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 Jonathan Moores (Contaminant Load Modelling) on behalf of the **NZ Transport Agency**

Dated: 10 November 2010

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STATEMENT OF EVIDENCE OF JONATHAN MOORES ON BEHALF OF THE NZ TRANSPORT AGENCY

INTRODUCTION

1 My full name is Jonathan Philip Moores. I am an Urban Aquatic Scientist at the National Institute of Water and Atmospheric Research (NIWA) in Auckland, by whom I have been employed for 5 years.

2 I have the following qualifications and experience relevant to the evidence I shall give:

2.1 I hold a Bachelor of Science from the University of Bristol (1991) and a Masters Degree in Hydrology for Environmental Management from Imperial College, University of London (1992).

2.2 I have 5 years' experience in research on stormwater contaminants, preceded by 13 years' in hydrology and water resource management. My previous employers were the United Kingdom Institute of Hydrology (1992-1995) and the Auckland Regional Council (ARC) (1996-2005).

2.3 As part of my present position I have held the role of Group Manager, Urban Aquatic Environments Group since January 2009. I have led over 30 projects on stormwater contamination and currently lead a Foundation for Research Science and Technology (FRST)-funded research programme in this area.

2.4 Of particular relevance to the Waterview Connection Project (Project) is my research into the quality of road runoff and the performance of stormwater treatment devices. I was lead author of the NZ Transport Agency (NZTA) Research Publication 395, which reports on the results of a road runoff sampling programme to characterise variations in copper and zinc in road runoff and the effectiveness of their removal by stormwater treatment devices.[1]

[1] Moores J, P Pattinson and C Hyde. 2010. Enhancing the control of contaminants from New Zealand's roads: results of a road runoff sampling programme. New Zealand Transport Agency research report 395. 161pp.

3 Other particularly relevant projects I am, or have been, involved in include:

3.1 Research into the dispersion pathways of particulate metals emitted from vehicles;[2]

3.2 The evaluation of innovative treatment devices for removing contaminants from road runoff (in progress, NZTA-funded research programme);

3.3 A study into the performance of a sediment retention pond receiving chemical treatment (for ARC);[3] and

3.4 Contaminant load modelling to investigate the effects of varying urban development and stormwater management scenarios on the accumulation of sediments and metals in the Southeastern Manukau[4] and Central Waitemata[5] Harbours (for ARC and Waitakere City Council).

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

4.1 The State Highway 16 (SH16) Causeway Project; and

4.2 The State Highway 20 (SH20) Waterview Connection Project.

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

6 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2006). My evidence has been prepared in compliance with that Code in the same way as I would if giving evidence in the Environment Court. In particular, unless I state otherwise, this evidence is within my

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[2] Moores, J., Pattinson, P., Reed, J., McHugh, M. and Cavanagh, J. 2008. Mitigation Strategies for Controlling the Dispersion of Particulate Metals Emitted from Vehicles. NIWA report AKL-2008-048 prepared under FRST contract C01X0405. 78p.

[3] Moores, J. and Pattinson, P. 2008. Performance of a Sediment Retention Pond Receiving Chemical Treatment. Auckland Regional Council Technical Report 2008/021.

[4] Moores, J. and Timperley, M. 2008. South Eastern Manukau Harbour Contaminant Study: Predictions of Stormwater Contaminant Loads. NIWA Client Report AKL2008-078 prepared for Auckland Regional Council.

[5] Moores, J. and Semadeni-Davies, A. 2010. Project Twin Streams Value Case: Stage 2 Estimation of Contaminant Loads for Evaluation of 'Smart' Urban Development Options. NIWA client report AKL-2010-020 prepared for Waitakere City Council.

sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

7 My evidence will deal with the following:

7.1 Executive summary;

7.2 Background and role;

7.3 Summary of assessment of associated sediment and contaminant loads;

7.4 Post-lodgement events; and

7.5 Response to submissions.

EXECUTIVE SUMMARY

8 NIWA prepared an assessment of annual sediment, zinc and copper loads discharged from the above-ground sections of the Project to the Oakley Inlet, Waterview Estuary and other parts of the Waitemata Harbour. We estimated that, during the construction phase, the Project will result in a small increase on the existing baseline sediment load discharged to the Oakley Inlet and Waterview Estuary. Loads of sediment, zinc and copper discharged during the operational phase were predicted to be less than the current baseline because of improvements to the treatment of stormwater from SH16.

9 Subsequent to completion of the Report, additional information became available on the design of stormwater treatment devices associated with the Project. Based on this additional information, we have estimated that the annual sediment load from the Project area will be around 20% lower than the original estimates, while loads of zinc and copper will be little changed.

10 A submission lodged by the Auckland Regional Council has questioned some of the sediment and contaminant removal rates we used in modelling the performance of sediment and stormwater treatment devices. I have reviewed the assumptions that we made and, in one case, considered the sensitivity of our results to lower removal rates. I have concluded that the removal rates we adopted do provide a reasonable basis for modelling the performance of the stormwater treatment associated with the Project.

BACKGROUND AND ROLE

11 NIWA was retained[6] to assist with aspects of the planning works for the Project and to provide an assessment of sediment and contaminant loads associated with the Project in stormwater discharges to the Waterview Inlet. I managed the NIWA scientists responsible for preparing the Assessment of Associated Contaminant and Sediment Loads Report (the Report), which provides estimates of the loads of sediment, zinc and copper discharged from the above-ground sections of the Project. The Report was written by Dr Sharleen Harper, Environmental Modeller and peer-reviewed by Dr Sandy Elliott, Group Manager, Catchment Processes (both of NIWA). Dr Tim Fisher, Director and Senior Water Engineer at Tonkin & Taylor Limited, had input into developing the scope of the Report.

12 As project manager, I provided guidance on sediment and contaminant modelling work undertaken by Dr Harper leading to the preparation of the Report. Subsequently, Dr Harper and I have undertaken further modelling in response to the provision of updated design data (described in Technical Report G.15 - Assessment of Stormwater and Streamworks Effects)[7] and matters raised in submissions. The results of this additional work are presented in my evidence.

13 The results of the modelling, and the assumptions upon which they are based, have been the subject of ongoing discussion and correspondence between myself, Dr Harper, Dr Fisher and Graeme Ridley of RidleyDunphy Environmental Limited.

14 The 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.30).

15 The Report informs other Technical Reports lodged with the EPA in support of the Project, namely:

15.1 Assessment of Coastal Processes (Report G.4);

15.2 Assessment of Marine Ecological Effects (Report G.11);

15.3 Assessment of Stormwater and Streamworks Effects (Report G.15); and

15.4 Erosion and Sediment Control Plan (Report G.22).

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[6] By Beca Infrastructure Ltd, on behalf of the NZTA.

[7] See AEE, Part G.

SUMMARY OF ASSESSMENT OF ASSOCIATED SEDIMENT AND CONTAMINANT LOADS

Scope and Methods

16 The scope of the assessment of sediment and contaminant loads for the Project (described in the Report), included the above-ground sections of the Project only (i.e. the surface motorway and the tunnel portals) It comprised three separate components:

16.1 An estimate of the baseline annual sediment, zinc and copper loads delivered to Oakley Inlet, Waterview Estuary and other parts of the Waitemata Harbour from the catchments within which the Project lies;

16.2 An estimate of the additional sediment load delivered from these catchments during the construction phase of the Project; and

16.3 An estimate of the annual sediment, zinc and copper loads delivered from these catchments under the long-term operation of the Project (represented by the years 2016 and 2026).

17 The baseline loads were derived from the results of the Central Waitemata Harbour contaminant accumulation study previously conducted by NIWA for ARC. [8] That study involved the use of the ARC's Contaminant Load Model to predict annual loads of sediment, zinc and copper discharged to the CWH over the period 2001-2100.

18 The construction-phase and operational-phase loads were estimated using a combination of two other predictive models: the GLEAMS[9] sediment generation model and NIWA's Catchment Contaminants Annual Load Model (C-CALM). Input data for the models, comprising information on land areas, slopes and the location and types of sediment and stormwater treatment measures were provided by Beca Infrastructure Ltd and Tonkin & Taylor Ltd.

Results – construction phase

19 During its construction phase, our modelling determined that the Project will discharge an estimated 30 tonnes of sediment to Oakley Inlet and Waterview Estuary, bringing the total from all sources to 493 tonnes. This figure represents a 6.5 % increase on the existing

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8 Timperley, M. and Reed, J. 2008 Central Waitemata Harbour Contaminant Study. Predictions of Stormwater Contaminant Loads. Auckland Regional Council Technical Report TR2008/039.

9 Groundwater Loading Effects of Agricultural Management Systems. Refer to Knisel, W.G. (ed.). (1993). GLEAMS. Groundwater Loading Effects of Agricultural Management Systems, version 2.10. Publication No. 5, Biological & Agricultural Engineering Department, University of Georgia Coastal Plain Experiment Station, Tifton, 260p.

baseline sediment load of 463 tonnes. In other catchments within which parts of the Project are located, the increase is around 3% of the baseline sediment load.

20 The importance of the erosion and sediment control measures that are proposed during the Project construction phase is highlighted by the fact that, without them, the estimate of the additional load discharged to Oakley Inlet and Waterview Estuary rises to 514 tonnes, which would bring the total sediment load delivered to the Inlet to 977 tonnes. This figure is more than double the existing baseline sediment load. The erosion and sediment control measures are described in the evidence of Mr Ridley.

Results – operational phase

21 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). Loads estimated for 2026 are slightly higher than those for 2016, in response to a projected increase in vehicle numbers, but still remain less than the existing baseline loads.

22 These load reductions reflect proposed improvements in the treatment of stormwater discharged from SH16 as a result of the Project, compared with the current level of treatment associated with the existing motorway. The stormwater treatment measures are described in the evidence of Dr Fisher. The estimated future annual loads generated by the SH16 motorway area are substantially lower (between 20 and 40% lower) than those estimated for the current motorway that has only limited areas of stormwater treatment.[10]

23 Loads are also projected to decrease for those parts of the Project discharging to other parts of the Waitemata Harbour, other than Meola and Motions Creeks. In these two catchments, loads are projected to increase slightly (by less than 1%) because the improvement in treatment is offset by increased loads associated with the projected increase in vehicle numbers.

POST-LODGEMENT EVENTS

Additional design data

24 Subsequent to completion of the Report, additional information became available on the design of stormwater treatment devices.[11] This information includes:

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[10] Refer to Technical Report G15, Section 5 and Table 6.24 (page 95).

[11] See pages 63 to 93 inclusive of Technical Report G.15.

24.1 Changes to the locations and sizes of stormwater treatment device catchment areas; and

24.2 The specification that stormwater treatment in Sectors 1 to 5 will remove at least 80% of total suspended solids (TSS).[12]

25 These changes are of consequence for the estimation of loads of sediments, copper and zinc during the operational phase of the Project for two reasons:

25.1 The change in the size of a catchment area results in a change in the estimate of untreated loads from that catchment: the larger the catchment area, the larger the estimate of untreated contaminant loads (assuming that all other attributes remain constant); and

25.2 The original load estimates were based on 75% removal of TSS across all sectors of the Project.

26 As a result, operational-phase loads have been recalculated to reflect the revised catchment areas and the 80% TSS removal rate in Sectors 1 to 5. In these calculations, TSS removal in Sectors 6 and 9 has remained at 75%. Removal rates for zinc and copper are unchanged from those used in the original calculations reported in the Report.

Results of additional modelling

27 Results of the additional modelling undertaken since the Report are attached to my evidence as **Annexure A**. Table 1 in Annexure A presents the revised loads for each Sector and for the Project in total and compares these with the original load estimates discussed in the Report. For the Project area as a whole, TSS is estimated to be around 20% lower than the original estimates, while loads of copper and zinc are little changed (between 1% lower and 3% higher, respectively, than the original estimates).

28 Loads of TSS, zinc and copper are lower than the original estimates in most Sectors, but not all. The reduction in TSS in Sectors 1-5 is the result of a combination of the increased TSS removal rate (80%) and changed catchment areas in these Sectors. Changes (both increases and decreases) in TSS, zinc and copper loads in other Sectors are the result solely of changes in the locations and sizes of catchment areas. The largest increase is in Sector 9, as a result of a marked increase in one stormwater catchment area in this Sector (wetland TD9B). This stormwater catchment area includes the Christ the King School, which the NZTA had previously agreed to provide stormwater treatment for.

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[12] The terms TSS and sediment are used interchangeably here and in Technical Report G.30.

29 Table 2 in Annexure A presents the revised loads of sediment, zinc and copper discharged from the catchments within which the Project is located relative to the current baseline. The estimated loads for 2016 and 2026 are little changed from the originals, remaining lower than the estimated baseline loads.

RESPONSE TO SUBMISSIONS

30 In this section of my evidence I respond to parts of the ARC's submission[13] that relate to the modelling of sediment and contaminant loads associated with the Project. Specifically, I respond to:

30.1 Sections 4.7.25 to 4.7.27 of the ARC's submission, which relate to the way in which the performance of chemical-treated sediment ponds was characterised in the modelling of construction-phase sediment loads; and

30.2 Sections 4.7.28 to 4.7.32 of the ARC's submission, which relate to the way in which the performance of stormwater treatment devices was characterised in the modelling of operational-phase zinc and copper loads.

Performance of chemical-treated sediment ponds

31 The ARC questions the use of a value of 94% in the modelling of sediment load reductions achieved by sediment retention ponds treated with chemical flocculant. It seeks the use of a more conservative value, of 85% or less.

32 NIWA's estimation of construction-phase sediment loads discharged from ponds receiving chemical treatment was a two-step process. First, untreated sediment loads discharged from the Project area were estimated using the GLEAMS sediment generation model. These estimates took account of land cover, topography, soil type and climate.

33 Second, the untreated loads were provided as inputs to a post-processing module for pond simulation. This module models sediment removal based on the particle size characteristics of the incoming sediments. Flocculation associated with chemical treatment is modelled as an increase in the proportion of the total sediment load falling into coarser size fractions. Since the coarser sediment size fractions are removed more readily than finer ones, the model predicts that a chemically treated pond will remove more of the incoming sediment load than a pond not receiving chemical treatment.

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[13] Submission No. 207.

34 The average reduction in sediment loads achieved by ponds modelled in this way was 94%. During some events, removal rates were estimated to be higher and during other events, lower.

35 While this average value of 94% is consistent with the highest removal rate estimated from sampling of a chemical-treated pond located at the ALPURT B2 motorway construction project,[14] it is important to note that the value was not simply adopted from the results of that study. It is the result of running the model described above.

36 As part of modelling the sediment loads discharged during the construction-phase of the Project, NIWA took a conservative approach in relation to the performance of other sediment control measures. Specifically, in sectors treated by chemical-treated ponds, NIWA did not take account of any additional load reduction achieved by silt fences and decanting earth bunds.

37 The ALPURT B2 pond study found that sediment removal rates of close to, or greater than, 90% were achieved by chemical treatment during the majority of events sampled. These results, along with the contribution that would be made by other sediment control measures, indicate that in those Project Sectors that will be served by chemical treated ponds, a reduction in sediment loads of 94% is realistic.

38 However, the ALPURT B2 study also found relatively low removal rates of 47.5% and 60.3% during two events. As part of the study, observations were made by NIWA relating to the management of the chemical dosing system, some of which may have been linked to the poorer performance of the pond during these events. The achievement of 94% sediment removal by chemical treatment of sediment retention ponds employed in the Project is therefore contingent on the systems being well-managed.

Performance of stormwater treatment devices in removing zinc and copper

39 The ARC submission raises two issues relating to the way in which the performance of stormwater treatment devices was characterised in the modelling of operational-phase zinc and copper loads:

39.1 The ARC seeks clarification of the removal rates for dissolved metals, described in the Report as ‘medium’; and

39.2 The ARC considers the adoption of a flat-rate of 75% for the removal of copper and zinc by all treatment devices is too

[14] Moores, J. and Pattinson, P. 2008. Performance of a Sediment Retention Pond Receiving Chemical Treatment. Auckland Regional Council Technical Report 2008/021.

high. It seeks the use of a variable removal rate to reflect differences in the performance of different treatment devices.

Removal rates for dissolved zinc and copper

40 NIWA's C-CALM model, a version of which was used to estimate the operational loads of sediment, zinc and copper, allows different removal rates to be selected to represent the performance of a range of treatment devices. While some of these removal rates have been derived from simulation, the majority are based on a review of relevant international and New Zealand literature.[15] All removal rates for dissolved zinc and copper fall into the latter category. Removal rates of dissolved copper and zinc are categorised as 'low', 'medium' or 'high,' with the values in each category varying by type of device.

41 For this Project, treatment of dissolved copper and zinc was modelled using 'medium' removal rates. These rates are:

41.1 Cartridge filters - removal of 70% dissolved copper and 60% dissolved zinc;

41.2 Swales and infiltration strips - removal of 40% dissolved copper and 60% dissolved zinc; and

41.3 Wetlands - removal of 50% dissolved copper and 40% dissolved zinc.

42 There is considerable variation in the literature on the effectiveness of stormwater treatment devices for removing dissolved metals. Based on the literature reviewed in the derivation of the C-CALM removal rates, I consider that the adoption of the 'medium' C-CALM removal rate provides a reasonable basis for the modelling of dissolved zinc and copper loads, while acknowledging that there is uncertainty in relation to the removal of dissolved metals by stormwater treatment devices.

Removal rates for particulate zinc and copper

43 While varying rates were used to model the treatment of dissolved copper and zinc, a 75% flat-rate value was adopted to model the removal of particulate copper and zinc (including Sectors 1-5 for which an 80% TSS removal rate has since been specified). The removal rate for total copper and zinc was therefore a value less than 75% for all devices, being a function of the dissolved metal removal rate, the particulate metal removal rate and the proportion of the metal in the dissolved and particulate forms. For example, the removal rate of total zinc by swales was 67.5%, this being the result of applying different removal rates in calculating the dissolved

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[15] Semadeni-Davies, A. and Altenberger, A. 2009 Catchment Contaminant Annual Loads Model (C-CALM): User Manual. NIWA client report: AKL-2009-060.

and particulate zinc loads discharged by this form of treatment. The lower the dissolved metal removal rate and the greater the proportion of the metal in its dissolved form, the lower the removal rate of the total metal.

44 The adoption of the 75% removal rate of particulate copper and zinc for all devices was made on the assumption that the distribution of the particulate form of the metals among particle size classes is consistent with the distribution of sediments among these classes. Where this assumption holds true, the removal of 75% of TSS will result in the removal of 75% of particulate zinc and copper.

45 Monitoring by NIWA of the performance of ponds treating stormwater discharged from locations in the Auckland motorway network has found that removal rates of particulate zinc and copper can be lower or higher than removal rates of TSS. Monitoring of a pond full of emergent vegetation on State Highway 1 (SH1) near Redvale found that loads of TSS, particulate zinc and particulate copper were reduced by 71%, 77% and 63%, respectively.[16] Monitoring of an un-vegetated pond at the intersection between SH1 and SH17 near Silverdale found that loads of TSS, particulate copper and particulate zinc were reduced by 56%, 69% and 60%, respectively.[17] These results suggest that particulate metals can be disproportionately distributed across either the coarser or finer particle size fractions.

46 In order to examine the influence of the situation in which lower proportions of particulate zinc and copper are removed than TSS, comparative loads of zinc and copper have been calculated, based on a lower particulate zinc and copper removal rate of 60% for wetlands. This is consistent with the lowest of the rates estimated from the monitoring of the ponds at Redvale and Silverdale.

47 Table 3 in Annexure A presents the comparative loads of zinc and copper for each Sector and in total, and compares these with the original loads. For the Project area as a whole, loads of zinc and copper are estimated to be 13-19 % higher then the original estimates. Increases are again highest in Sector 9 due to the marked increase in the stormwater catchment area in this Sector.

48 Table 4 in Annexure A presents the comparative loads of zinc and copper discharged from the catchments within which the Project is located relative to the current baseline. The estimated loads for

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16 Moores J, P Pattinson and C Hyde. 2010. Enhancing the control of contaminants from New Zealand's roads: results of a road runoff sampling programme. New Zealand Transport Agency research report 395. 161pp.

17 Moores, J., Pattinson, P., Reed, J., McHugh, M. and Cavanagh, J. 2008. Mitigation Strategies for Controlling the Dispersion of Particulate Metals Emitted from Vehicles. NIWA report AKL-2008-048 prepared under FRST contract C01X0405. 78p.

2016 and 2026 are slightly higher than the original estimates (up to 1.9%). They remain lower than the estimated baseline loads discharged from the catchments, other than zinc in 2026 (0.5% higher than baseline).

49 In calculating these comparative load estimates, no changes were made to the 75% removal of particulate zinc and copper by swale and infiltration strips or cartridge filters.

50 The value of 75% removal for swales and infiltration strips coincides with the mean of the ‘medium’ and ‘high’ literature-derived values available in C-CALM. Monitoring by NIWA of a swale adjacent to SH1 near Northcote Rd found that loads of particulate zinc and copper were reduced by 90% and 87%, respectively[18] Based on the literature reviewed in the derivation of the C-CALM removal rates and these local monitoring results, I consider that 75% is a realistic value for the removal of particulate zinc and copper by a well-designed and maintained swale or infiltration strip.

51 The value of 75% removal for cartridge filters coincides with the ‘medium’ literature-derived value available in C-CALM. The C-CALM ‘high’ value is 95%. There is a lack of local field data on the performance of these devices and NIWA is currently involved in a research project which aims to address this gap. Based on the literature reviewed in the derivation of the C-CALM removal rates, I consider that the adoption of the ‘medium’ C-CALM removal rate provides a reasonable basis for the modelling of particulate zinc and copper loads treated by a well-designed and maintained cartridge filter unit while acknowledging that there is uncertainty in relation to the performance of these types of device.

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Jonathan Moores
November 2010

Annexure:

Annexure A Results of additional sediment and contaminant load modelling

[18] Moores J, P Pattinson and C Hyde. 2010. Enhancing the control of contaminants from New Zealand’s roads: results of a road runoff sampling programme. New Zealand Transport Agency research report 395. 161pp.

ANNEXURE A: RESULTS OF ADDITIONAL SEDIMENT AND CONTAMINANT LOAD MODELLING

Table 1: Estimated future annual sediment load (tonnes year^{-1}) and zinc and copper loads (kg year^{-1}) for the above-ground parts of the Project motorway area, based on revised device catchment areas and 80 % TSS removal in sectors 1 to 5. All other model inputs are unchanged. Values in brackets are the original load estimates presented in Report G30.

Sector	TSS		Zn		Cu	
	2016	2026	2016	2026	2016	2026
1	3.21 (4.59)	3.59 (5.14)	85 (97)	96 (111)	10 (11)	11 (12)
2	0.43 (0.62)	0.47 (0.68)	9 (10)	10 (11)	1 (1)	1 (2)
3 and 4	3.81 (4.28)	4.15 (4.66)	78 (69)	87 (76)	11 (9)	12 (10)
5	2.21 (3.42)	2.34 (3.59)	50 (44)	53 (47)	6 (6)	6 (6)
6	1.68 (3.61)	1.76 (3.78)	38 (58)	40 (61)	4 (8)	4 (8)
9	2.88 (1.67)	3.31 (1.92)	61 (36)	73 (42)	7 (4)	8 (5)
Total	14.22 (18.19)	15.62 (19.77)	321 (314)	359 (348)	39 (39)	42 (43)

Table 2: Estimated total baseline and future annual sediment load (tonnes $year^{-1}$) and zinc and copper loads (kg $year^{-1}$) discharged from all catchments within which the Project is located based on revised device catchment areas and 80 % TSS removal in sectors 1 to 5. All other model inputs are unchanged. Values in brackets are the percentage change from the original load estimates presented in Report G30.

	TSS	Zn	Cu
Baseline	1603	3736	480
2016	1588 (-0.3 %)	3665 (-0.2 %)	462 (-0.2 %)
2026	1590 (-0.3 %)	3715 (+0.2 %)	466 (-0.2 %)

Table 3: Estimated future zinc and copper loads (kg year^{-1}) for the above-ground parts of the Project motorway area, based on revised device catchment areas and a 60 % particulate metal removal rate for wetlands. All other model inputs are unchanged. Values in brackets are the original load estimates presented in Report G30.

Sector	Zn		Cu	
	2016	2026	2016	2026
1	97 (97)	110 (111)	13 (11)	15 (12)
2	9 (10)	10 (11)	1 (1)	1 (2)
3 and 4	78 (69)	87 (76)	11 (9)	12 (10)
5	54 (44)	58 (47)	7 (6)	7 (6)
6	45 (58)	47 (61)	6 (8)	6 (8)
9	72 (36)	85 (42)	9 (4)	11 (5)
Total	355 (314)	397 (348)	47 (39)	52 (43)

Table 4: Estimated total baseline and future annual zinc and copper loads (kg $year^{-1}$) discharged from all catchments within which the Project is located based on revised device catchment areas and a 60 % particulate metal removal rate for wetlands. All other model inputs are unchanged. Values in brackets are the percentage change from the original load estimates presented in Report G30.

	Zn	Cu
Baseline	3736	480
2016	3712 (+1.1 %)	471 (+1.7 %)
2026	3754 (+1.3 %)	476 (+1.9 %)