sides in his evidence states the loss in stream length is 137m, which is based on an independent measure. The longer length of 137m has been used by Mr Sides for the calculation of the required offset mitigation.

[44] Refer to Technical Report No. G.6.

96.1 Streamworks as described above;

96.2 Location of the SH20 motorway in the 100 year floodplain;

96.3 Retention of floodplain storage over future sports fields in Goldstar property (at 25 Valonia Street); and

96.4 Placing of engineered fill associated with the southbound cut and cover tunnel structure at Ch 3880m in the floodplain of Oakley Creek (Sector 7).

97 The flooding effects of the proposed motorway and streamworks have been assessed using the Catchment Model. The increase in impervious surface due to the motorway is mitigated by the provision of stormwater treatment wetlands TD9A and TD9B that attenuate flows for events up to the 100 year ARI rainfall, refer to details given previously in paragraph 60. The proposed streamworks have more flow capacity than the existing channel, which results in a lower maximum water level in the Project area and a reduced extent of flooding.

98 However, the Project reduces local flood storage as part of the SH20 motorway is within the existing floodplain, and also as a consequence of the otherwise beneficial effect of lower flood water levels[45]. As a result the peak flow downstream of the Project increases by 3.3% for the 100 year ARI event. These changes result in an increase in water levels upstream of the Bollard Avenue culverts of 150mm for a 100 year ARI flood event, which I discuss further below. Downstream of this location, no effects are evident from the modelling.

99 The Project slightly reduces flood extents upstream of the SH20 Oakley Bridge, and more significantly reduces flood extents through the streamworks reach of the Project area.[46] In general, more of the peak flow is contained within the channel, and less overflows to surrounding reserve land and properties than at present, resulting in an overall positive environmental effect of the Project on flood extents.

100 Six habitable floors have been identified as currently at risk of flooding in the Project area and downstream (to the New North Road culverts at Bollard Avenue) by AECOM[47]. The Project reduces the flood risk for two houses, and leaves it unchanged for four other

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[45] A lower flood water level in a given cross section means that there is less water stored in that cross section.

[46] Refer to Figure 8.6 (page 169) and Figure 8.7 (page 170) of my Report.

[47] AECOM (2010). Flood Hazard Mapping Report – Oakley (OAK). 1 October 2010. For Metrowater/ACC.

houses.[48] No additional habitable floor levels are put at risk due to the Project. The reduction in flood extent has benefits to properties along Valonia Street, Whittle Place, Methuen Road (a large improvement) and Hendon Avenue.

101 There are minor adverse effects in terms of small increases in water levels during extreme events to properties upstream of the Bollard Avenue culverts[4950]. The only building identified as being adversely affected is the basement garage of 12A Bollard Avenue. The flooding depth in the garage for the with motorway case is 1.32m, compared to the existing case of 1.19m, for the 100 year ARI event[51]. The effect of the Project is an increase in flooding depth of 130mm, within a garage that is already predicted to flood severely. Flooding of the basement garage at 12A Bollard Avenue is understood to have occurred in the past.[52] Considering that flooding of this basement garage already occurs (and under the 100 year ARI event is predicted to already occur to a substantial depth), the increase in predicted flood depth in a 100yr ARI event is considered to be a minor effect. NZTA will offer to relocate any affected electrical fittings in the garage to above the flood level as mitigation for change of flood levels predicted due the Project. In the post lodgement period we have developed designs to reduce the flood water level at this location[53], but these need to be developed with Auckland Council and as part of their catchment planning process.

102 Flood protection standards are proposed for the motorway. Flood protection for the portals will be provided for the 100 and 2500 year ARI flood events. Flood protection for the portals will also allow for scenarios where the downstream Bollard Avenue culverts become blocked and the flood water level increase before overflowing the western railway line. The final flood protection levels will be confirmed with Auckland Council, as they are developing flood management options for the Oakley Catchment.

POST LODGEMENT EVENTS

103 In the post lodgement period a number of design changes and assessments have been initiated to refine the design and to further

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48 Refer to page 167 in my Report for details of these properties. Improvements are for 33 Valonia Street and 33 Whittle Place, whereas unchanged are 1254 New North Road, 1260 New North Road, 1248-1250 New North Road and 21A Bollard Avenue.

49 Refer to Figure 8.5 (page 165) of my Report.

50 Properties identified include 12a Bollard, 12 Bollard, 14A Bollard, 20 Bollard, 22A Bollard, 22B Bollard, 32A Bollard, 32 Bollard, 44 Bollard and 46 Bollard.

51 Note that the hydrological events I use in the assessment allow for climate change and maximum probably development in the catchment.

52 pers. comms Metrowater.

53 Refer to paragraph 113 and **Annexure E**.

mitigate environmental effects (including responses to issues raised by submitters). These design changes are:

103.1 Addition of stormwater treatment for the causeway bridges (Sector 4).

103.2 Addition of stormwater treatment for SH16 eastbound off ramp at Great North Road interchange (Sector 5).

103.3 Clarification of stormwater treatment and attenuation for the ventilation buildings at the northern (Sector 5) and southern portals (Sector 7).

103.4 Updates to the contaminant load model by NIWA to reflect changes in location and size of treatment device catchment areas and the 80% TSS removal in Sectors 1-5.

103.5 Improvements proposed to the Bollard overflow culvert, beneath New North Road (Sector 9), to increase the inlet capacity to mitigate the effect of increased water levels upstream.

Stormwater treatment for the Causeway Bridges

104 In the Report stormwater treatment was not included for the Causeway Bridges because of perceived technical difficulties with draining the water off the bridge and the low hydraulic head difference between the pavement and the MHWS level. This was reviewed in the post lodgement period because it was the only area of additional motorway impervious service not receiving treatment. It was also a concern raised by some submitters.[54]

105 The Project now proposes to provide stormwater treatment for both the existing and additional impervious areas of the Causeway bridges. Each bridge (west and east bound) will have stormwater reticulation system on the outside of the bridges that will consist of bridge type catchpits and piped reticulation. The reticulation for each bridge will drain to the east abutment of the bridge. Stormwater treatment will be provided at the east abutments by cartridge filters designed to remove 80% of TSS in accordance with the proposed level of treatment for Sector 5. The updated design is included in my set of revised drawings which is attached as **Annexure A** to my evidence.[55] The extra treatment area is included in the Table 1 summary.

[54] Including the ARC – Submitter No. 207.

[55] Refer to Drawing 20.1.11-3-D-D-300-108 Rev C in Annexure A

Drainage for Existing SH16 Eastbound Off Ramp at Great North Road Interchange

106 The Cook Family Trust[56] and Peter and Karen Cook[57] were concerned about the "*inadequate present drainage system under SH16 eastbound off ramp into the harbour"* and that "*the existing motorway stormwater drainage is upgraded to the standard of new discharges and that any repaired wetland is subject to a permanent maintenance and monitoring programme*". I have reviewed the stormwater system for the SH16 eastbound offramp in light of this submission and now propose that the stormwater from this offramp be reticulated and treated. Also drainage improvements to the area between SH16 and the SH16 eastbound offramp and onramp are proposed.

107 The SH16 eastbound offramp is not modified by the Project and so its stormwater discharge is not an effect of the Project. However, it can be connected to the stormwater system and NZTA has decided to provide treatment for that area as environmental betterment for the Project. Runoff from the offramp will be collected with kerb and channel into catchpits, and piped to the cartridge filter TD5C, which will be enlarged to provide stormwater treatment for the additional area. The design changes are noted on the drawings[58] in Annexure A. The extra treatment area is included in the Table 1 summary.

108 The area north of SH16 and between SH16 eastbound offramps and onramps will be modified to include an earth embankment as part of Ramp 3[59]. As a result the drainage in this area will be improved. Swales will be used to manage the surface water. The existing culverts under SH16 eastbound offramps are a 700/750mm diameter and a 750mm diameter and these will be maintained.

Stormwater Treatment for Ventilation Buildings

109 The Project will provide stormwater systems to mitigate the potentially adverse effects from stormwater from ventilation buildings. Revised design options for the ventilation buildings are detailed in the evidence of Mr David Gibb. The ventilation buildings will not use uncoated zinc or copper in the roof or guttering/downpipe systems to prevent the discharge of zinc and copper that are associated with these material types. The proposed stormwater systems are noted on the drawings[60] in Annexure A.

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56 Submitter No. 094.

57 Submitter No. 095.

58 Refer to Drawing 20.1.11-3-D-D-300-109 Rev C in Annexure A.

59 Refer to Drawing 20.1.11-3-D-D-300-109 Rev C in Annexure A.

60 Refer to Drawing 20.1.11-3-D-D-300-113 & 117 Rev C in Annexure A. Note these building shapes do not reflect the latest design concepts by Mr David Gibbs, but are included to note the concept for the stormwater treatment.

110 For the northern portal ventilation building, stormwater treatment will be provided for the carparks and access roads. The stormwater treatment will be preferably by low impact design systems such as raingardens or by cartridge filters. The treatment devices will be designed to remove 75% TSS on a long term average basis. The stormwater from the carparks, access roads and building roof will be discharged into the stormwater system in Great North Road.

111 For the southern portal ventilation building, stormwater treatment will be provided for the carparks and access roads. The stormwater treatment will preferably be by low impact design systems such as raingardens or by cartridge filters. A green roof is being considered for the southern portal ventilation building that would provide water quality benefits. Attenuation will be provided for impervious areas by underground storage tanks such as aquacells, to retain the above ground usage of the area. The treatment devices will be designed to the standards proposed for Sector 9, to remove 75 % TSS on a long term average basis, with attenuation of 2, 10 and 100 year ARI flows. The discharge will be to the Hendon Avenue swale outlet pipe.

Updates to the Contaminate Load Model

112 NIWA have updated the contaminant load modelling for the design presented in the Report[61] to include changes in the location and size of treatment device catchment areas and 80 % removal of TSS in Sectors 1- 5. These updates were necessary because the Report was completed close to the lodgement date and after G30[62]. The contaminant load modelling is reported in the evidence of Dr Jonathon Moores. For the Project area as whole, TSS is estimated to be around 20 % lower than the original estimates while loads of zinc and copper are little changed (between 1 % lower and 3% higher than the original estimates). The additional treatment to be provided for the Causeway Bridges and ventilation building carparks/access roads will not affect these results to any significant degree.

Mitigation for Increases in Flood Water Levels Upstream of Bollard culverts

113 As I noted earlier in my evidence, the only adverse hydrological effect from the Project is the predicted increase by 150 mm to the 100 year ARI flood peak level for areas upstream of the Bollard culverts. The Bollard culverts consists of twin box culverts (Bollard Avenue Culverts) that carry the normal stream flow under Bollard Avenue and the separate Bollard overflow culvert that diverts flood flows under New North road to the lower Oakley Creek downstream

[61] Refer to Table 6.1 and Appendix A in my Report.

[62] Technical Report G.30. Assessment of Associated Sediment and Contaminant Loads.

of the western rail line.[63] Options to reduce/eliminate the increase in 100 year ARI flood peak level were lead by myself with analysis by AECOM[64] using the Catchment Model and hydraulic analysis including:

113.1 An increase in floodplain storage for the area upstream of the Bollard culverts.

113.2 An increase in the capacity of the Bollard Avenue overflow culvert by reduction of pipe friction.

113.3 An increase in the inlet capacity of the Bollard Avenue overflow culvert by provision of a secondary inlet for that culvert.

114 A number of options that increased the flood storage by widening and lowering the floodplain in the area upstream of the Bollard culverts were investigated. These were considered because an increase in flood storage volume upstream of the Bollard culverts will help to reduce the flood peak flows and corresponding water level. The largest reduction in water level of 30mm that was predicted by the modelling required increasing the floodplain width by 20m for a length of approximately 300m upstream of the culverts. I considered this would be too great an effect on Alan Wood Reserve for a relatively modest improvement in flood level. Therefore options to increase flood storage were not considered further.

115 An option to increase the capacity of the Bollard overflow culvert by a reduction in pipe friction was investigated. This option would involve lining the interior of the culvert to increase the pipe flow capacity. The modelling of this option did not reduce water levels upstream of the culvert, which confirmed that the capacity of the Bollard overflow is constrained by the flow through the culvert inlet rather than the culvert pipe itself.

116 The last option considered was to increase the inlet capacity of the Bollard overflow culvert with a secondary inlet to allow extra flow into the culvert at high water levels as shown in the drawing.[65] This option involves the construction of a 2.55m diameter secondary inlet over the 2.55m diameter Bollard overflow culvert near the main inlet.

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[63] For details of Bollard culverts refer to Table 5.3 (page 45), Figure 5.10 (page 46) and Drawing 20.1.11-3-D-D-300-116 (Appendix A) of my Report

[64] Refer to Annexure E for AECOM letter report, 11 November 2010, Options Investigated to Reduce Water Level at Bollard Road

[65] Refer to Drawing 20.1.11-3-D-D-310-220 in Annexure A.

117 A hydraulic relationship was developed for discharge (Q) versus water depth (h) relationship for the Bollard overflow culvert that allowed for the extra capacity through the secondary inlet[66]. For the 100 year ARI flow of 50.7m^3/s[67] at the culverts, the flow splits with approximately 26.1m^3/s flows through Bollard Avenue (twin box) culverts with 23.2m^3/s through the Bollard overflow culvert. For this flow, the water depth at the existing Bollard overflow culvert is 3.7m. With the secondary inlet the water depth reduces to 3.35, a decrease of 0.35. This demonstrates that the previously stated increase in water depth of 150 mm upstream of the Bollard Culverts can easily be eliminated by the addition of a secondary inlet to the Bollard overflow culvert. The secondary inlet also increases the resilience of the Bollard culverts to blockage, due to the extra inlet that is protected by a screen, so there is reduced risk of blockage and backwater for all flood events.

118 Detailed design is required to confirm the size and level of the secondary inlet, but that design is dependent on the identification by Auckland Council of a preferred catchment management option. The effect on the lower Oakley Creek of passing more flow will need to be considered. The Council is currently reviewing catchment management option for Oakley Creek and if a pass forward type options is implemented it may require adding more capacity to the Bollard overflow culvert. Options they are likely to consider are the secondary inlet proposed here or a duplicate overflow culvert. Given the pending decision by Auckland Council on the preferred catchment management, and because these assets are owned by Auckland Council, the NZTA are not able to formally propose this solution at this time[68].

119 In conclusion on this issue, the increase in 100 year ARI flood peak level upstream of the Bollard culverts predicted as an adverse effect of the Project, can be mitigated by provision of secondary inlet to the Bollard overflow culvert. The options for a secondary inlet for the Bollard overflow culvert need to be developed with Auckland Council as part of their catchment planning process.

COMMENTS ON SUBMISSIONS

120 I have read submissions lodged on the Project that raise stormwater or streamworks issues relevant to my area of expertise. There were more than 80 submissions on stormwater, streamworks and flooding issues. In this section of my evidence I will address these submissions.

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66 Refer to Annexure E for AECOM letter report, 11 November 2010, Options Investigated to Reduce Water Level at Bollard Road

67 Refer to page 173 of my Report.

68 In any event NZTA can, as noted above, mitigate the effects on 12A Bollard Avenue by relocation of any affected electrical fittings to above the flood level.

Stormwater Management

121 Numerous submissions raised general concerns about lack of stormwater management during construction and operation. There were also a number of comments on the increase in impervious surfaces. Stormwater management is comprehensively covered in my Report and in this brief of evidence. The main points are that that stormwater treatment has been provided in excess of the requirement of the PARP:ALW and ARC TP10 guidelines by the 80% TSS removal rate for stormwater treatment in Sectors 1-5 and by the inclusion of most of the existing (presently untreated) SH16 motorway surfaces. For Sectors 6 to 9, stormwater treatment will comply with PARP:ALW and ARC TP10 with a 75% TSS removal rate.

122 In regard to the stormwater measures the ARC[69] states that the improvements proposed for the Project are *"strongly supported in principle"*. With regard to stormwater treatment in areas with potential to affect the Motu Manawa Marin Reserve the ARC[70] states that the causeway stormwater treatment is welcomed and "*will result in a significant improvement in stormwater treatment along the causeway.*" Similarly, Auckland City Council (*ACC*)[71] states that "*The technical solutions proposed to treat the increased runoff have been successfully implemented in many similar projects and are therefore likely to work as design for this project*". Waitakere City Council (WCC)[72] strongly supports the proposed improvements in the treatment of stormwater runoff from the SH16 corridor. They support the higher treatment level of 80% removal of TSS, compared to the 75% TSS removal required by TP10.

123 In response to submitters[73] who want 95% treatment of stormwater prior to discharge, I note the PARP:ALW and ARC TP10 guidelines require a 75% removal of TSS. The 75% removal of TSS on a long term average basis is the marginal point of return for sediment removal versus device size. [74] Aiming for a higher degree of removal would require an undue increase in treatment device size and therefore cost. An increase in treatment device size would leave less space available for other Project mitigation including open space replacement. The NZTA intends nonetheless to exceed the ARC TP10 requirement, by targeting 80% removal of TSS in Sectors 1-5. This extra treatment in Sectors 1-5, is part of a package of

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69 Submitter No. 207 Clause 4.7.2

70 Submitter No. 207 at section 4.7.3

71 Submitter No. 111 at paragraph 293.

72 Submitter No. 212 at section 3.2.2.

73 Submitters Nos. 179, 206, 229.

74 ARC Technical Publication No. 4, Selection of Stormwater Treatment Volumes for Auckland (1992)

offset mitigation to compensate for effects of the coastal reclamation.

Water quality effects on Oakley Creek and Motu Manawa Marine Reserve

124 Numerous submissions raised general concerns about the effects of the Project on water quality and receiving environments including Oakley Creek and Motu Manawa Marine Reserve. In response to these submissions, I would reiterate the high level of stormwater treatment that is proposed either complies with or exceeds PARP:ALW and ARC TP10 for new impervious surfaces and significantly improves treatment for existing impervious surfaces.

125 Dr Moores in his evidence says that the estimated annual loads delivered to the Oakley Inlet and Waterview Estuary during the operational phase of the Project are lower than the estimated existing baseline annual loads (2 % less for sediment, 8 % less for zinc and 10 % less for copper in 2016) due to the extra treatment being provided for SH16.

126 The ecological effects of the residual stormwater contaminants after treatment on Oakley Creek and Motu Manawa Marine Reserve are detailed in the evidence of Mr Sides and Dr De Luca, respectively.

Contaminants from Construction Affecting the Local Population

127 A number of submitters[75] were concerned about contaminants/discharges to water during construction affecting the local population. Stormwater from construction areas will be treated as described in my Report[76] and earlier in my evidence. Dr Black in his evidence will comment on the human health aspects of this issue.

Wetlands

128 Adrienne and Richard Stanton[77] and Wendy John[78] want the stormwater treatment wetlands to be accessible to the public. It is the intention the wetland be accessible to the public. They will be integrated into the open space design with pathways and cycleways providing viewing access.[79] However, design features such as wetland emergent plants, littoral zone edge planting and riparian bank planting will be used to discourage physical access to the water[80]. The wetlands will have a 3m wide, shallow, submerged

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75 Submitters Nos. 017, 091, 132, 133, 231 and 232.

76 Refer to Section 7 of my Report.

77 Submitter No. 206.

78 Submitter No. 229.

79 Refer to the evidence of Mr Little.

80 Refer to Figure 6.1 of my Report.

bench[81] for safety purposes and to support wetland emergent plants. This is a safety feature recommended by ARC TP10 guidelines. The stormwater wetlands have been designed to link with the rehabilitated Oakley Creek to provide enhanced aquatic and terrestrial habitats. Ecosourced plants will be used for the wetland planting.

129 Auckland Conservation Board[82] has concerns about the longterm care of wetlands and the accumulation of toxic chemicals and the leaching of these to the environment. In response, the wetlands will accumulate sediment and associate contaminants such as heavy metals and hydrocarbons, as this is their purpose. The contaminated sediment will be removed from the wetland when the forebay is full to 50% of the design volume. The sediment will be disposed off site to a landfill suitable and certified for contaminated materials.[83] The wetlands will be designed to contain water to maintain a permanent pool of water to ensure a healthy wetland. To do this they will be constructed in low permeability materials or have a low permeability clay liner. Therefore, leaching of toxic chemicals to the environment is not expected.

Discharges from Whau River Bridge

130 Mr David Norman Brown[84] raised the issue of "*stormwater outfalls that may run down on boats using the channel under the bridge*". Runoff on the Whau River Bridge will be collected by a stormwater system and reticulated to the eastern abutment where it will be treated. The stormwater conveyance system will be design for the 10 year ARI rainfall event. For more extreme events there may be some overflow and discharge of stormwater from the bridge. Therefore, only in very extreme events will stormwater be discharged directly off the bridge, so there is not considered to be an adverse effect on boat users.

Use of Goldstar (25 Valonia Street)

131 There were multiple submissions on use of the Goldstar property (25 Valonia Street) for stormwater treatment, stream realignment, sports fields and flood storage. These are summarised below:

131.1 The North Western Community Association and Rory and Heather Docherty[85] believe that the Goldstar area should be allowed to revert back to natural wetlands and not be used

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81 For details of wetland planting and safety bench refer to Report, Appendix A Drawings 20.1.11-3-D-D-340-201.

82 Submitter No. 209 at paragraph 3.

83 For details refer to Appendix D Operation Stormwater Management Plan and Appendix E Temporary Stormwater Management Plan in my Report.

84 Submitter No. 004.

85 Submitter Nos. 185 and 209.

for sports fields. Adrienne and Richard Stanton[86] and Wendy John[87] also want natural wetlands to be restored.

131.2 The Friends of Oakley Creek[88] want the sports field to be relocated to allow Valonia Street to act as floodplain and natural groundwater sink, with the two separate Sector 9 stormwater ponds amalgamated there.

131.3 Duncan and Joan McKenzie and Marian Riley[89] believe the Valonia Street area will need substantial development before being used for recreation activities and that it is more suited to stormwater treatment than active recreation.

132 In response to these issues, I note the Project requires this land for many reasons – stormwater treatment, sports fields for open space/recreation replacement, flood storage and Oakley Creek rehabilitation.

133 The location proposed for the Valonia Wetland TD9B is considered to be the BPO location[90] because it is closest to the low side of the motorway (which is super elevated on this bend), it is mostly outside the 100 year flood plain (which is an ARC preference)[91] and avoids conflicts with the existing major sewer that affects other locations.

134 The Goldstar property is currently in the floodplain[92] (except for the area proposed for TD9B) and this flood storage helps to mitigate downstream flooding. The Goldstar property has consent for residential development including the raising of ground levels to be above flood level, which would eliminate the flood storage[93] and the present appearance of open space. The retention of this land for flood storage is necessary to partially mitigate for loss of flood storage due to the Project, which occupies 9,331 m^3 of the current floodplain for the 100 year ARI flood event. The flood storage retained in the sports field equals approximately 8,000 m^3.[94]

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86 Submitter No. 206.

87 Submitter No. 229.

88 Submitter No. 179 in Section 5Topic No. 6(f) & 6(h).

89 Submitter Nos. 204 and 221.

90 Refer to Section 6.10.2 (page 88) for details of the BPO assessment.

91 Submission No. 207, Section 4.7.13.

92 Refer to Figure 8.6a (page 169) in my Report.

93 Refer to **Annexure B** for Drawing 1A, Site Plan, 25 Valonia Street, Gold Star Insurance

94 The Project also reduces the flood storage by lowering the flood water levels. Refer to page 171 of my Report.

135 The requirement for sports fields as offset mitigation for active recreation lost elsewhere is covered in the evidence of Mr Little, who considers this dual usage of this land for sports field and flood detention to be the best usage for this land.

136 If it wasn't for the Project requirement for this land it is likely that the land would be developed as residential given the property owner holds consents for such development. The Projects use of this land will also enable Oakley Creek to be mostly retained in its current location and rehabilitated, compared to the less satisfactory shortened stream realignment[95] along the northern boundary of the Goldstar site that is consented as part on the proposed residential development.

Alan Wood Wetland (TD9A)

137 Duncan and Joan McKenzie[96] are concerned about the use of this area of Allan Wood Reserve for stormwater treatment as they consider it is useful open space.[97]

138 A second stormwater treatment wetland is required to collect the runoff from the motorway west of TD9B (the Valonia Wetland), as these areas will not drain back to TD9B. The section of motorway between chainage 1110 m and 1333 m is above ground level and the only suitable location for it to drain to is the location proposed for TD9A. The southern portal from chainage 1333m to ~1900m is below ground and is pumped back to TD9A.

Effects from Construction Yard 7 on Oakley Creek

139 Marianne Riley[98] expressed concern that stormwater from construction yard 7 will have severe adverse effects on Oakley Creek. In response, I note that the stormwater system for construction yard 7 has been designed so that most of the stormwater will be contained onsite and will be treated in CD7B[99]. A small area in the northern corner of construction yard cannot be drained to CD7B. For this area the super silt fence[100] proposed for the earthworks phase will remain in place and only activities with low risk to stormwater quality such as storage will be undertaken. These measures will minimise the potential for any adverse effects from stormwater from construction yard 7 on Oakley Creek. The

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95 Refer to Annexure B for Drawing 1A, Site Plan, 25 Valonia Street, Gold Star Insurance

96 Submitter No. 204.

97 As noted above the Friends of Oakley Creek also want wetland TD9A removed and amalgamated with the Valonia Street wetland.

98 Submitter No. 221.

99 For details of construction yard 7 and CD7B refer to Report, Appendix A Drawings 20.1.11-3-D-D-350-113 & 114.

100 For details of super silt fence refer to erosion and sediment plans in G22, Appendix F, Drawing 20.1.11-3-D-EN-740-113.

drawings showing the construction phase stormwater measure have been amended to show this more clearly[101].

Disposal of waste products from concrete batching plants

140 William Wood[102] and the Friends of Oakley Creek[103] raise concerns about the disposal of waste products from concrete batching plants. This issue is comprehensively covered in my Report[104] and appropriate controls, treatment and monitoring are proposed. With these controls in place the effect of concrete batching plants on the water environment will be negligible.

Friends of Oakley Creek

141 Friends of Oakley Creek[105] raised a number of specific additional concerns that have not been covered already. Those concerns and my responses are given below:

141.1 The submitter is concerned about the proximity of works to Oakley Creek, the diversion of Oakley Creek, the location of the depot and the negative impacts of construction with the floodplain of Oakley Creek.[106] In response, the management of construction associated with Oakley Creek and in close proximity to Oakley Creek has been carefully considered and is detailed in my Report, in the Erosion and Sediment Control Plan[107] and the evidence of Mr Ridley. If these measures and the Construction Environmental Management Plan are implemented the risks to Oakley Creek from construction can be minimised.

141.2 The submitter is concerned about the realignment and loss of 137m of Oakley Creek.[108] The realignments and loss of length of Oakley Creek was minimised to the least extent possible during design. The remaining loss of length is unfortunately unavoidable. The proposed realignments and rehabilitation of connecting sections of stream will however have net ecological, environmental and recreational benefits by providing greater access to the stream, better ecological habitats, and more vegetation than currently exists in these reaches. It is noted that ACC[109] supports the proposed

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101 Refer to Drawing 20.1.11-3-D-D-350-113 & 114 Rev C in Annexure A.

102 Submitter No. 16.

103 Submitter No. 179 Topic No. 3 point (g).

104 Refer to Section 7.13 (page 113) and Appendix F - Concrete Batching and Crushing Plant Management Plan of my Report.

105 Submitter No. 179.

106 Submitter No. 179 Section 3 Topics 4(e) and 6(b) and Section 4 Topic 4(e).

107 Technical Report G.22.

108 Submitter No. 179, Section 4 Topic 6(b).

109 Refer to ACC Submission (Submitter No. 111) Clause 295.

streamworks for the benefits that they will provided. The ecological effects and environmental compensation for the Streamworks are covered in the evidence of Mr Sides.

141.3 The submitter is concerned about the location and engineered type design of stormwater treatment facilities.[110] In response, a BPO approach has been followed to develop the best treatment options for each location in accordance with the requirements of PARP:ALW and ARC TP10 guidelines. Stormwater treatment devices have been designed to enhance the local environment where possible. For example the stormwater treatment wetlands will have a natural form to fit into the environment and will use native vegetation.[111] Elsewhere, biofilters and swales will use native vegetation where this is suitable.

141.4 The submitter requests[112] that contaminants and by-products be disposed of through a means other than discharge to the CMA and/or stormwater system. The receiving environments of stormwater cannot be changed so discharges must be to the CMA and stormwater systems. However, as described previously all new motorway and most existing motorway will have treatment of stormwater prior to discharge. The contaminants collected in the treatment devices will be removed and disposed off site to a landfill suitable and certified for contaminated materials

141.5 The submitter requests[113] that passive recreation paths be permeable surfaces where appropriate and that new impermeable surfaces, including those associated with mitigation have stormwater run-off treatment sympathetic to Oakley Creek i.e. rain gardens. Also, that all associated mitigation, such as recreation facilities have "natural" stormwater treatment such as rain gardens, wetlands and swales. In response, recreation paths and cycleways do not need stormwater treatment as there is little pollutant load generated from these sources. I agree that recreational facilities such as carparks may be suitable for low impact design approaches such as raingardens, and the Project should try and use these approaches where they are appropriate. A BPO approach should be used to determine the appropriate treatment devices, with a preference for low impact design solutions for these areas. The requirement for treatment of adjunct impervious surfaces, such as access

[110] Submitter No. 179, Section 5 Topic 6(n) page 6.

[111] Refer to paragraph 130 above.

[112] Submitter No. 179, Section 4 Topic 7(e) page 7.

[113] Submitter No. 179, Section 5 Topic 6(g) page 7

roads and carparks for recreation facilities and ventilation buildings should be a condition of consent.[114]

141.6 The submitter requests all stormwater treatment facilities be redesigned to achieve a more "*naturalistic*" outcome and include features such as boardwalks, viewing platforms and interpretation signs, to enable the stormwater features to become part of the wider "*open space and green corridor*". The ACC (Submitter No. 111) also requests that stormwater treatment devices have a naturalistic form sympathetic to their surrounding environment. In response, it is the Project desire that stormwater treatment facilities, especially the wetlands in open space area, be designed in conjunction with landscape designers to achieve a naturalistic and integrated outcome.

Potential Flooding Downstream of the Project

142 Numerous submissions raise general concerns about the potential for flooding downstream of the Project and that this has not adequately been assessed. Allan Woolf[115] was concerned with the increase in flooding of the Oakley Creek in Alan Wood park.

143 In response, I believe the flooding effects were comprehensively covered in my Report[116] and has been supported by this brief of evidence. The hydrological effects of the Project on flooding are mitigated by attenuation of stormwater from motorway areas to the predevelopment peak flows for events up to the 100 year ARI flood event. The effects of the Project on the Oakley Creek floodplain have been mitigated by channel design and the provision of floodplain storage in the Goldstar property in conjunction with sports fields. The only adverse effect from flooding is the increase in flood water levels upstream of the Bollard Avenue culverts, which has been discussed previously in this evidence.

144 The approach to flooding has been to work cooperatively with Auckland City Council through Metrowater because flooding in the catchment is an issue for both ACC and the NZTA. The effects of the Project and the proposed mitigation measures have been independently assessed using the Metrowater/AECOM Catchment Model that was developed for the purpose of flood hazard mapping and flood management.

145 The ARC[117] have said that "*The information supplied in respect of motorway flood protection measures in Alan Wood Reserve*

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[114] Refer to consent condition SW.11 in Annexure C.

[115] Submitter No. 234

[116] Refer to Section 8.4 (page 162) and Section 8.5 (page 175) in my Report.

[117] ARC s149G Key Issues Report

adequately covers a range of possible design scenarios to enable potential effects to be assessed". Also that " *Additional information will be ultimately required in this respect once the Oakley Creek flood management plans are finalised by ACC/Metrowater, in order to confirm the design assumptions made.*" This echoes the recommendations of my Report[118] that flood protection levels are dependent on flood management options in the Oakley Catchment to be implemented by Auckland Council. Despite the need to refine the final levels for flood defences to take into account flood management options to be selected by Auckland Council, the assessment of effects will remain unchanged as this is based on a comparative assessment of the existing situation compared to the with the Project.

Fencing of the Proposed Floodplain

146 David Hamp[119] raises a concern about the proposed floodplain and the possible drowning hazard. He wants the flood storage area to be fenced off and suitable planting provided. In response, the area will only flood in extreme events, of the order 10 year ARI flood, and the water will rise slowly over this area and have low velocity because of its large footprint. The flood depth for the 100 year ARI flood are estimated to be 0.3m and 0.6m for the upstream and downstream sportsfields, respectively. Fencing of the floodplain will impede public access to these areas that are intended for recreation. Other public spaces in the catchment are already used for flood storage such as Keith Hay Park. Oakley Creek runs through parks for most of its catchment and is generally not fenced. In the Project area the proposed naturalised channel cross-section will be wider and contain more of the flow than the existing channels. The proposed channel cross-section also has flatter side slopes and riparian planting that will reduce the flood hazard to persons, compared to the existing channel. For these reasons fencing of floodplain areas is not considered to be necessary.

Waitakere City Council

147 WCC[120] recommend the use of natural vegetation instead of mown grass on stormwater swales. I agree that native vegetation is preferred, as the biofilters rely on infiltration and compaction of those biofilters by mowers will be detrimental to the performance of the biofilters.

148 Wetland swales will be use in areas where there is low gradient and high groundwater levels, and these are accepted by ARC TP10. In steeper areas, native grasses will be considered at the detained design stage and used if they can meet the treatment criteria.

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[118] Refer to pages 5 and 176 of my Report.

[119] Submitter No. 25

[120] Submitter No. 212.

149 They note the potential or the Jack Colvin Wetland (TD1A)[121] to be enlarged to provide stormwater treatment for Te Atatu Road and local catchments. It may be possible to extend the pond westward. However the viability and effects of this would need to be properly assessed. This change is not included at this time, as it is not necessary to address the effects of the Project, however it could be developed between Auckland Council and NZTA at the detailed design stage if mutually agreeable, and subject to the Council obtaining appropriate consents.

Stella Maris Trust

150 The Stella Maris Trust[122] raised a number of specific issues related to the property at 7 Bollard Avenue.

151 The submitter is concerned that the increase in water level from stormwater runoff from the motorway poses a serious risk of flooding to their land, to the performance of their septic tank and increases the risk of erosion to their land. These concerns come from the observed increase in the number of storm water channels that are piped directly into Oakley Creek, and the shortening of the length of Oakley Creek which the submitter considers will increase water level.

152 In response, the stormwater runoff from the Project is attenuated for flows for events up to the 100 year ARI rainfall.[123] , An increase in water levels upstream of Bollard Avenue occurs due to changes to the flood plain. The submitter's property at 7 Bollard Avenue is downstream of the Bollard culverts. The changes in water level and peak flow at this location from the Catchment Model are summarised in Table 2. The changes in peak flows and water level at this location that result from the Project are negligible. Therefore the effect of the Project on this property in terms of water levels, flows, erosion and the performance of the septic tanks will be no more than minor.

Table 2: Changes in water level and peak flow [and differences] for 100 year ARI flood flow at 7 Bollard Avenue

Scenario	Peak Flow (m^3/s)	Maximum Water Level (mRL)
Existing	26.03	35.90
Project	26.39 [+1.4%]	35.91 [+0.01]

[121] For details of wetland TD1A refer to Report, Appendix A Drawings 20.1.11-3-D-D-300-101.

[122] Submitter No. 135

[123] Refer to details given previously in paragraph 60.

153 The submitter says that Oakley Creek flows through private land have not been measured or quantified. In response, the flows at this location have not been measured, but the catchment model developed by Metrowater/AECOM has been used to assess the effect the Project on the hydrology at this location as described in paragraph 152.

154 The submitter notes that all maps which show Project flooding under given scenarios "do not include our property, or those further downstream, as being at risk". In response, as described in my Report[124] only the flooding in the MIKE21 part of the model is shown in Figure 8.6 and 8.7[125] and not for the MIKE11 model that generally represents the main channel. These figures were included to show the change in flood extent rather than flood hazard. Flood hazard information[126] is available from Auckland Council.

155 The submitter requests ongoing checks and maintenance of, and the clearing of "excess plant and debris (rubbish and silt that comes from Alan Wood reserve)" from the Oakley Creek bed. In response I note that, the NZTA will provide treatment for stormwater generated from SH20 prior to discharge into Oakley Creek. NZTA will maintain modifications to Oakley Creek until completion of a defect period, at which time responsibility will be given back to Auckland Council. The issues of excess plant growth and debris (rubbish and silt) from the wider catchment are not NZTA's responsibility.

Duncan and Joan McKenzie

156 This submitter[127] raised the concern that consideration be given to the likely effect of wider catchment development on the Oakley Creek, including reasonable intensification of urban development and the separation of combined drainage systems, adding stormwater discharges to the stormwater discharge from the Project. In response, the flooding assessment has allowed for maximum future development and climate change to 2090. The Catchment Model does not include stormwater entering the combined drainage systems. It assumes all rainfall enters the stormwater system. Therefore, the model conservatively represents the current situation (that has some combined sewers) and provides for the future when all stormwater and wastewater services are separated.

157 This submitter also requested that an assessment of the likely flood flows downstream of the Bollard Avenue Culvert be carried out and

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[124] Refer to first paragraph page 167 of my Report.

[125] Refer to Figure 8.6 (page 169) and Figure 8.7 (page 110) of my Report.

[126] AECOM (2010). Flood Hazard Mapping Report – Oakley (OAK). 1 October 2010. For Metrowater/ACC.

[127] Submitter No.204

any necessary mitigation measures be implemented. In response, my Report provides comparisons of water levels at key locations downstream of the Bollard culverts[128]. I found that downstream of the Bollard culverts the effects of the Project on flood water levels is expected to be negligible.

Auckland Samoan Assembly of God Church

158 This submitter[129] raised the suggestion that the required area to achieve the diversion of the stream be reduced by using a pipe under their property. In response, while a culvert would require less space, it would eliminate aquatic habitat and can be a barrier to fish passage, and is less effective at managing overland flows. Furthermore, ACC currently holds consent[130] from the ARC for the catchment with a condition "*Piping of existing open channel watercourses and removal of riparian vegetation shall not be allowed unless covered under the General Authorisation or a separate resource consent obtained*". Therefore, an open channel is the preferred option. I note that this stream realignment is only required in the future when the rail line is developed.

Auckland Regional Council

159 The ARC[131] while strongly supportive of the stormwater treatment proposed for the Project, raises a number of concerns with stormwater treatment. The first is that the causeway bridge will not include collection and treatment of stormwater. As discussed earlier in the post lodgement section of my evidence, stormwater treatment has now been added for this bridge.

160 The ARC also raises a concern[132] about the viability of the proposed wetlands and the need for these to receive a continuous flow of water to endure survival of plants during extended dry periods and mitigate the impacts from mosquitoes and thermal impacts of discharges. In response, I note that wetlands are used extensively in the Auckland region and for the motorway network for stormwater treatment. They are a BPO in many situations because they provide a high level of treatment as well as attenuation, while providing amenity and habitats. Very few of these wetlands would have a continuous flow of water and most would rely on rainfall-runoff to refresh the water.

161 The ARC's own TP10 guideline recommends a minimum catchment area for wetlands of 2-3 ha. The wetlands proposed for this Project

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[128] Refer to Table 8.7 (page 166) in my Report.

[129] Submitter No.177

[130] ARC consent No. 24973. To divert and discharge stormwater within and from the Oakley Creek Catchment into the Waitemata Harbour.

[131] Submitter No. 207 at section 4.7.1.

[132] Submitter No. 207 at 4.7.9.

are listed in Table 3 with their catchment areas. The wetlands are generally larger than this criterion, with the exception of the Northern Portal wetland, but this will receive groundwater[133] pumped from the tunnel. The Alan Wood wetland is also small, but will receive supplementary flow from groundwater that seeps into the southern portal and is pumped out via the stormwater system.

162 Table 3: Project wetland and catchment areas[134]

Name	Area (ha)
TD1A – Jack Colvin Wetland	9.45
TD5F – Northern Portal Wetland	1.79
TD5G – SH16 Onramp Eastbound TDM Wetland	5.19
TD6A – Meola Wetland	4.47
TD9A – Alan Wood Wetland	2.94
TD9B- Valonia Wetland	11.59

163 The ARC is concerned[135] with the description of Valonia Wetland TD9B[136] in my Report as being "*mostly outside of the 100 year ARI floodplain".*[137] In response, I note that the location of TD9B was chosen to be outside the floodplain (though its edge may contact the existing floodplain in places).[138] This was done to eliminate the risk of contaminants being flushed and reduce the impact of the Project on the flood plain storage. The banks surrounding TD9B have been designed at a height to ensure that TD9B is separated from the floodplain. The flood extents for the Project for the 100 year ARI flood, confirm that TD9B is outside the floodplain.[139] The effects of changes to landform in this area are encompassed in the flood assessment already detailed.[140]

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133 Refer to page 81 of my Report.

134 Refer to Table 6.1 (page 50) of my Report.

135 Submission No. 207, section 4.7.13.

136 Note TD9B Valonia Wetland is mislabelled as TD9B Hendon Wetland in Table 6.1 (page 53) of my Report.

137 Refer to page 89 of my Report.

138 Refer to Figure 8.6 (page 169) of my Report.

139 Refer to Figure 8.7 (page 170) of my Report.

140 Refer to Paragraphs 96 to 102 of this evidence and Sections 8.4 (page 162) and 8.5 (page 175) of my Report.

164 The ARC raises two technical issues about the design of swales. The first concerned the slope of the swales.[141] In response, the minimum side slopes for grass swales will be 1 vertical to 4 horizontal as requested to facilitate mowing. However, where native vegetation is used and mowing is not required steeper slopes will still be considered. The other question was about how velocities were calculated in the swale design for residence time and erosion checks. I confirm the velocities were correctly and conservatively calculated at the end of the swale for the full catchment.

165 The submitter raised the issue of the treatment efficiency of cartridge filters and that overtime the efficiency is likely to decrease.[142] The level of performance of the cartridge filters can be improved by limiting the flow rate, which is specified in my Report.[143] This is done by adding more filters to the cartridge vault. I agree with the ARC that ongoing monitoring and maintenance of all filters will be required. The Operational Stormwater Management Plan[144] provides details of the maintenance activities and frequencies to endure performance of the cartridge filters. These are living documents and the maintenance frequencies can be increased[145] to ensure performance

166 The ARC requests a condition[146] that requires monitoring and management of tunnel water. I believe that such controls would be beneficial and a condition[147] has been proposed. The monitoring programme should have duration of two years to develop a data set of observed water quality for a range of events and situations. This will be used to update the management plan so the correct treatment/disposal option for tunnel water can be selected by tunnel operators. The Operational Stormwater Management Plan[148] covers maintenance activities for the tunnel.

167 The submitter raises[149] a number of issues to do with the assumptions and modelling of sediments and heavy metals by NIWA and these are addressed in the evidence of Mr Moores.

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141 Submission No. 207, section 4.7.15.

142 Submission No. 207, section 4.7.19.

143 Refer to page 58 of my Report.

144 Refer Appendix D to my Report.

145 Or conversely the maintenance frequency can be reduced if the prescribed maintenance frequency is not beneficial. For example a higher frequency of maintenance is normally required early in a project, until the catchments and treatment devices are working as per design, and then the frequency of maintenance can be decreased.

146 Submission No. 207, section 4.7.24.

147 Refer to condition SW.16 in annexure C.

148 Refer to Appendix D of my Report.

149 Submission 207, section 4.7.28 to 4.7.32.

168 The ARC requests[150] that polycyclic aromatic hydrocarbons (PAH) and total petroleum hydrocarbons (TPH) be considered in the design of stormwater treatment, included in ongoing monitoring and that treatment is a condition of consent. The treatment devices that have been proposed do not target hydrocarbons, but will have some effect at removing them. Treatment processes for hydrocarbons include sedimentation, filtration, oxidation, photolysis, volatisation and microbial decomposition. The design of treatment devices for hydrocarbons is not well understood and the effectiveness at removing hydrocarbons would be difficult to quantify. Hydrocarbons are mentioned in design guidelines such as ARC TP10, but there is little guidance of design procedures and likely treatment efficiencies. Where techniques to enhance the treatment of hydrocarbons are known these have already been incorporated. An example of this is the baffled outlets for wetlands[151] to encourage volatilisation of hydrocarbons trapped on the surface. Due to the lack of knowledge and technologies for stormwater treatment of hydrocarbons it would be difficult to set consent conditions. Dr De Luca in her evidence comments on the low concentrations of observed PAHs that have arisen under a regime where the existing run-off discharges untreated to the CMA, and that the stormwater treatment areas proposed for Sectors 1-5 of the Project will assist with ensuring that PAHs remain below effect threshold concentrations.

169 The submitter recognises the Operation Stormwater Management Plans[152] and the maintenance provisions included in these. They seek conditions of consent that require maintenance of stormwater devices and the monitoring of ongoing environmental effects. In response, I believe the management plans and monitoring proposed by NZTA will be adequately to manage the ongoing effects of the project. Conditions of consent for the requirement of operation and maintenance plans for stormwater have been proposed.[153]

Auckland City Council

170 Auckland City Council[154] seeks that the Project does not prejudice its own application for stormwater network consents. In response, I note that the Project proposes standalone stormwater treatment systems for the motorway. NZTA has been working closely with Metrowater on flooding issues to ensure the potential impacts from the Project on the Oakley Creek are minimised. The design of streamworks was assessed for the "pass forward" scenario[155] that was considered by Metrowater to give the greatest flows through

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150 Submission 207, section 4.7.33.

151 Refer to Drawing 20.1.11-3-D-D-340-201, Appendix A of my Report.

152 Refer to Appendix D of my Report.

153 Refer to conditions SW.5 and SW.16 in Annexure C.

154 Submitter No.111

155 Refer to page 176 of my Report.

the project area of all the catchment management options they are considering. These steps have demonstrated that Project will not adversely impact upon the flood management plans or unduly restrict catchment development. NZTA will continue to work with Council and use their preferred catchment management option for detailed design. Conditions of consent are proposed to ensure this occurs.[156] By these actions I believe the Project will not prejudice the Councils application for the stormwater network consents.

171 Auckland City Council has several comments about design details, such as the tailwater condition for the design of pipes and the minimum cover for stormwater pipes under the carriageway which they recommend to be 1200mm. I consider these to be design issues that are not relevant to the assessment of effects of the Project, provided the stormwater mitigation measure work as intended. Furthermore, NZTA will own and maintain the stormwater systems, so their design requirements should apply.

172 In response to the specific issues, stormwater systems will be designed for mean high water spring sea level and climate change, for stormwater treatment to function for these conditions. I have specified the minimum pipe cover to be 900mm under the carriageway[157] with specific design measures used when this cannot be achieved. Given the low elevation of the SH16 motorway relative to sea level, shallow pipes may be required in some areas. As little as 600 mm cover is commonly used for motorways and other urban stormwater applications. Design procedures allow for the strength of the pipe or its installation to be increased for special design situation, so this is considered to be a detailed design issue.

173 Auckland City Council supports the proposed streamworks "*due to the expected net ecological environmental and recreational benefits from greater access to the waterways, improved ecological habitats and more vegetation than currently exists in these reaches*"[3]. They require that the restoration of Oakley Creek be in line with the NZTA Oakley Creek Realignment and Rehabilitation Guidelines[158] and conditions of consent are proposed to achieve this outcome.

PROPOSED STORMWATER AND STREAMWORKS CONDITIONS

174 In the documentation lodged with the AEE, the NZTA included a set of Proposed Consent Conditions (see Part E, Appendix E.1). This Appendix included proposed stormwater and streamworks conditions which I recommended would be appropriate to attach as conditions to the relevant consents sought. A further condition (SW21) was

156 Refer to condition STW.30 in Annexure D.

157 Refer to Page 10 of Technical Report No. G27. Stormwater and Streamworks Design Philosophy Statement

158 Appendix C to Technical Report G.6 Assessment of Freshwater Ecological Effects.

added to the proposed stormwater conditions in the Addendum to the AEE.[159] A copy of the proposed Stormwater conditions and the proposed Streamworks conditions are contained in **Annexure C** and **Annexure D** respectively to my evidence.

175 I consider that these conditions are still appropriate with the modification of SW11 and SW16 and the addition of condition STW30 to:

175.1 Provide stormwater treatment for adjunct activities (SW.11);

175.2 Include a tunnel water quality monitoring requirement in the OSMP (SW16)

175.3 Ensure flood design defences take into account the Council's preferred catchment management option (STW30).

Tim Fisher
November 2010

Annexures:

Annexure A: Updated Drawings

Annexure B: Goldstar Site Plan

Annexure C: Proposed Stormwater Conditions

Annexure D: Proposed Streamworks Conditions

Annexure E: Options investigated to reduce water level at Bollard Road

[159] Technical Addendum Report G.31, refer Appendix 9.

ANNEXURE A: UPDATED DRAWINGS

Drawing 20.1.11-3-D-D-300-108 Rev D
– Addition of stormwater treatment to Causeway Bridges

Drawing 20.1.11-3-D-D-300-109 Rev C – Addition of stormwater treatment for SH16 eastbound offramp at Great North Road interchange and modifications to TD5C.

Drawing 20.1.11-3-D-D-300-113 Rev C
– Addition of stormwater treatment for Northern Portal Ventilation Building

Drawing 20.1.11-3-D-D-300-116 Rev C
– Addition of Bollard Overflow Culvert

Drawing 20.1.11-3-D-D-300-117 Rev C
– Addition of stormwater treatment for Southern Portal Ventilation Building

Drawing 20.1.11-3-D-D-300-118 Rev C
– Show flood storage area for clarity

Drawing 20.1.11-3-D-D-310-220 Rev A
– Bollard Overflow Culvert Inlet Capacity Enhancement

Drawing 20.1.11-3-D-D-330-211 Rev B
– Show flood storage area for clarity

Drawing 20.1.11-3-D-D-350-113 Rev C
– Clarification of stormwater management for construction yard 7

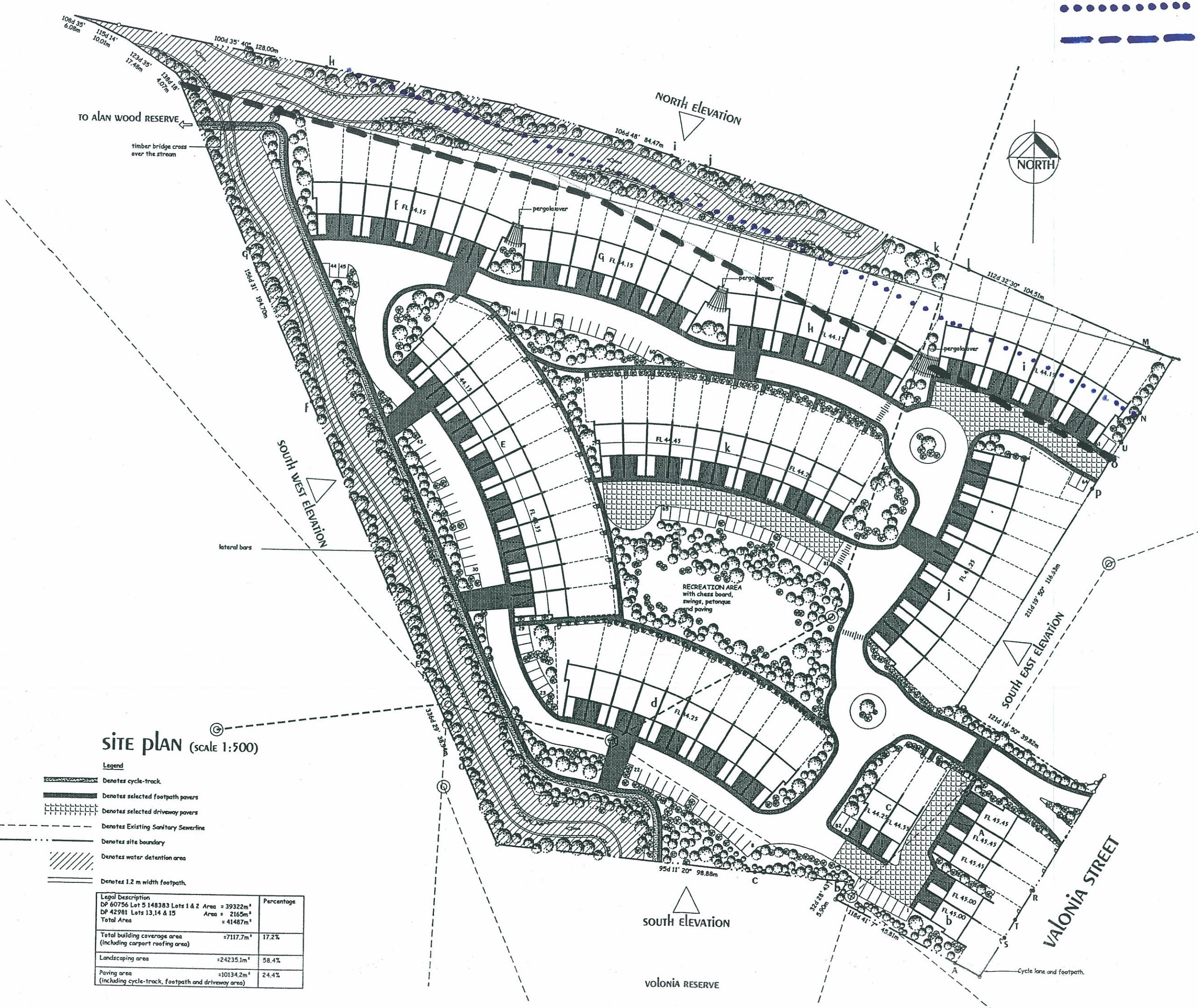
Drawing 20.1.11-3-D-D-350-114 Rev C
– Clarification of stormwater management for construction yard 7

ANNEXURE B: GOLDSTAR SITE PLAN

Site Plan, Drawing 1A, 25 Valonia Street, Gold Star Insurance

Approximate alignment

Construction buffer



SITE PLAN (scale 1:500)

Legend

- Denotes cycle-track.
- Denotes selected footpath pavers
- Denotes selected driveway pavers
- Denotes Existing Sanitary Sewerline
- Denotes site boundary
- Denotes water detention area
- Denotes 1.2 m width footpath.

Legal Description		Percentage
DP 60756 Lot 5 148383 Lots 1 & 2 Area = 39322m² DP 42981 Lots 13,14 & 15 Area = 2165m² Total Area = 41487m²		
Total building coverage area (including carport roofing area)	=7117.7m²	17.2%
Landscaping area	=24235.1m²	58.4%
Paving area (including cycle-track, footpath and driveway area)	=10134.2m²	24.4%

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facsimile 415-8786
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po box 33 186 takapuna

all dimensions shall be checked on site before fabrication of components scale A1 as shown / A3 half size

Status	Issue date
information	-
resource consent	23-11-2004
building consent	-
tender	-
construction	-
revisions	

project no 2328
sheet no 1A

TERRACE HOUSING
25 VALONIA STREET Mt. ROSKILL
GOLD STAR INSURANCE
project

ANNEXURE C: PROPOSED STORMWATER CONDITIONS

PROPOSED STORMWATER CONDITIONS

	Construction
SW.1	Stormwater management during construction shall be undertaken in accordance with the plans and information submitted with this application and the information contained within Technical Report G.15 *Assessment of Stormwater and Streamworks Effects*. In particular this requires the construction and completion of stormwater management works to the treatment standards detailed in Table 7.1 for the catchment areas detailed in Tables 7:20 and 7:21 of Technical Report G.15 *Assessment of Stormwater and Streamworks Effects*.
SW.2	The NZTA shall inform the [Auckland Council] in writing at least 10 working days prior to the start date of the works authorised by this consent.
SW.3	The NZTA shall submit the final design of the construction stormwater system to the [Auckland Council] prior to the commencement of construction works. This shall include, but not be limited to: (a) Design calculations for the following: i) flow attenuation devices, ii) stormwater treatment device sizing, iii) bypass device design, iv) stormwater treatment device efficiency; (b) Design drawings, including all structures, outfalls, treatment devices, bypass devices, wetlands and ponds; (c) Catchment plans detailing the area draining to each device; and (d) Outfall locations. Any amendments to these designs shall be approved in writing by the [Auckland Council] prior to implementation.
SW.4	That the NZTA shall arrange and conduct pre-construction site meetings between the [Auckland City] and all relevant parties, including the site stormwater engineer, with regard to the temporary stormwater management works, prior to construction of these works. Any resulting amendments may be reviewed at that time and shall be approved in accordance with Condition SW.3.
SW.5	The NZTA shall finalise and implement the Temporary Stormwater Management Plan (TSMP) submitted with this application. The purpose of the TSMP is to ensure appropriate controls are in place to manage stormwater during construction.
SW.6	Any amendments to the TSMP shall be approved by the [Auckland Council] in writing.
SW.7	The NZTA shall undertake regular inspections of all stormwater treatment devices installed during construction to ensure they are operating successfully.
SW.8	The NZTA shall arrange and conduct a post construction site meeting within 30 days of completion of installation of the stormwater management works between [Auckland Council] and all relevant parties, including the site stormwater engineer.
SW.9	The NZTA shall ensure that, for stormwater flows in excess of the capacity of the primary systems, major overland flow paths shall be provided and maintained to allow surplus stormwater from critical storms, up to the 100-year ARI event, to discharge with the minimum of nuisance and damage.

PROPOSED STORMWATER CONDITIONS

	Advice note: for the purposes of this Consent, "major overland flow paths" are those that accompany a primary drainage system of a nominal 600 mm diameter pipe or larger or with peak overland flow exceeding 0.5 m³/s in the 100-year ARI event.
SW.10	Any stormwater outfalls authorised by this Consent shall incorporate erosion protection measures to minimise the occurrence of bed scour and bank erosion.
	Operation
SW.11	The permanent stormwater measures shall be installed and operated in accordance with the plans and information submitted with this application and the information contained within Technical Report G.15 *Assessment of Stormwater and Streamworks Effects*. In particular this requires the construction and completion of stormwater management works to the treatment standards detailed in Table 6.1 for the catchment areas detailed in Tables 6:24 of Technical Report G.15 *Assessment of Stormwater and Streamworks Effects*. Stormwater treatment should also be provided for adjunct activities associated with the Project including access roads and carparks for the tunnel ventilation buildings**.**
SW.12	The NZTA shall inform the [Auckland Council] in writing at least 10 working days prior to the start date of the works authorised by this resource consent.
SW.13	The NZTA shall submit the final design of the operational stormwater system to the [Auckland Council] prior to the commencement of construction works on the permanent stormwater system. This shall include, but not be limited to: (a) Design calculations for the following: i) flow attenuation devices, ii) stormwater treatment device sizing, iii) bypass device design, iv) stormwater treatment device efficiency; (b) Design drawings, including all structures, outfalls, treatment devices, bypass devices, wetlands and ponds; (c) Catchment plans detailing the area draining to each device; and (d) Outfall locations. Any amendments to these designs shall be approved in writing by the [Auckland Council] prior to implementation.
SW.14	The NZTA shall arrange and conduct pre-construction site meetings between the [Auckland City] and all relevant parties, including the site stormwater engineer, with regard to the operational stormwater management works, prior to construction of the permanent stormwater devises. Any resulting amendments may be reviewed at that time and shall be approved in accordance with Condition SW.13.
SW.15	Within 90 days of the practical completion of the stormwater management system, "As Built" plans and documentation of the stormwater system which are certified as a true record of the stormwater management system by a suitably qualified Chartered Professional Engineer shall be supplied to the [Auckland Council]
SW.16	The NZTA shall submit to the [Auckland Council] within 90 days of the completion of installation of the stormwater management system an updated and final version of the Operational Stormwater Management Plan (OSMP) submitted with the application. The purpose of the OSMP is to set out operation and maintenance requirements for the long term operation of stormwater

PROPOSED STORMWATER CONDITIONS

	systems implemented as part of the Project. The OSMP shall include a monitoring programme for tunnel water quality to be agreed with [Auckland Council]. The monitoring programme shall have duration of two years. The water quality report shall be submitted to the [Auckland Council] at the end of each year. The OSMP shall be updated at the end of the monitoring programme to revise procedures for the treatment and disposal of tunnel water.
	The OSMP shall include, but not be limited to: (a) A programme for regular maintenance and inspection of works; (b) A programme for the collection and disposal of debris and sediment collected by the stormwater management devices or practices; (c) A programme for inspection and maintenance of outfall erosion; (d) A programme for post-storm maintenance; (e) General inspection checklists for all aspects of the stormwater management system; (f) Details of the person or bodies whom will hold responsibility for long-term maintenance of the stormwater management system and the organisational structure which will support this process.
SW.17	Any amendments to the OSMP shall be approved by the [Auckland Council] in writing.
SW.18	The NZTA shall arrange and conduct a post construction site meeting within 30 days of completion of installation of the stormwater management works between the [Auckland Council] and all relevant parties, including the site stormwater engineer.
SW.19	The NZTA shall ensure that, for major overland flow paths in excess of the capacity of the primary systems, secondary flow paths shall be provided and maintained to allow surplus stormwater from critical storms, up to the 100-year ARI event, to discharge with the minimum of nuisance and damage. Advice note: for the purposes of this consent "major overland flow paths" are those that accompany a primary drainage system of a nominal 600 mm diameter pipe or larger, or with peak overland flow exceeding 0.5 m^3/s in the 100-year ARI event.
SW.20	Any stormwater outfalls authorised by this Consent shall incorporate erosion protection measures to minimise the occurrence of bed scour and bank erosion.
SW.21	The NZTA shall finalise and implement through the CEMP, the Concrete Batching and Crushing Management Plan (CBCMP) submitted with the application. The NZTA shall provide the CBCMP to the [Auckland Council] prior to the commencement of any site works. The CBCMP shall be revised to accurately reflect the conditions of this consent and changes to the details of construction processes prior to construction commencing. The CBCMP shall include, but not be limited to, details of: (a) Design of the stormwater treatment device(s) (b) Monitoring requirements (c) Procedures to be undertaken in the event of unexpected discharges (d) Complaints, investigation, monitoring and reporting.

ANNEXURE D: PROPOSED STREAMWORKS CONDITIONS

PROPOSED STREAMWORKS CONDITIONS

STW.1.	**General conditions** The streamworks shall be undertaken in accordance with the plans and information contained within Technical Report G.15 *Assessment of Stormwater and Streamworks Effects* and Technical Report G.22 *Erosion and Sediment Control Plan*, submitted with this application.
STW.2.	Any future amendments that may affect the performance of the streamworks shall be approved by the [Auckland Council] in writing, prior to construction. Any amendments to the design should be in accordance with the Western Ring Route: Oakley Creek Re-alignment and Rehabilitation Guidelines (Boffa Miskell, 2010).
STW.3.	The NZTA shall inform the [Auckland Council] in writing at least 10 working days prior to any streamworks commencing, and again 10 working days before any environmental protection measures are removed.
STW.4.	Prior to streamworks commencing on site the NZTA shall arrange and conduct a pre-construction site meeting between [Auckland Council], NZTA and the primary contractor, prior to any works commencing on the site.
STW.5.	Prior to commencement of streamworks associated with the realignments of Oakley Creek and the Stoddard Road tributary, the construction design details associated with these works shall be submitted to the [Auckland Council] for approval. The details shall include but not be limited to: (a) Detailed design of the proposed streamworks including long sections, cross sections and details of the design including any freshwater habitat improvement and riparian planting; (b) Construction erosion and sediment control plans (ESCP).
STW.6.	The NZTA shall forward a detailed construction programme and methodology to the [Auckland Council] prior to the commencement of works, and shall provide monthly updates during the streamworks. These shall include details of: (a) The commencement date and expected duration of the streamworks; (b) The location of any works and structures in relation to the streamworks; and (c) Dates for the implementation of erosion and sediment controls.
STW.7.	No streamworks shall be undertaken between 1 May and 30 September unless written approval has been obtained from the [Auckland Council]. Any such approval shall be sought at least 10 working days prior to the proposed commencement of the works.
STW.8.	All erosion and sediment controls associated with the streamworks shall be constructed and installed in accordance with Technical Report G.22 *Erosion and Sediment Control Plan* submitted with this application.
STW.9.	The site shall be stabilised against erosion as soon as practicable and in a progressive manner as streamworks are finished.
STW.10.	All uncompacted material shall be kept clear of the channel during and after streamworks.
STW.11.	The NZTA shall ensure that any temporary dam structure built within the stream shall be constructed from non-erodible material (such as sandbags or sheet piles).

PROPOSED STREAMWORKS CONDITIONS

STW.12.	The NZTA shall ensure that when dewatering the in-stream works area, no sediment-laden water shall be discharged directly into a watercourse. Any sediment-laden water must be treated in an appropriate sediment treatment device.
STW.13.	All machinery shall be maintained and operated in a way which ensures that spillages of fuel, oil and similar contaminants are prevented, particularly during refuelling and machinery servicing.
STW.14.	The NZTA shall ensure that: (a) Any excavated sediment that requires temporary stockpiling shall not be placed within the 100 year ARI flood plain, and (b) Erosion and sediment control measures around the stockpile perimeter shall be constructed in accordance with TP90.
STW.15.	The design engineer and Project ecologist shall monitor the construction of the streamworks. The NZTA shall submit a certificate signed by an appropriately qualified and experienced engineer and ecologist to certify that the streamworks have been undertaken in accordance with the drawings supplied with this application, or as otherwise amended under Condition SW.2, within 60 working days of completion of the streamworks.
STW.16.	The NZTA shall obtain approval of the stream realignment works from the [Auckland Council] prior to diversion of Oakley Creek into the new channel.
STW.17.	**Bridge Structure** The NZTA shall submit a certificate signed by an appropriately qualified and experienced engineer to certify that the Oakley Creek bridge (SH20) has been constructed in accordance with the drawings supplied with this application, within 60 working days of completion of the structure.
STW.18.	Any erosion occurring as a result of construction of the Oakley Creek bridge (SH20) shall be remedied as soon as possible and to the satisfaction of the [Auckland Council].
STW.19.	The area of Oakley Creek beneath the Oakley Creek bridge (SH20) shall be maintained free of debris to ensure stream flows are not restricted.
STW.20.	**Streamworks Environmental Management Plan (SWEMP)** The NZTA shall submit for approval to the [Auckland Council] a Streamworks Environmental Management Plan (SWEMP) which shall include details of the final freshwater mitigation and environmental enhancement works associated with the Project. This SWEMP shall cover the mitigation for the loss of an area of Pixie Stream, Oakley Creek and the Stoddard Road tributary. It shall be submitted to the [Auckland Council] at least 40 working days prior to the proposed enhancement works being commenced under this consent and shall include, but not be limited to, the following: (a) The nature of works to be undertaken; (b) The location of works; (c) Detailed design and plans of all enhancements to the stream bed and/or stream channel, including any structures or other engineering works; (d) Riparian planting programmes, including detailed planting plans and specifications relating to species mix, location, density, size and maintenance; and (e) Timing of implementation.

PROPOSED STREAMWORKS CONDITIONS

STW.21.	The SWEMP shall be prepared in general accordance with the "Western Ring Route – Maioro Street Interchange and Waterview Connection - Oakley Creek Realignment and Rehabilitation Guidelines" (Boffa Miskell, 2010) appended to *Technical Report G.6 Assessment of Freshwater Ecological Effects*.
STW.22.	The NZTA shall implement the mitigation and environmental enhancement works contained in the approved SWEMP within 12 months of practical completion of the Project.
STW.23.	The NZTA shall supply to the [Auckland Council] within 30 working days of the completion of the riparian planting works written confirmation from an appropriately qualified landscape architect or ecologist that the riparian plantings have been implemented in accordance with the SWEMP approved under Condition SW.20.
STW.24.	Any material amendments to the SWEMP shall be submitted for approval by the [Auckland Council] prior to any amendment being implemented.
STW.25.	**Fish Passage** All proposed stream bed and/or stream channel structures shall not impede the passage of fish both upstream and downstream.
STW.26.	**Flooding** Works in the floodplain (including motorway embankments, ancillary earthworks and streamworks) shall be undertaken in accordance with the plans and information submitted with this application including, but not limited: (a) Waterview Connection Project. Assessment of Environmental Effects Report (Dated August 2010). I. Plan F.2 Operation Scheme Plans II. Plan F.14 Streamworks and Stormwater Discharges (b) Technical Report G.15 *Assessment of Stormwater and Streamworks Effects.*
STW.27.	Within 60 working days of completion of the works, the NZTA shall submit to the [Auckland Council] "as built" plans certified by a qualified and experienced engineer to confirm that the works have been carried out in accordance with Condition SW.26.
STW.28.	Any amendments to works by the NZTA in the floodplain that may increase the flooding effects shall be submitted to the [Auckland Council] for approval in writing, prior to construction. These proposed amendments shall include updated drawings and hydraulic modelling using the Oakley Creek Catchment Model to assess the effects of the change.
STW.29.	The NZTA shall submit to the [Auckland Council] a certificate signed by an appropriately qualified and experienced engineer to certify that the flood protection works for the tunnels have been constructed in accordance with the drawings, approach and standards supplied with this application, prior to the opening of the Project.
STW.30.	Design of flood defences for the southern portal shall take into account the catchment management option preferred by Auckland Council with allowances for climate change and maximum probable development.

ANNEXURE E: OPTIONS INVESTIGATED TO REDUCE WATER LEVEL AT BOLLARD ROAD

AECOM letter report, 11 November 2010

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11 November 2010

Tim Fisher
Tonkin & Taylor
PO Box 5271
Wellesley Street
Auckland

Dear Tim

Options Investigated to Reduce Water Level at Bollard Road

Introduction

AECOM have been working with Metrowater, Auckland City Council, NZTA and Tonkin & Taylor to assess the effects to flood levels due to the proposed SH20 extension to the Waterview Connection Project. Following on from this work, NZTA and Tonkin & Taylor have requested AECOM to investigate options at Bollard Avenue to reduce the backwater from the culverts. The objective is to reduce the calculated peak water level for the proposed Waterview Connection Project of 37.45mRL to the existing water level of 37.30mRL for the 100yr flood, a change of 150mm.

Three options were discussed and agreed with Tonkin & Taylor to determine their likely impact on the water level at Bollard Overflow Culvert. The three options modelled were:

1. Additional storage upstream of the culvert
2. Decreasing the roughness in the culvert
3. Secondary inlet above the existing culvert inlet

These options are discussed in more detail in the following sections.

Option Details

Details of the options assessed are as follows:

1. Additional storage upstream of the culvert

AECOM modified the terrain in the Mike21 model to create additional storage. It was calculated that the storage volume is required above a water level of approximately 37.05m to have an effect on the peak water level at the Bollard Overflow Culvert. A volume of 2000m^3 was able to be stored within the terrain. The water level was reduced by only 30mm. To achieve this storage volume the flood plain width must be increased by 20m for a length of 300m upstream of the culverts. Due to the extent of civil works required for this option and the effect on Alan Wood Reserve, the option for additional storage upstream of the culverts is believed to be impractical.

2. Decreasing the roughness in the culvert

The Manning's roughness n was set at 0.013 in the original model. AECOM set up a model run changing the Manning's roughness to 0.010 in order to assess whether the friction loss would impact on the upstream water level. This option could be achieved by lining the culvert barrel to reduce friction losses and increase capacity. The changes in roughness made no difference in the upstream water level of the peak flow in the culvert. This confirms that the culvert is inlet controlled, so that improvements to the inlet are more likely to increase culvert capacity.

3. Secondary inlet above the culvert inlet

The third option investigated is a secondary inlet above the existing inlet of the Bollard Overflow Culvert. The objective is to increase capacity into the inlet controlled culvert.

It is not possible to model a secondary inlet structure in the Mike11 model. To assess the effect of the secondary inlet on the culvert capacity a Q-H relationship for the culvert was calculated based on hydraulic theory. Two scenarios were calculated to provide rating curves for possible flow conditions within the culvert.

In both scenarios the secondary inlet was 2.55m diameter with a crest level 0.5m above the soffit of the existing culvert. A scruffy dome type screen was assumed for the secondary inlet. For details refer to Tonkin & Taylor Drawing 20.1.11.3-D-D-310-220.

The Bollard overflow culvert was determined to be inlet controlled as the barrel capacity is greater than the inlet capacity (see below) and the barrel runs part full at design flows with low tail water levels. This is supported by the Mike 11 modelling results from Option 2 (above).

The Bollard culvert is a 2.55m diameter culvert with a slope of 1.04%. The upstream invert level is 33.32mRL and the downstream invert level is 30.05mRL. The length is 315m.

Scenario 1 – The QH relationship was calculated assuming a drowned inlet once the water level reaches the secondary inlet. In this scenario the flow through the inlet will act as multiple converging pipes flowing full. This scenario assumes:

- Scruffy bars are 20mm diameter and 80mm spacing giving a K factor of 1.8, the scruffy inlets are sharp edged with a k=0.5
- Bars are unobstructed by debris
- Scruffy inlet is fully submerged and is acting as a pipe entrance.

Scenario 2 – The QH relationship above the secondary inlet level was calculated as a combination of the inlet controlled culvert flow plus the flow through the secondary inlet acting as a weir. This scenario assumes:

- Secondary inlet acting as a sharp crested weir with free overflow
- Weir coefficient = 0.75

The rating curve for these two flow condition scenarios along with the existing case can be seen in Figure 1 below. The existing scenario seen in Figure 1 has been calculated using nonographs. The two secondary inlet scenarios have used the existing flow rates up to the secondary inlet level at which point the extra capacity due to the secondary inlet is added.

A check has been undertaken for the existing predictions between the Mike 11 peak QH and the nomograph derived QH. This can be seen in Figure 1 and shows a good correlation.

Results for the Secondary Inlet

With the design flow of 23.2m^3/s the head water (water depth at inlet) for the existing case is 3.7m (refer Figure 1). At the same flow but with the secondary inlet the head water decreases to 3.35m, which is a decrease of 0.35m. This is for the weir scenario (2), which has less capacity than the submerged scenario.

Due to the secondary inlet the culvert capacity at headwater depth 3.7m increases in flow from 23.2m^3/s to 31m^3/s by 25%. The peak flow in the twin box culverts is 26.1m^3/s, resulting in a combined flow increasing from 49.3m^3/s to 57.1m^3/s.

Comparing the increased combined capacity of 57.1m^3/s to the peak inflow of 53.6m^3/s (future scenario peak flow) shows surplus capacity. The actual water level in the future scenario will therefore likely be reduced below the existing water level should the additional inlet not become blocked with debris.

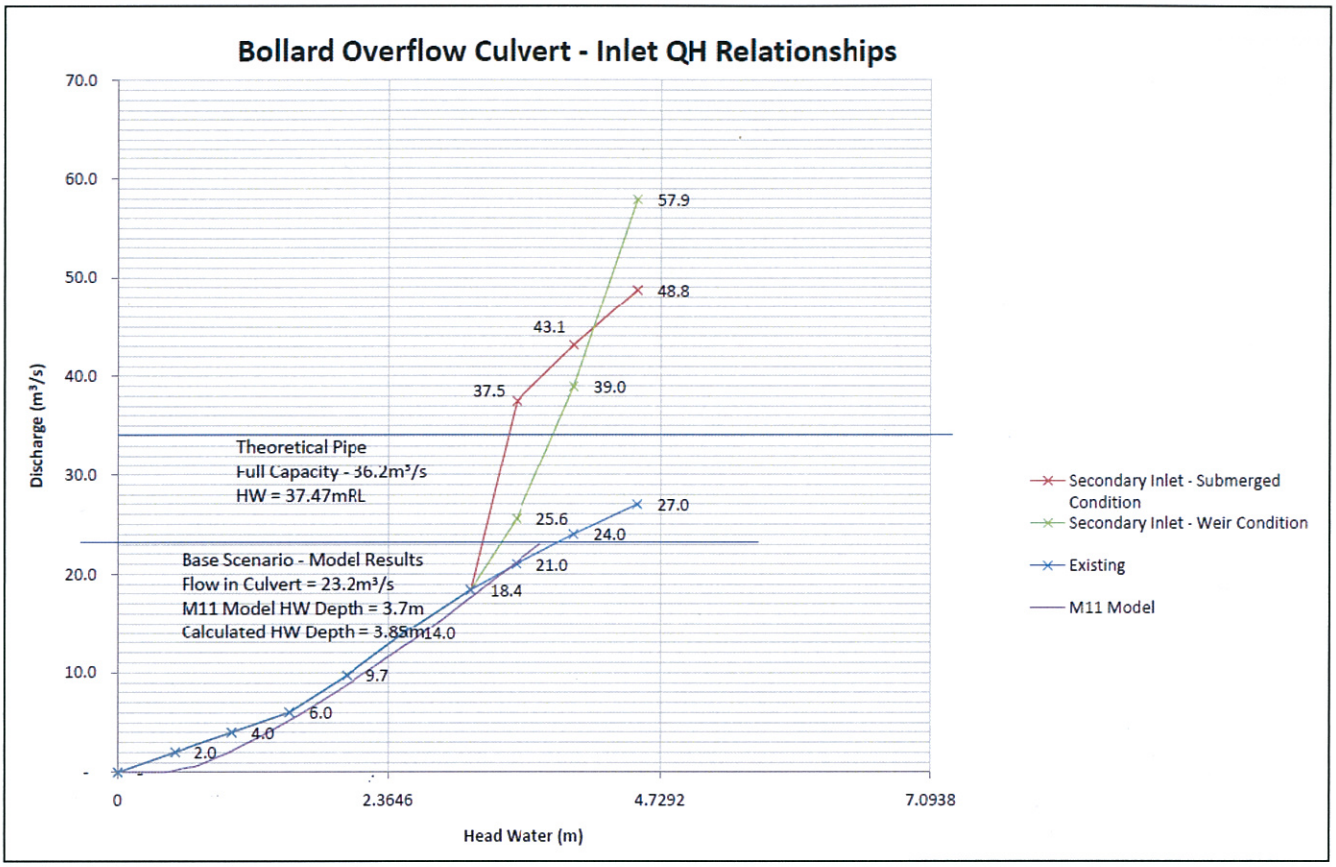
Culvert Barrel Capacity

Tonkin & Taylor undertook a check on the culvert barrel capacity and determined that:

Description	Upstream Water level	Downstream Water level	Slope	Calculated Capacity
Pipe full, uniform flow, pipe slope	35.87m	32.6m	1.04 %	29.68 m^3/s
Pipe full, non-uniform flow, hydraulic grade line based on flood level at inlet and soffit level at outlet	37.47m	32.6m	1.55%	36.23 m^3/s

The modelled capacity is 23.2m^3/s and therefore it can be said that the capacity is not reached yet and the culvert is inlet controlled, which confirms the observation from the Mike 11 model.

Figure 1 Bollard Overflow Culvert – Inlet QH Relationships



Conclusion

In conclusion the preferred option for reducing the peak water level upstream of the Bollard Overflow Culvert is by the addition of a secondary inlet. For the existing scenario flows the culvert headwater decreases by 0.35m.

The detailed design should be checked with a hydraulic model, which will account for flow sharing (balancing) with the Bollard Ave twin box culverts, and dynamic effects.

Yours faithfully

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