APPENDIX I Hydrogeological Memorandum

TREC – Effect on Wetlands – Bridge 217 (PNGL)

To	Sean Crocker (TREC)
CC	Lisa Arnold (TREC), Emily Frost (TREC), Melanya King (TREC), Ben Ryder (TREC)
From	Tony Reynolds
Date	1 October 2025
Subject	Bridge 217 Wetland Effects
Reference	-
Revision	FINAL

1. Introduction

The site is located around Bridge 217 on the Palmerston North Gisborne Line (PNGL), at Awatoto, south of Napier, on the Tūtaekurī River (refer Figure 1). For detailed information on site history, background, and need for the works, please refer to the main application.

KiwiRail temporarily repaired Bridge 217 (PNGL) after it was significantly damaged during Cyclone Gabrielle in February 2023. The bridge was reopened in September 2023 with an expected lifespan of 5 years. It is currently proposed to extend the target design life of the rail bridge. This will require significant work to extend the life of the temporary repair, to maintain the same level of resilience to future flood events as existed before the cyclone.

Specifically, it has been proposed that the dry riverbed (often referred to as a berm[1]) levels of the Tūtaekurī River around Bridge 217 (PNGL) will be lowered. The dry riverbed lowering will take place through to the coastal gravel bank/beach, including in and under State Highway 51 (SH51) Tūtaekurī (Awatoto) Bridge. The dry riverbed will be lowered on the northern and southern side of the river by approximately 1-2 m to RL 1.2 or 0.5m above mean high water springs (MHWS), facilitated by the removal of aggraded silt. Protection of the bridge piers (8, and 16 to 22) and the northern abutment, using rock riprap protection installed 2 – 3 m below the existing dry riverbed level will be completed as part of the lowering works.

[1] A berm is the strip of land beside the river. If there are stopbanks, it is the land between the river and the stopbank. The berm area is a natural extension of the main river channel and can carry flood flows.

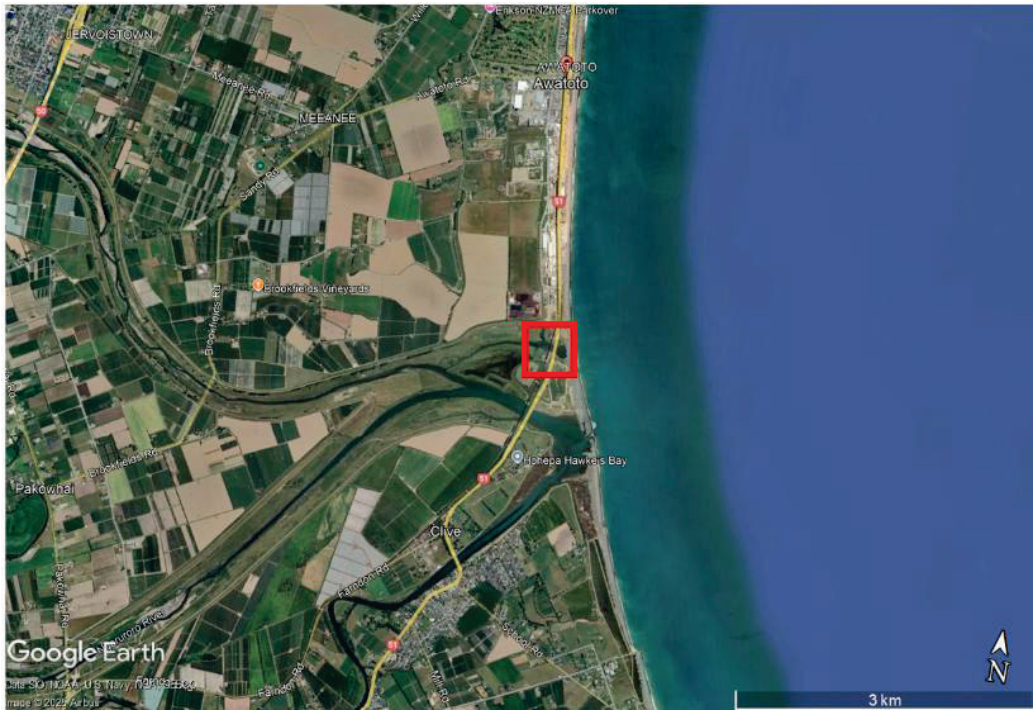

Figure 1. Site location (red box) in relation to rivers discharging at the coast. The Ravensdown factory is located directly to the north of the site, with Awatoto further north. The townships of Clive and Whakatu are located to the south southwest.

2. Purpose and scope

This memorandum assesses the relationship between the proposed bed disturbance activities, lowering the dry riverbed of the Tūtaekurī River, and the influence this may have on groundwater and water levels within the four large wetlands south of the river. The four wetlands are located between the Tūtaekurī River, in the north, and the mouth of the Te Awa o Mokotūāraro and Ngaruroro River, to the south.

Eight further wetlands have recently been identified (King, 2025) on the true left (northern) and true right (southern) banks of the Tūtaekurī River. Some are located within or close to the proposed works area, with the potential for groundwater or overland flows to these wetlands to be affected. Some of these wetlands are natural inland wetlands (Wetlands A to C, and 1, 4, 4.5, and 6 to 8), others are coastal wetlands (Wetlands D and 2, 3, and 8). The same evaluation methodology has been applied to each wetland.

Additionally, this study evaluates how the installation of in-ground rock riprap scour protection around the piers and northern abutment may affect water levels in the eight natural inland wetlands.

The report details the relationship between the river, the bed removal works, and the water levels in the large wetlands south of the river.

Recommendations and/or conditions on how the adverse effects of these works can be avoided, remedied, or mitigated and/or monitored during the construction have also been included.

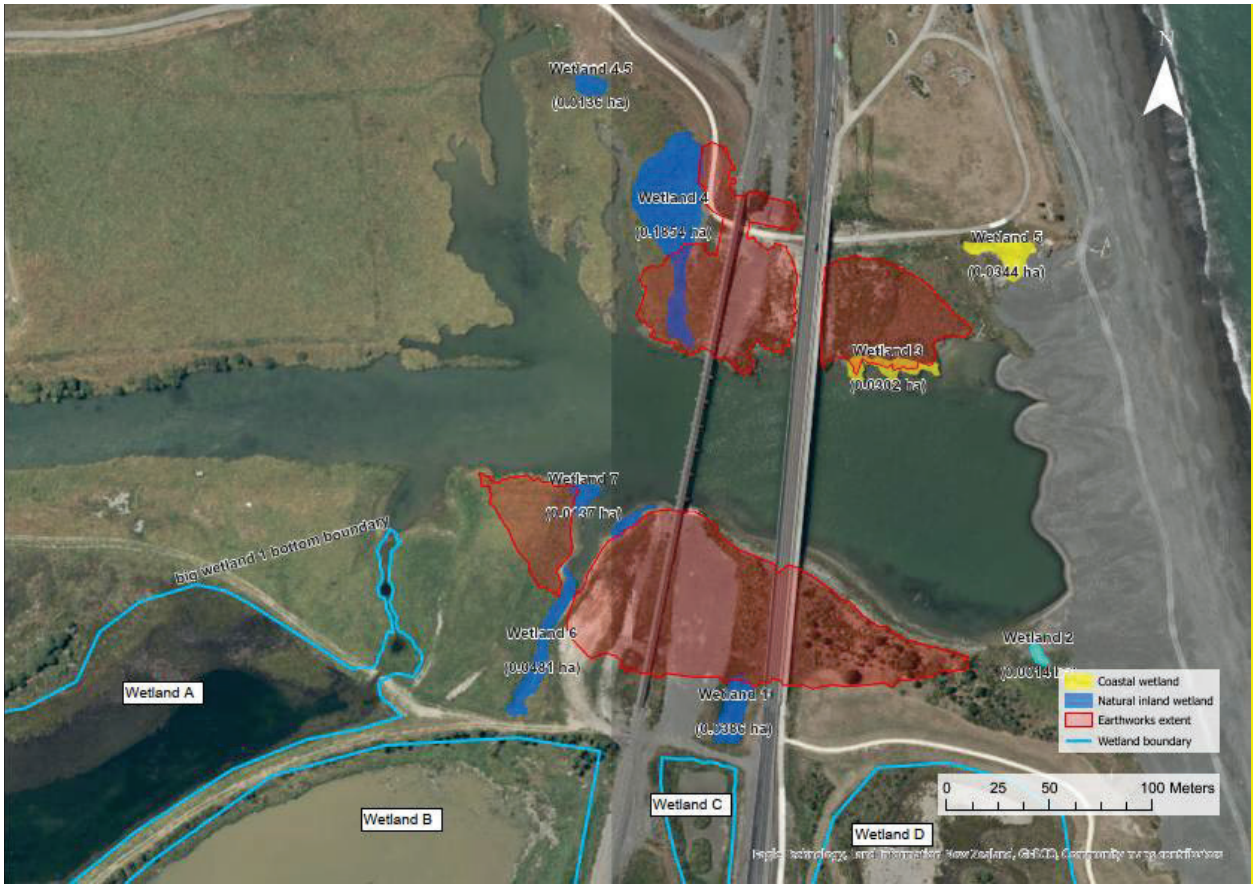

Figure 2. Wetlands evaluated in this memorandum (includes earthworks boundary). Note that wetland 2 does not meet the definition of a wetland and wetlands A, B, C, and D are not affected by the works.

3. Hydrogeological setting

3.1 Hydrogeological model

The hydrogeological model adopted for this site is that of an unconfined aquifer with a groundwater table in the near surface silty sand material. In elevated parts of the site the groundwater level is approximately 2 m bgl and expected to be above mean sea level. Close to the river groundwater levels are expected to be similar to river levels. Groundwater levels are supported by rainfall recharge and by high river flows. Groundwater flow is generally expected to be towards the river when river levels are low (typically median flow or lower). Further details are provided below.

3.2 Lithology

Details of the site geology are provided in Blaiser and McInnes, 2025. The geological long section[2] provides geotechnical unit layer names and labelling. Based on the long section and drawing set information, the dry riverbed removal and riprap protection will be completed in the uppermost layer A. Layer A is described as: -

> *Silty sand – sandy silt, dark grey to brown, very loose to loose / very soft to soft, moist, low plasticity. Sands are typically fine with some medium size. Unit contains some bands of medium to coarse gravel.*

[2] Refer drawing entitled Bridge Repairs Existing Rail Bridge Plan and Geological Section, TREC document code A0006-PL-00-00000-BR-DG-TREC-003001 dated 03/06/2025.

The underlying Layer B is described as: -

> *Gravel – gravelly sand, medium dense to dense, poorly / gap graded. Mainly fine gravel to coarse sand with coarse rounded gravels. Upper part of unit may have silt / clay matrix.*

This layer is inferred to form part of the unconfined aquifer.

3.3 Aquifer parameters

Based on the description of Layer A, the hydraulic conductivity (often referred to as permeability) of the water table aquifer is expected[3] to be in the range 10^{-3} – 10^{-1} m/day and specific yield in the range 0.06 – 0.16. However, the hydraulic conductivity may be variable (e.g. higher than reported here). For example, hydraulic conductivity is modelled as higher than expected when considering its effect on groundwater levels in combination with rainfall recharge.

3.4 Climate parameters

The shallow groundwater is expected to be affected by the tide level and to be recharged by rainfall over the site. The adopted annual recharge value (Westerhoff et al 2018) for this area is 0.66 mm/day or 0.241 m/year. The mean annual rainfall recorded in Napier (Nelson Park) is 786 mm/year (Chappell, 2013). Based on Napier Port tidal levels and datum descriptions[4] mean sea level near the site is -0.12 mRL with MHWS at 0.77 mRL and MLWS at -0.97 mRL.

3.5 Water levels

3.5.1 Groundwater level

Shallow groundwater was reported in the geotechnical factual report (RDCL, 2023) as 1.9 mbgl or 0.35 mRL. This level was observed at BH103 drilled on the northern bank of the Tutaekuri River. The report noted that groundwater levels were expected to be similar on the southern bank. Artesian groundwater was encountered over 32 mbgl at boreholes drilled on the southern and northern banks. The reported artesian groundwater level was over 1.5 m above ground level (over 3.8 mRL) in both boreholes.

Based on the shallow groundwater level Layer A contains the water table (phreatic surface) of the unconfined aquifer. The groundwater level is affected by tide and river levels as noted on drilling logs.

Groundwater levels have been reported[5] recently from a hand auger investigation at Wetland 1 (HA 1) and to the north of Wetland 1 (HA 2). Wetland 1 is located on the southern bank. Table 1 (below) summarises the groundwater levels noting that reported groundwater levels are close to mean sea level, i.e. well below the proposed cut level.

Table 1. September 2025 groundwater level summary based on hand auger investigation.

WETLAND	APPROXIMATE LOCATION (NZTM)	GROUNDWATER LEVEL (M RL)
HA 1	1937022 5613482	- 0.045
HA 2	1937025 5613495	- 0.3

[3] Kruseman, G.P. and de Ridder, N.A. (1994) Analysis and Evaluation of Pumping Test Data. 2nd Edition, ILRI, Publication 47.
[4] https://www.linz.govt.nz/guidance/marine-information/tide-prediction-guidance/standard-port-tidal-levels
https://www.linz.govt.nz/guidance/marine-information/tide-prediction-guidance/standard-port-datum-descriptions
[5] Email Doherty/Crocker "Wetland 1 Groundwater Levels" dated 29/09/2025 08:26.

3.5.2 Surface water levels

River flows are typically controlled by the flow area perpendicular to the flow direction (i.e. river cross-section), slope of the river, and channel conveyance capacity. As river flows increase the depth and width of flows typically increase. The proposed dry riverbed removal is intended to improve passage of flood flows by increasing the size of river cross-section above 1.2 mRL at Bridge 217. The proposed works are unlikely to have any effect on typical flows whose level is below the cut level and MHWS.

4. Wetland description

Thirteen wetlands have been reported in the vicinity of the site (refer to Figure 2). There are four large wetlands (referred to as Wetlands A, B, C, and D, labelled from west to east) located to the south of the Tūtaekurī River. The remaining wetlands comprise two coastal wetlands, a third that does not meet the threshold for a wetland and six natural inland wetlands. These nine locations are described in King, 2025. The full list, with areas is tabulated below.

Table 2. Wetland summary.

WETLAND	CLASSIFICATION	WETLAND AREA (M^2)
A	Natural Inland Wetland	136,675
B	Natural Inland Wetland	62,230
C	Natural Inland Wetland	2,386
D	Coastal Wetland	47,347
1	Natural Inland Wetland	386
2	Does not meet wetland threshold	14
3	Coastal Wetland	302
4	Natural Inland Wetland	1,853
4.5	Natural Inland Wetland	135
5	Coastal Wetland	344
6	Natural Inland Wetland	481
7	Natural Inland Wetland	137
8	Natural Inland Wetland	98

5. Methodology and assumptions

5.1 Effect of dry riverbed modification on Wetlands A, B, C, and D

This memorandum assesses the effect of lowering the dry riverbed of the Tūtaekurī River, and the influence this may have on groundwater and water levels within Wetlands A, B, C, and D.

The adopted method is used to show whether groundwater will be intercepted by the proposed dry riverbed removal. The method considers steady flow in an unconfined aquifer (Fetter, 1994) with rainfall recharge between two known water levels. In this case, the water levels adopted are mean sea level in the Te Awa o Mokotūāraro and Ngaruroro Rivers and Tūtaekurī River. We have used Wetland B for this assessment and applied the results to the other wetlands A, C, and D. Assumptions of this method include:

- The hydraulic gradient is equal to the slope of the water table,
- Where water table gradients are small the equipotential lines are vertical, and
- No seepage face is modelled.

5.2 Dry riverbed modification on Wetlands 1 - 8

Nine additional wetlands (Wetlands 1 to 8) are located on the true left and true right banks of the Tūtaekurī River. Some are located within or close to the proposed works area, with the potential for groundwater or overland flows to these wetlands to be affected.

The adopted methodology considers the changes to the wetland size and wetland catchment area resulting from the works. The catchment area is included to help determine whether the input of groundwater and surface water to the wetlands may change because of the works. Any changes in these areas are interpreted as showing change in water inputs to the wetlands. The same evaluation methodology has been applied to each wetland.

5.3 Riprap protection on Wetlands 1 - 8

Additionally, this study evaluates how the installation of in-ground rock riprap scour protection may affect water inputs to potentially affected wetlands. Drawings showing the proposed riprap works are provided in the drawing set. Wetland 8 on the southern bank and wetland 4 on the northern bank are the potentially affected wetlands.

The adopted methodology considers groundwater levels beneath each wetland and whether these may be affected by the installation. This evaluation is qualitative as wetland 8 will also be affected by dry riverbed removal works and parts of wetland 4 will be removed during dry riverbed removal and riprap protection installation. The key assumption is that the observed depth to groundwater can be applied across the site.

6. Results

6.1 Effects of dry riverbed modification on Wetlands A, B, C, and D

We have estimated the water table level between Wetland B and the river level in the Tūtaekurī River and assumed that the wetland water surface represents the water table level beneath the wetland. The groundwater beneath the wetland will flow towards the river, driven by the slope of the water table. When the groundwater table intercepts the cut surface (1.2 mRL), it is reasonable to assume that it will be observed as surface water and will start to drain the wetland. On this basis, the cutting of the adjacent dry riverbed should only be undertaken where the predicted water table is below 1.2 mRL.

The results of the analysis for Wetland B are shown in Figure 3. The figure shows the estimated water table, based on rainfall recharge, under existing conditions with river levels at mean sea level and wetland water surface at an estimated 1.7 mRL (based on review of 2023 LiDAR information). This figure shows that the cut surface is unlikely to intercept the groundwater table under these conditions, providing the cut is located at least 40 m from the mapped edge of each wetland. The edge of the cut surface is located more than 40 m from each of Wetland A, B, C, or D.

Note that this analysis does not consider the effects of increased wetland water levels or river levels. Should these increased levels occur, during and following high rainfall and/or periods of high river flow, it is possible that groundwater seeps from the wetland may be observed, commencing near the toe of the finished cut slope closest to the wetland. These seeps, if they occur, may have the potential to cause erosion near the toe of the cut slope and some drainage of the wetland. Providing the edge of the works remains at least 40 m from Wetland A, B, C, or D with a finished cut slope of 45 degrees or less, and considering recently observed low groundwater levels, the risk of seepage and wetland drainage is expected to be negligible.

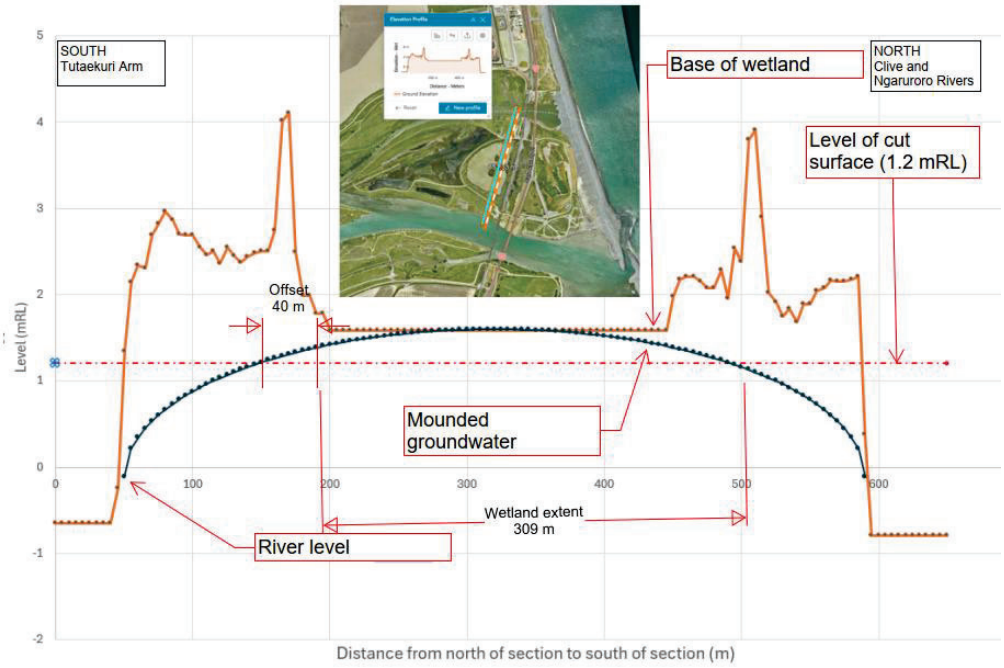

Figure 3. Cross section model through Wetland B between the Tutaekuri Arm and Te Awa o Mokotūāraro and Ngaruroro Rivers. The inset shows the location of the cross-section. Note that the inferred groundwater level is well below the cut surface, while a 40 m offset from the wetland is required considering the potential elevated groundwater surface beneath Wetland B.

6.2 Effects of dry riverbed modification on Wetlands 1 – 8

The effect of the dry riverbed modification on wetlands 1 – 8 is tabulated below with a description of proposed mitigation to offset the loss of the wetland.

Table 3. Wetland commentary and mitigation

WETLAND	COMMENTARY	MITIGATION REQUIRED?
1	The catchment for the wetland does not extend into the cut zone and so there is no reduction of water input to the wetland and therefore no effect. The proposed cut north of the wetland will not intercept reported groundwater levels in the dry riverbed and therefore no drainage effect is expected.	None
2	No effect.	None

WETLAND	COMMENTARY	MITIGATION REQUIRED?
3	Proposed dry riverbed removal area extends into the current catchment for this wetland. There will be an approximate loss of 70% of the catchment input to the wetland.	Assume mostly lost. Wetland offsetting recommended to support a favourable DOC concession decision outcome. This mitigation is recommended in and around wetland 5 as part of the lizard habitat offset planting. Funding will be provided to Ngāti Parau as part of the wider offset planting to mitigate the adverse effects of wetland loss across the wider project. The offsetting value will be determined by the ecology team.
4	A portion of this wetland will be lost to dry riverbed removal and riprap protection works and ongoing operation of the riprap. However, the inferred groundwater level is below the level of the remaining wetland. No drainage effects are expected following the loss.	Partial loss. Bund proposed on the eastern edge of the wetland to give a slight improvement and act as a visual boundary. In combination with wetland 3 offset mitigation will be provided to Ngāti Parau to offset the loss of the wetland. The offsetting value will be determined by the ecology team.
4.5	No drainage effect expected either by change in catchment or the cut for dry riverbed removal. We understand that site works will be managed to avoid this area and the catchment.	No further mitigation required
5	No drainage effect expected either by the change in catchment or the cut for dry riverbed removal. We understand that site works will be managed to avoid this area and catchment.	No further mitigation required
6	Approximately 25% of the catchment and wetland will be lost to works.	Mitigation required. In-situ remediation will be undertaken, ensuring that the surface water catchment is retained. Where parts of the wetland have been lost to dry riverbed works these sections will be reinstated to the original extent.
7	The current catchment for this wetland extends into the proposed dry riverbed removal area. There will be an approximate loss of 30% of the catchment input to the wetland. Most of the remaining wetland is at 1.2 mRL or lower, so no further drainage effects are expected.	Mitigation required. In-situ remediation will be undertaken, ensuring that the surface water catchment is retained. Where parts of the wetland have been lost to dry riverbed works these sections will be reinstated to the original extent.
8	The current catchment for this wetland extends into the proposed dry riverbed removal area. There will be an approximate loss of 50% of the catchment input to the wetland. The remaining wetland is at 1.2 mRL or lower, so no further drainage effects are expected.	Mitigation required. In-situ remediation will be undertaken, ensuring that the surface water catchment is retained. Where parts of the wetland have been lost to dry riverbed works these sections will be reinstated to the original extent.

6.3 Effect of riprap protection on Wetlands 1 - 8

As noted, earlier, Wetland 8 on the southern bank and Wetland 4 on the northern bank are potentially affected by the riprap protection works. The cuts and riprap protection locations are shown on the proposed earthworks figure[6]. The installed riprap comprises of the placement of large rock with a median diameter of 900 mm. It will generally be installed from -0.6 mRL (i.e. about 0.48 m below MSL) back to 1.2 mRL. The riprap typically has a higher hydraulic conductivity than the surrounding soils and may reduce groundwater levels in the part of the groundwater flow path from the higher ground to the river.

On the southern bed the riprap will be installed around pier 8 and extend 4 m from the pier. As this riprap forms a small part of the total cut dry riverbed, and is isolated from the river, the effects on groundwater

[6] Refer drawing A0006-PL-00-00000-BR-DG-TREC-001001 in the drawing set.

are difficult to quantify. However, groundwater level changes are expected to be small and may not be observed, considering the likely larger water level changes associated with the daily tidal cycle.

On the northern bed the riprap installation is larger, running from an area supporting the northern embankment and down the line of piers towards the Tūtaekurī River. The riprap is likely to drain groundwater from the area around it as the riprap will be installed to a depth below the existing groundwater level and provide a drainage path to the Tūtaekurī River.

The riprap is located adjacent to Wetland 4. The southern part of Wetland 4 will be removed by the dry riverbed modification and so is not considered further. The part of Wetland 4 that will not be removed has a surface level of approximately 1.6 - 2.3 mRL. The groundwater level reported during drilling BH103 (about 10 m from pier 16) was 1.9 mbgl or 0.35 mRL. On this basis, any groundwater intercepted by the riprap protection would not cause drainage from the wetland. Notwithstanding the effect of the removal of parts of the wetland for the riprap protection, and the groundwater drainage caused by the riprap, the works are not expected to affect the hydrological functioning of the remaining portion of Wetland 4.

7. Summary

This memorandum evaluates the potential impacts of proposed engineering works at Bridge 217 on the Palmerston North Gisborne Line (PNGL), located at Awatoto on the Tūtaekurī River. The works aim to extend the target deign life of the bridge following damage from Cyclone Gabrielle in 2023. Key components addressed in this memorandum include lowering the dry riverbed and installing rock riprap protection around bridge piers and abutments.

The assessment focuses on how these activities may affect nearby wetlands through changes in groundwater levels and surface water catchments.

7.1 Key findings

The proposed dry riverbed modification and riprap protection works around Bridge 217 (PNGL) are expected to have varying impacts on nearby wetlands, depending on their location and the hydrological characteristics of the wetlands.

7.1.1 Dry riverbed Modification Effects

For Wetlands A to D, it is recommended that dry riverbed cuts be located at least 40 metres away from the wetlands with a finished cut slope of 45 degrees or less to reduce the risk of seepage flows from the toe of the cut slope and wetland drainage.

For Wetlands 1 to 8, the effects are more varied:

- Wetlands 3, 4, 6, 7, and 8 are expected to experience loss of catchment area or direct physical impact from the works. Therefore, mitigation measures such as offset planting, bunding, and in-situ remediation are required for these wetlands.
- Wetlands 1, 2, 4.5, and 5 are not expected to be affected by the dry riverbed modification, and no mitigation is needed for these areas.

7.1.2 Riprap Protection Effects

Wetland 4 will have its southern portion removed due to the riprap installation and dry riverbed works. However, the remaining part of the wetland is not expected to be affected, as the groundwater level is sufficiently deep to prevent drainage.

Wetland 8 may experience a low level of effects due to the small area of riprap installation and the influence of tidal fluctuations. These effects are considered negligible.

8. Limitations

This desk study memorandum has been prepared on the basis of publicly available information and information from works completed by others. We have not independently verified the information and have relied upon it being accurate and sufficient for use by us in preparing this memorandum.

9. References

Blaiser T, and McInnes B, 11 September 2025, A0006 Bridge 217 PNGL – Remedial Works, Geotechnical Interpretive Report, Transport Rebuild East Coast document A00006-PL-00-17000-GO-RP-TREC-000001 Rev 1.0

Chappell, P.R. 2013. The climate and weather of Hawke's Bay. NIWA Science and Technology Series 58, 44 pp.

Drawing set Bridge 217 PNGL – 170.5031, 21 pages at #17_A0006_BR 217_drawing set.pdf

Fetter, C.W. 1994 Applied Hydrogeology. 3rd Edition, Prentice-Hall Inc, New Jersey.

Frost, E. 23 April 2025, Awatoto Bridge 217 Ecological Report Summary, Revision 1, Transport Rebuild East Coast document C5001-02-577-12000-EW-PP-TREC-000001 Rev. 1

King M, 26 August 2025, Bridge 217 (Wetland delineation report), Transport Rebuild East Coast document C5001-02-577-12000-EW-PP-TREC-000001 Rev. 1

RDCL, 22 June 2023, Tutaekuri Bridge - Geotechnical Factual Report (BH102 & BH103). Reference L230430-01.

Westerhoff, R.S.; White, P.A.; Rawlinson, Z.J. 2018 Incorporation of satellite data and uncertainty in a nationwide groundwater recharge model in New Zealand. Remote Sensing, 10(1): article no. 58; doi: https://doi.org/10.3390/rs10010058

Wetland shapefiles, existing surface tif, and cut surface tif stored at TREC sharepoint link to GIS Team data for wetland evaluation