EGL
Geotechnical, Earthquake and Dam Engineers

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Te Tai Tokerau Water Trust
6 Woods Street
Whangarei

6 December 2021

Attention: Andrew Carvell

Dear Andrew,

OTAWERE WATER STORAGE RESERVOIR
839 TE AHU AHU ROAD, NORTH WAIMATE
PEER REVIEW OF DESIGN – STAGE 1

Engineering Geology Limited (EGL) has been engaged to provide peer review of the preliminary design (Stage 1) of the dams that form the proposed Otawere Water Storage Reservoir. The dams are to be constructed on a property at 839 Te Ahu Ahu Road, North Waimate. The preliminary design of the dams has been undertaken by Riley Consultants Limited (RCL). The reservoir will be formed by two earthfill embankment dams (Main dam and a Saddle dam). The Main dam is approximately 15 m high, and the Saddle Dam is approximately 8 m high. The spillway is located at the site of the Saddle Dam. The 1.8 m diameter pipe will function as a diversion during construction.

Our peer review has been based on review of the following reports, along with a site inspection and meetings with RCL:

1. Hydrology and Hydraulics Assessment (RCL Ref. 210038-OTA-D, Issue 1.0)
2. Preliminary Dam Design Assessment (RCL Ref. 210038-OTA-M, Issue 1.0)
3. Draft Dam Safety Management Plan (RCL Ref. 210038-OTA-K, Issue 1.0)
4. Draft Emergency Action Plan (RCL Ref. 210038-OTA-N, Issue 1.0)

Based on our review of draft versions of the above documents we provided comments in review registers, one for geotechnical investigations and preliminary dam design and the other for hydrology and hydraulics. RCL has considered and provided responses and they are included in the attached review registers. RCL has incorporated our comments in the reports submitted in support of the Resource Consent application where applicable. Some comments will not be acted upon until the detailed design stage and this is considered appropriate.

RCL has undertaken geotechnical investigations, assessed the technical feasibility, prepared a technical risk register, developed design concepts and preliminary design details for the embankments, prepared Drawings, undertaken hydrologic and hydraulic studies, and assessed the Potential Impact Classification (PIC). Further geotechnical investigations are proposed to address identified geotechnical risks and to provide information for detailed design.

From a geotechnical perspective the proposed Water Supply Scheme is a challenging one with the presence of quite different material types to the East and West with associated slope instability, an inferred major thrust fault with an accompanying disturbed and possibly permeable zone through

the reservoir and at both dam sites, as well as a considerable depth of near-surface weak alluvium with permeable layers. Deep excavations will be necessary to remove weak and permeable ground to provide a suitable foundation on which the dams can be constructed.

From our review of the documents provided, site inspection (15 July 2021) and discussions with RCL we are satisfied that RCL are well aware of the geotechnical issues and risks and that they are developing appropriate engineering solutions in their initial design. A programme of additional boreholes and other field tests has commenced and should greatly help in refining the geological model and provide information for detailed design. In view of the complex site geology a greater intensity of subsurface investigation than would perhaps normally be needed, is warranted for the successful design of the scheme components, especially at the dam sites. However, we consider that none of the geotechnical issues identified to date are beyond a satisfactory engineering solution. It will be necessary to undertake more site investigations for detailed design with the process subject to ongoing peer review.

The site geology and geotechnical conditions are the biggest challenge for this project. Comprehensive geotechnical investigations have been undertaken to allow development of a geological model that is considered sufficient to develop a preliminary design. Site investigations are ongoing to refine the understanding of the site geology.

In general, the preliminary dam design is based on sound principles and design concepts are considered appropriate. The preliminary design assumes sub excavation to considerable depth to remove weak, compressible, and permeable ground. This is considered appropriate based on the results from the site investigations.

RCL has also prepared a draft Dam Safety Management Plan (daft-DSMP) and a draft Emergency Action Plan (draft-EAP). The DSMP is important to assure the ongoing safety of the dam post construction. It has been prepared in accordance with Module 5 of the New Zealand Dam Safety Guidelines (NZDSG, 2015) published by the New Zealand Society on Large Dams (NZSOLD). The purpose of an EAP is to provide guidance on preparedness and actions to be taken to minimise the potential for dam failure and damage through preventive and emergency actions. It has been prepared in accordance with Module 6 of the NZDSG. It is envisaged that both these documents be updated and provided to stakeholders, authorities, and emergency response parties at least four months before the end of construction.

Yours sincerely
ENGINEERING GEOLOGY LTD

Prepared by

T. Matuschka CPEng, FEngNZ

Attachments:

Peer Review Register – Geotechnical Investigation and Preliminary Dam design
Peer Review Register – Hydrology and Hydraulics

Peer review summary sheet – Geotechnical Investigations and Preliminary Dam Design

Project details

Project title	Otawere Water Storage Reservoir
Project location/Address	839 Te Ahu Ahu Road, North Waimate (-35.05855, 173.9007)
Project description	Peer Review of Dams that form the Otawere Water Storage Reservoir
Designer/Study author	Riley Consultants Limited
Reviewer	Engineering Geology Limited (EGL)
Reviewer's Client	Te Tai Tokerau Water Trust
Review scope	Review of geotechnical investigation and studies for report in support of application for Resource Consent

Review sheet revision history

Version	Date	Issued By	Description of Revision
A	26/07/2021	EGL	First issue
B	10/09/2021	EGL	Second issue
	24/11/2021	RILEY	Replies to earlier EGL comments
B	3/12/2021	EGL	Replies to RCL feedback

Reviewer comment categories

Major Issue	Review comment raises potential critical issue – review comment requires resolution through change and additional information
Important Issue	Review comment raises important issue – requires discussion and/or additional information
Request for Info	Review comment requests further information – please provide information
Note	Review comment makes notes for designer/author – no response to comment required
Comment Closed	Comment closed

Review documentation list

Doc. Ref Number	Date Received	Document Reference
1	8/07/2021	Letter - MN02 Initial Geotechnical Findings and Considerations
2	8/07/2021	Report – MN-02 Preliminary Hydrology and Hydraulics Assessment
3	8/07/2021	Report – Preliminary Geotechnical and Site Suitability Assessment Otawere (MN-02) Water Storage Reservoir, Waimate North. Note, Geotechnical Factual Report included in Appendix B.
4	8/07/2021	Geotechnical Feasibility and Risk Register Update (draft). Note, this includes rev. 2 of the Geotechnical Risk Register.
5	10/09/2021	Otawere Water Storage Reservoir Preliminary Dam Design Assessment Report Rev02

Review Comments

No.	Document	Peer Reviewer				Designer/Study Author		Peer Reviewer		Status
		Date	Reference	Comment	Comment category	Date	Comment	Date	Comment	
1	1	23/7/21	Letter 17 Feb and risk register	Adequate initial scheme description. Risk Register updated in letter 24 May 21	Note					
2	2		Hydrology Report	No dam break analysis is given for Saddle Dam. Needs a comment	Request for Info	17 Nov. 21	This has been undertaken – refer RILEY Hydrology and Hydraulics report ref. 210038-OTA-D	3/12/2021	Accepted	Closed
3	3		Preliminary Geotechnical Report- Fault definition	The geological model needs updating, particularly the emplacement thrust fault location and its orientation. If the fault trace is at a low angle it will tend to follow the contour and will not be a straight line. The engineering geological map could be improved. Could some of the valley floor be the weathered fault surface? The fault interface zone could be quite complex. Some of the west facing hillslopes in greywacke might also be old fault trace remnants.	Major	17 Nov. 21	Revised geological and geotechnical models, updated for 2021 mapping and 100-level test pits and reinterpretation of existing investigations has been outlined in RILEY Geotechnical Interpretative Report (GIR) and Preliminary Dam Design Assessment (ref. 210038-OTA-F, and 210038-OTA-M). The geo-models will be treated as 'live' and periodically updated during detailed design and with observations during construction monitoring.	3/12/2021	Accepted	Ongoing
4			ditto	The ground conditions adjacent to the thrust fault need defining in regard to the thickness and strength of the, crush/breccia zones in the greywacke and mudstone, as well as the permeability of this zone and the potential for shear surfaces and clay gouge (as found in MH04,05 &06)	Major	17 Nov. 21	This important matter is being progressed with detailed design subsurface investigations, analysis, and interpretation of findings.	3/12/2021	Accepted	Ongoing
5			ditto	The drillholes require relogging to better define the crush zones and layers in the alluvium such as sands and gravels	Important	17 Nov. 21	Selected boreholes have been relogged following the peer reviewers verbal comments and amendments recorded in the logs – appended to the Geotechnical Factual Report (GFR – RILEY ref. 210038-OTA-L) which is included in Appendix C of the GIR (RILEY ref. 210038-OTA-F).	3/12/2021	Accepted	Closed
6			Main Dam left abutment	Owing to deep weathering in the left abutment (MH01), the amount of excavation required, and associated stability needs analysis.	Major	17 Nov. 21	A preliminary analysis has been undertaken, which incorporates the deep weathering profile, and the stability analysis for undercut and construction stability will be confirmed during detailed design.	3/12/2021	Accepted	Ongoing
7			ditto	There appears to be an existing deep slump upstream on the left abutment. The stability of this feature and stability improvement measures require assessment.	Major	17 Nov. 21	This feature has been discussed specifically in the GIR (RILEY ref. 210038-OTA-F). Specific stability modelling, with stabilisation measures (if any), will be assessed during detailed design.	3/12/2021	Accepted	Ongoing
8			ditto	The stability of the downstream left abutment needs assessment as well as seepage and erosion potential through the abutment.	Major	17 Nov. 21	Seepage and erosion potential through the left abutment has been assessed in the Preliminary Dam Design Report (ref. 210038-OTA-M). Specific stability modelling, with stabilisation measures (if any), will be assessed during detailed design.	3/12/2021	Accepted	Ongoing
9			ditto	There is possibly a basalt outcrop in the gully immediately downstream of the left abutment. The rock should be identified and mapped, as well as the nature of the interface with the adjoining greywacke, especially for seepage potential.	Request for Info	17 Nov. 21	This item has been discussed specifically in the GIR (RILEY ref. 210038-OTA-F). Mapping has been unable to identify the contact between the basalt and the greywacke. This nature of the basalt and potential for foundation and/or abutment seepage will be further investigated and assessed during detailed design.	3/12/2021	Accepted	Ongoing
10			Main Dam foundation	There is deep, weak and organic alluvium in the foundation with sand and gravel at its base over apparent greywacke breccia over hard fractured rock. The amount of excavation needs defining as well as means of underseepage control and whether a cut off and /or grouting is required. The stabilty of the excavation needs considering as well as the foundation strength.	Major	17 Nov. 21	Foundation conditions in the valley floor are a key consideration. The preliminary design is proposing a full over-excavation of the alluvium as a risk mitigation measure for the variable thickness, permeability, and strength of alluvium in the valley floor (RILEY ref. 210038-OTA-M). The foundation undercut, and the benefit for locally seepage cut off or foundation grouting will be confirmed during detailed design. The design and specification for the deep temporary undercut slope, with stabilisation measures (if any), will be confirmed during detailed design.	3/12/2021	Accepted	Ongoing
11			ditto	The extent of a possible upstream natural seepage blanket within the alluvium needs assessment.	Major	17 Nov. 21	Investigations to date indicates there is a natural blanket of lower permeability material (e.g. alluvium, colluvium, and/or deeply weathered greywacke or NAM) that is least 4m thick and laterally continuous across the reservoir. It is considered that this blanket will act as a natural low permeability liner for the reservoir. This aspect of the geological model will be further investigated and assessed during	3/12/2021	Accepted	Ongoing

							detailed design – and consideration given to the implications, risks and treatment measure(s) if necessary.			
12			Main Dam right abutment	The nature of the greywacke contact with the mudstone needs confirming ie if this is a fault and its permeability and are there possible shear surfaces below the dam.	Major	17 Nov. 21	It is planned to investigate and assess this further with additional cored boreholes during detailed design.	3/12/2021	Accepted	Ongoing
13			ditto	The depth of mudstone weathering and amount of excavation proposed needs defining, together with excavation stability	Major	17 Nov. 21	It is planned to investigate and assess this further with additional cored boreholes during detailed design.	3/12/2021	Accepted	Ongoing
14			ditto	Consideration should be given to possible shear surfaces within the mudstone and the abutment stability as well as seepage and erosion potential through the abutment.	Major	17 Nov. 21	It is planned to investigate and assess this further with additional cored boreholes during detailed design.	3/12/2021	Accepted	Ongoing
15			ditto	There is existing instability in the mudstone slopes on the sides of the ridge above the abutment, upstream and downstream, which require assessment for abutment stability and any remedial works required.	Major	17 Nov. 21	Agreed – this will be assessed during detailed design.	3/12/2021	Accepted	Ongoing
16			Main Dam	What are the risks of total and differential settlements across dam in view of the different materials it crosses as well as a possible fault zone?	Major	17 Nov. 21	We consider that the preliminary design philosophy to undercut the weak near-surface alluvium will substantially mitigate risk of unacceptable differential and total settlement effects on the dam. The alluvium is anticipated to be particularly susceptible to consolidation settlement. Current investigations, and the geotechnical model, do not expect the material beneath the alluvium to be particularly susceptible to consolidation. However, this will be assessed and confirmed during detailed design.	3/12/2021	Accepted	Ongoing
17			Saddle Dam	Definition is required of the thrust fault location and orientation, the thickness and strength of the adjacent crush/breccia zone in greywacke and mudstone, its permeability and potential for possible shear surfaces below the dam.	Major	17 Nov. 21	This will be confirmed and updated during detailed design investigations, and the implications on the dam engineering design, and any treatment measures, reassessed	3/12/2021	Accepted	Ongoing
18			ditto	There is weak and organic alluvium in the foundation with sand and gravel at its base over crushed greywacke. The depth of excavation and its stability needs assessment together with consideration of potential underseepage and its control, the foundation strength and possible shear surfaces eg in the crushed greywacke.	Major	17 Nov. 21	Refer Item 10 – this will be assessed and confirmed, along with treatment/stabilising measures (if any) during detailed design.	3/12/2021	Accepted	Ongoing
19			ditto	The extent of possible natural seepage blankets within the alluvium upstream of the dam needs to be considered.	Major	17 Nov. 21	As noted under Item 11 - investigations to date, including several sub-surface investigations on the reservoir side of both dams, indicates there is a natural blanket of lower permeability material (e.g. alluvium, colluvium, and/or deeply weathered greywacke or NAM) which is at least 4m thick and laterally continuous across the reservoir. It is considered that this blanket will act as a natural low permeability liner for the reservoir. This will be assessed and confirmed, along with treatment measures (if any) during detailed design.	3/12/2021	Accepted	Ongoing
20			ditto	Assessment is needed of the right abutment stability within mudstone, together with seepage and erosion potential through the abutment and depth of excavation required.	Major	17 Nov. 21	Noted. This will be considered and confirmed during detailed design, with defensive design measures developed if necessary.	3/12/2021	Accepted	Ongoing
21			ditto	Artesian pressures and gas were found at some test locations, the source and implications of which need assessment for dam design	Major	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
22			ditto	There is a massive sandstone unit over greywacke downstream of dam which may possibly be pre - Allochothon Ruatangata Sandstone. Geological mapping should be undertaken and assessment of any implications for the dam design.	Request for Info	17 Nov. 21	Material correlated to the Ruatangata Sandstone has only been mapped in a small gully approximately 400m downstream (north) of the Saddle dam (ref: Location F on Dwg 210038-5 in the Geotechnical Interpretative Report). This unit has not been confirmed in any of the subsurface investigations (including the TP and BH's at the dams). On this basis, we currently do not consider that additional mapping of the pre-Allochthon Ruatangata Sandstone is a critical task for detailed design. However, during planned 100-level boreholes (for detailed design) we will task the supervising geologist to undertake a some additional mapping in the gullies immediately downstream of the Saddle dam.	3/12/2021	Accepted	Ongoing

23			ditto	Assessment is required of potential total and differential settlements across the dam since it crosses various materials including a fault zone	Major	17 Nov. 21	Noted. This will be considered and confirmed during detailed design, once the 100-level drilling programme findings have been incorporated into the geological and geotechnical models.	3/12/2021	Accepted	Ongoing
24			Spillway	Exploration is required for the spillway excavation, the foundation materials and cut slope stability	Important	17 Nov. 21	We consider that adequate sub-surface investigations have been completed (e.g. number, location, and depth of test pits) have already been undertaken to undertake the detailed design the spillway weir and channel and to assess the slope stability (e.g. TP101 to TP107, TP07 and TP13).	3/12/2021	Accepted	Closed
25			Reservoir	Stability of the margin slopes need assessment including the risk of remobilisation during operation and the consequences of failure. What remedial works can be undertaken?	Major	17 Nov. 21	Preliminary stability assessment of the reservoir margin (rim) slopes has been undertaken for the resource consent engineering reports. Additional assessment will be undertaken during detailed design. Our current assessment, including likelihood of movement and potential consequences / impacts of movement are summarised in Section 7 of the Preliminary Dam Design Assessment (RILEY ref: 210038-OTA-M). Potential remedial options to increase the stability of known landslides around the reservoir rim and / or reduce the consequences if movement were to occur, are also outlined in Section 7.7.4 of the Preliminary Dam Design Assessment.	3/12/2021	Accepted	Ongoing
26			ditto	Springs are common. The ground water hydrology should be assessed together with seepage and erosion potential. There may be leakage potential from open joints noted in the greywacke, the thrust fault surface with crush zones and the sand and gravel layers below the alluvium, all of which require assessment	Major	17 Nov. 21	Springs observed at the site are above the reservoir level. It is therefore very unlikely that the reservoir will directly affect observed springs. There may be open defects in the bedrock, which could be a preferential flow path for groundwater. However, as noted under Item 11 above the investigations have identified a natural blanket of low permeability soils and deeply weathered greywacke and NAM across the reservoir. This natural (low permeability) liner will substantially reduce seepage losses from the reservoir. Notwithstanding this, detailed design will re-assess the potential for higher permeability seepage paths beneath the dams and reservoir - which are “connected” to the reservoir water. If necessary, management options will be developed during detailed design.	3/12/2021	Accepted	Ongoing
27			ditto	The extent of potential natural seepage blanket soils in alluvium and the mantle soils on the slopes need assessment.	Major	17 Nov. 21	The current geo-model infers that the higher permeability (e.g. sand and gravel) layer is present at the base of the deep alluvium deposit beneath both dams. The current dam(s) design conservatively proposes to remove all the alluvium including higher permeability layers from both dam foundations.	3/12/2021	Accepted	Closed
28			Borrow	Borrow locations and material volumes need to be defined	Major	17 Nov. 21	Agreed – and this will be undertaken during detailed design.	3/12/2021	Accepted	Ongoing
29			ditto	The suitability of materials for earthfill construction require confirmation	Major	17 Nov. 21	Agreed – and this will be undertaken during detailed design and as laboratory soil tests become available.	3/12/2021	Accepted	Ongoing
30			ditto	Borrow stability and slope regrading and other stability improvement measures need consideration	Major	17 Nov. 21	Agreed – detailed design will consider the effects of cut and filling works (temporary and permanent) on the stability of hillslopes at the dams and reservoir, along with stabilisation measures (if any).	3/12/2021	Accepted	Ongoing
31	4		Letter 24 May and risk register update	The detailed Risk Register covers many of the items mentioned above requiring assessment. A budget is given for additional investigations to support feasibility and detailed design, which appear appropriate. Further investigations are likely to be necessary in view of the geological complexities of the site.	Note	17 Nov. 21	The requirement for further investigations, beyond those outlined in our May 2021 letter is being periodically reviewed and will be discussed with the Client and Peer Reviewer nearer to the end of the 100-level drilling works.	3/12/2021	Accepted	Closed
a32	5	10/09/2021	General Comments	The site geology and geotechnical conditions are the biggest challenge for this project. Comprehensive geotechnical investigations have been undertaken to allow development of a geological model that is considered sufficient to develop a	Note	17 Nov. 21	Agreed – refer Item 3 and RILEY response above.	3/12/2021	Accepted	Closed

				preliminary design. Site investigations are ongoing to refine the understanding of the site geology.					
33			General Comments	In general, the preliminary dam design is based on sound principles and design concepts are considered appropriate. The preliminary design assumes sub excavation to considerable depth to remove weak, compressible, and permeable ground. This is considered appropriate based on the results from the site investigations.	Note	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
34			Section 2, Table 1	Volume of general fill beyond embankment profile below original ground level is not included.	Note	17 Nov. 21	Table 1 has been amended to explicitly note the fill volume in the undercut beyond the embankment - for both dams.	3/12/2021	Accepted	Closed
35			Section 2, Table 1	Chimney drain volume based on nominal 1 m width, Drawings-108 and -112 show width varies. They scale at 0.5 m and 1 m wide.	Note	17 Nov. 21	Noted, and for the purposes of the resource consent report the chimney drain has been amended to a consistent 1m width on the dwgs.	3/12/2021	Accepted	Closed
36			Section 3.3	Table 2 is for embankment slopes. Suggest clarifying FoS (stability) to be adopted for natural slopes (short-term and long-term).	Important	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
37			Section 3.3	Table 3 title should be amended to reference “Seismic” rather than “Static” Assessment	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
38			Section 4.1	Location and alignment of embankments are logical	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
39			Section 4.2	Lab testing to determine geotechnical design parameters (peak and residual drained and undrained strength, compressibility, and permeability) have not yet been undertaken. It is assumed this testing will be undertaken for detailed design	Important	17 Nov. 21	Yes, laboratory strength tests will be undertaken to inform detailed design.	3/12/2021	Accepted	Closed
40			Section 5.2	Have permeabilities been determined from CPT dissipation tests?	Request for Info	17 Nov. 21	Preliminary permeabilities have been estimated from the CPT dissipation tests. Following internal review these results will be incorporated into the detailed design GFR and GIR documents to support Building Consent.	3/12/2021	Accepted	Closed
41			Section 7.2.1	Construction cut slopes at the embankment sites have a target FoS of greater than approximately 1.2. A FoS of 1.2 is quite low, although this is dependent on the basis for assumed soil strengths. For detailed design it is recommended the target FoS should consider uncertainties in the knowledge of ground conditions	Major	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
42			Section 7.2.1	Embankment slopes (1V:3H) are considered appropriate considering proposed foundation excavation depths	Note	17 Nov. 21	Noted. The final embankment slopes, and requirement for any berms etc. will be confirmed during detailed design taking into consideration assessed embankment and foundation strength parameters (which will themselves be confirmed at an early stage of detailed design).	3/12/2021	Accepted	Closed
43			Section 7.2.1	No details for surface water management are provided, but they should be straightforward given the modest height of the dam. Some lined drain at the abutment contacts is recommended to reduce the potential for surface erosion	Important	17 Nov. 21	Agreed, and surface water management will be confirmed and specified during detailed design.	3/12/2021	Accepted	Closed
44			Section 7.2.1	Instrumentation for monitoring performance is described in section 6.2 of the Draft Dam safety Management System report. In general terms it is appropriate, but details will need to be finalised as part of detailed design.	Important	17 Nov. 21	Agreed.	3/12/2021	Accepted	Closed
45			Section 7.2.1	A summary of potential failure modes is provided in the Draft Dam Safety Management System. We think there is some value	Important	17 Nov. 21	The dam design report will be amended to reference the potential failure modes table in the Draft Dam Safety Management System.	3/12/2021	Accepted	Closed

				in reporting this or referring to it in this report. A formal Failure Modes and Effects Analysis (FMEA) is of benefit in the design process as well as informing monitoring during operation. Will it be included in detailed design			We agree there is merit in undertaking failure modes and effects analysis (FMEA)/workshop, including client representative(s) as part of the detailed design. We will discuss the potential for an FMEA workshop with the Client shortly. For a FMEA process to provide the most 'value' to the detailed design process, and project, we consider it should be undertaken as early as possible in the detailed design programme.			
46			Section 7.2.2	Concept of central low permeability core using "clay rich materials is sensible	Note	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
47			Section 7.2.2	Suggest considering widening core by repositioning chimney drain further downstream (1 m) to reduce seepage gradient at detailed design stage	Important	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
48			Section 7.2.2	Could consider extending low permeability zone downstream of chimney drain to provide containment of seepage in chimney drain and for ease of construction assuming construction procedure is to raise chimney drain in stages by excavating down into placed fill	Important	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
49			Section 7.2.2	It is assumed the chimney drain will be designed as a filter but will also be relied upon to serve a drainage function. If this is the case it may be necessary to maintain 1 m width over full height. It is assumed this will be considered at detailed design stage	Important	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
50			Section 7.2.2	Consideration could be given to abutment contact subsurface seepage interception drains to reduce the potential for saturation of the downstream shoulder from seepage from the rising ground above	Important	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
51			Section 7.2.3	Conduit is appropriately identified as a critical element	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
52			Section 7.2.3	Proposed concepts are based on good practice for penetrations through an embankment	Note	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
53			Section 7.2.3	The proposed design flood of 1 in 50 AEP is appropriate (referenced in the Hydrology and Hydraulics Assessment report, 18 August 2021).	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
54			Section 7.2.3	The plinth concept will reduce the potential for settlement of the conduit, but detailed design should consider the risks associated with potential cracking of the fill due to differential settlement	Major	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
55			Section 7.2.3	Potential for cracking of concrete due to foundation settlement will need to be considered at detailed design	Important	17 Nov. 21	Noted. This will be considered and confirmed during detailed design, and if necessary defensive design measures will be incorporated to reduce the potential for unacceptable seepage or erosion.	3/12/2021	Accepted	Closed
56			Section 7.2.3	Detailed design will need to consider construction aspects (locations of construction joints and water stops, buoyancy of culvert)	Major	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
57			Section 7.2.3	Design should consider potential for gaps in annulus between culvert and concrete surround and consider provision for grouting, at least through the core zone	Important	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
58			Section 7.2.3	The connection of the intake structure to the conduit needs careful consideration at the detailed design stage	Major	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
59			Section 7.2.3	The sluice gate is a dam safety critical element. The design will need to be robust so it can be opened and closed under all conditions and be regularly tested to ensure it is an operating condition. It must be able to be serviced if required. This should be considered at the detailed design stage.	Major	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed

60			Section 7.2.3	The conduit has a high headwall at the downstream. The height can be reduced by extending the conduit further downstream, although this may be necessary to fit in a stilling basin.	Note	17 Nov. 21	Noted. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
61			Section 7.2.3	The form of the energy dissipator (i.e., stilling basin) is not confirmed at this stage. Will it be in direct alignment with the conduit? The drawings show a reasonably sharp change in alignment of the conduit and the long-term riprap lined channel downstream. Is it an option to align the final channel along the proposed temporary channel? This could minimise the risks of unusual flow conditions resulting in erosion of the channel	Request for Info	17 Nov. 21	Ideally the axes of the conduit and energy dissipator will be aligned. This will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
62			Section 7.2.4	Water is to be abstracted via floating intake to avoid a pressurised conduit through the embankment. The design is to be undertaken by another party. The location and details of any associated works (e.g., buried pipes passing through dam abutment) should be reviewed by the dam designer to ensure such works will not have any adverse impact on the integrity of the embankment or reservoir	Major	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
63			Section 7.2.5	There should be plenty of suitable fill to construct the embankment, particularly low permeability core	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
64			Section 7.2.5	General structural fill for the embankment could comprise a mix of rock in a silty matrix. The % fines will likely be sufficient to dominate the overall fill strength. The fines content will need to be appropriately conditioned to ensure it will not be placed too dry and then be subject to softening upon saturation where it is in the upstream shoulder.	Important	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
65			Section 7.2.5	It is proposed that verification tests on embankment fill will be undertaken by the Contractor. For a High PIC dam fill standards should also be independently verified by the Principal via a third party. Alternatively, the Principal could take responsibility for verification testing via a third party.	Important	17 Nov. 21	Noted, the verification testing programme and requirements will be confirmed during detailed design and drafting of the specification.	3/12/2021	Accepted	Closed
66			Section 7.2.5	Have sources of riprap been identified?	Request for Info	17 Nov. 21	Detailed design will confirm the specification for rip rap at the site. We anticipate this material will need to be imported.	3/12/2021	Accepted	Closed
67			Section 7.3.2	The foundations comprise weak and compressible ground that require excavation to considerable depth. Some is very low permeability and could take time to dewater. Consideration should be given to commencing dewatering as soon as possible to enable excavations to proceed as quickly as possible. Are piezometers proposed to be installed to monitor the effectiveness of dewatering.	Request for Info	17 Nov. 21	Noted. We agree that piezometers will be necessary in order to monitor the porewater pressures behind the key / main temporary cut slopes (e.g. in the valley floor) during construction excavation.	3/12/2021	Accepted	Closed
68			Sections 7.3.3 & 7.3.4	Stability of the abutment excavations will need careful consideration during detailed design.	Note	17 Nov. 21	Noted and agreed.	3/12/2021	Accepted	Closed
69			Section 7.4	As with the Main dam, geologic and geotechnical conditions are complex, and the understanding is being refined with ongoing investigations that need to be considered in detailed design. A considerable depth of undercut will be necessary.	Note	17 Nov. 21	Noted and agree that a considerable depth of undercut will locally be required to remove weak and compressive alluvium in the buried channel locally beneath the Saddle dam.	3/12/2021	Accepted	Closed
70			Section 7.5	The current spillway alignment includes a reasonably tight curve. It is suggested to consider reducing the curvature to minimise the potential for unusual flow conditions that could result in erosion. A straight alignment would be ideal if it can be achieved.	Important	17 Nov. 21	Noted – this will be assessed and confirmed during detailed design.	3/12/2021	Accepted	Closed

71			Section 7.5	It is not clear how low flows enter the low flow channel. Does the ogee weir have a lowered section in the middle or does the concrete lined light vehicle and stock access provide a transition	Request for Info	17 Nov. 21	The concrete lined light vehicle access will most likely provide the transition for low flows to the channel and this will be confirmed during detailed design.	3/12/2021	Accepted	Closed
72			Section 7.6	Details of the 1.8 m dia pipe through the upstream cofferdam will need special consideration to mitigate potential failure modes (seepage control, piping, settlement induced cracking).	Important	17 Nov. 21	This will be undertaken during detailed design. Note, the latest dam design report to support resource consent (ref. 2100385-OTA-M) proposes to widen the cofferdam crest so this is a main site access route. Appropriate detailing will be undertaken during detailed design to mitigate potential failure modes.	3/12/2021	Accepted	Closed
73			Section 7.7	Reservoir slope stability during excavation of material for embankment construction and during drawdown of the reservoir are identified as important design issues. Measures to mitigate slope stability risks are outlined. Further investigations maybe necessary to support detailed design, along with lab testing and stability analyses.	Major	17 Nov. 21	Noted, and agreed that stability analyses for reservoir slope stability will be undertaken during detailed design – with design load cases may include construction, operational reservoir level fluctuations, rapid drawdown, and seismic ground motions. The current design philosophy has shifted most earthworks at Borrow Area 3 and 5, in the NAM hillslopes, to above the reservoir level. Preliminary design indicates that this will remove surcharge and increases the stability of inferred ancient deeper-seated NAM landslides in both these areas. In addition detailed design will consider the benefit, to slope stability, from backfilling borrow areas in the valley floor inside the reservoir, and drainage measures.	3/12/2021	Accepted	Closed
74			Tables 13, 14 and 15	Tables 13, 14, and 15 in Appendix A should be relabelled Tables 14 to 16.	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
75			Appendix A Geotechnical Interpretative Report	In general, the geotechnical interpretive information presented appears fairly comprehensive. The geological model has been well considered with the complex nature of the geology fully recognised. Extensive site investigations have been carried out which are still ongoing, and which will allow further refinement of the geological interpretation. Engineering design requirements for the scheme are being well thought out appropriate to the complexity of the ground conditions.	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
76				Geotechnical comments have already been made in our review register, many of which have been addressed in the interpretive report. We make further comments in the items below including suggestions for additional investigations.	Note	17 Nov. 21	Noted	3/12/2021	Accepted	Closed
77				The nature of the NAM emplacement boundary is still unclear and needs further definition. Whether the boundary is actually a thrust fault plane or just a depositional contact between the NAM thrust sheet and antecedent topography within the WGG. Perhaps the concept of a "thrust fault" should be de-emphasised in the geological model and replaced with say an "emplacement surface" or boundary. The nature of the boundary is important for the design of the dams in relation to consideration of stability analyses and permeability.	Important	17 Nov. 21	Noted – refer Item 3 above. Specific cored boreholes (100-level) have been programmed to support the detailed design, with one key	3/12/2021	Accepted	Closed
78				Further test pits and possibly pendulum auger investigations would be useful upstream and downstream of the saddle dam to better delineate the NAM contact, the depth of the NAM and nature of the contact with the underlying WGG.	Important	17 Nov. 21	Noted	3/12/2021	Accepted	Closed
79				Consideration could be given to geophysical survey methods which could be useful with interpretation of the NAM/WGG geological contact and weathering profiles.	Important	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed

80				At the main dam, further close spaced CPT's along the centreline could be helpful in defining the depth and width of the alluvial channel.	Important	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
81				In view of the variability of the geology, additional geological cross-sections through both dam sites would be helpful since only one has been presented so far.	Request for Info	17 Nov. 21	Noted, and these will be and prepared during detailed design.	3/12/2021	Accepted	Closed
82				The geological plans don't show the first series of CPT locations.	Request for Info	17 Nov. 21	Noted, and this will be rectified for the final resource consent engineering documents.	3/12/2021	Accepted	Closed
83				In the text allochthonous material is stated to be "many thousands of meters thick". In published data it seems to be stated as 2 to 4km thick.	Note	17 Nov. 21	This will be clarified in the report text.	3/12/2021	Accepted	Closed
84				In the definition of WGG type 2 material could this also possibly be fault (or slide) breccia.	Note	17 Nov. 21	The potential that WGG type 2 rock mass could be fault-derived from tectonic events and conditions before the emplacement of the NAM will be clarified in the report(s).	3/12/2021	Accepted	Closed
85			Appendix E - Drawings	Suggest dimensioning proposed widths of chimney drain on Drawings -108 and -112.	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
86			Other Issues – Diversion during Construction	Diversion During Construction (covered in section 7 of the Hydrology and Hydraulics Assessment report, 18 August 2021) - The proposed design criteria and staging are considered reasonable	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed
87			Other Issues – Diversion during Construction	- Details will need to be confirmed during detailed design, including erosion protection of the channels upstream and downstream of the conduit through the embankment. It may be necessary to provide energy dissipation at the downstream end of the 1.8 m culvert beneath the cofferdam.	Note	17 Nov. 21	Noted, and this will be considered and confirmed during detailed design.	3/12/2021	Accepted	Closed
88			Construction Aspects	The report covers construction effects (section 8.0), but it is suggested that some comments on construction aspects could be useful for a resource consent application, unless covered elsewhere	Note	17 Nov. 21	Minor amendments (additions) to the Construction Aspects section of the dam design report have been added (e.g. the High PIC status, and complex nature of the ground conditions, necessitates an appropriately high level of contractor experience, and high level of experience, and time, from the Engineer monitoring the construction). Additional details on the construction aspects are outlined in the Draft E&SC Management Plan (210038-OTA-B) and Draft Construction Environmental Management Plan (210038-OTA-G).	3/12/2021	Accepted	Closed
89			Construction Aspects	The design report could include reference to New Zealand Dam Safety Guidelines that full time on-site representation is recommended for High PIC dams. The on-site design representative should have experience in the design and construction of High PIC dams. On-site inspections should be comprehensive, completed by an experienced dam engineer. The Designer should have adequate authority to order additional work necessary for dam safety.	Note	17 Nov. 21	Noted, and this will be discussed with the Client.	3/12/2021	Accepted	Closed
90			Construction Aspects	The design report could include reference to the New Zealand Dam Safety Guidelines recommendations for High PIC dams that the Contractor should have experience in the construction and successful commissioning of similar Medium or High PIC	Note	17 Nov. 21	Noted.	3/12/2021	Accepted	Closed

				dams. On-site construction should be managed by a representative of the Contractor with experience in the construction of similar Medium or High PIC dams.						
91			Construction Aspects	There are several issues that complicate construction and have implications for programme and cost (e.g., deep dewatering and excavations- the extent of which may not become apparent until construction, weak ground, borrow area stability). It is suggested that a construction risk assessment is undertaken at the detailed design stage.	Important	17 Nov. 21	We agree with the merits of developing a construction risk assessment and safety in design assessment during detailed design. We will discuss this with the Client shortly.	3/12/2021	Accepted	Closed

Peer review summary sheet -Hydrology and Hydraulics Assessment

Project details

Project title	Otawere Water Storage Reservoir Preliminary Hydrology and Hydraulics Assessment
Project location/Address	Otawere Water Storage Reservoir (-35.306545, 173.922715)
Project description	Peer Review of Otawere Water Storage Reservoir Preliminary Hydrology and Hydraulics Assessment
Designer/Study author	Riley Consultants Ltd
Reviewer	Engineering Geology Ltd (EGL)
Reviewer's Client	Te Tai Tokerau Water Trust
Review scope	

Review sheet revision history

Version	Date	Issued By	Description of Revision
A	16/08/2021	EGL	First issue
B	01/09/2021	EGL	Second issue
B	25/11/2021	RILEY	Replies to EGL second issue
B	3/12/2021	EGL	Replies to RCL feedback

Reviewer comment categories

Major Issue	Review comment raises potential critical issue – review comment requires resolution through change and additional information
Important Issue	Review comment raises important issue – requires discussion and/or additional information
Request for Info	Review comment requests further information – please provide information
Note	Review comment makes notes for designer/author – no response to comment required
Comment Closed	Comment closed

Review documentation list

Doc. Ref Number	Date Received	Document Reference
1	26/07/2021	Otawere Water Storage Reservoir Preliminary Hydrology and Hydraulics Assessment, Riley Consultants Ltd, dated 29/01/2021
2	20/08/2021	Otawere Water Storage Reservoir Hydrology and Hydraulics Assessment, Riley Consultants Ltd, dated 18/08/2021

Review Comments

No.	Document in Review	Peer Reviewer				Designer/Study Author		Peer Reviewer		Status
		Date	Reference	Comment	Comment category	Date	Comment	Date	Comment	
1	1	16/08/2021	Sections 4.7 and 10.0	In the assessment of natural flood, Riley has estimated the inflow based on three different methods, 1) the Rainfall-Runoff model using HEC-HMS, 2) a regional based flood frequency assessment according to McKercher and Pearson (1989) Regional Method, and 3) the NIWA flood frequency tool (NIWA GIS portal). Estimations from NIWA GIS Portal are approximately half of the values based on the other two methods. The estimates from rainfall-runoff model are similar to those based on the regional method of McKercher and Pearson (1989). Riley considers that the values from NIWA flood frequency tool is underestimated. The most relevant river flow gauge in the NIWA flood frequency is the Waitangi gauge at Wakelins, located at approximately 8.5 km downstream of the confluence of Waiaruhe River and Waitangi River. The Q_{100} estimated based on the monitoring data is 626 m^3/s, which is approximately half of that estimated using the McKercher and Pearson method (about 1,200 m^3/s as shown in Figure 3 of Riley's report). It appears the estimates for Waitangi River provided in the NIWA GIS Portal have been calibrated by the nearby monitoring data and should be more realistic comparing to the estimates based on McKercher and Pearson (1989). Riley has adopted the inflow estimated from the Rainfall-Runoff model to design the spillway. This value is approximately twice the value from NIWA GIS Portal, and we consider the approach is conservative. In the rainy-day dam breach analysis, the base flows of rivers were based on McKercher and Pearson (1989). The approach potentially overestimates the baseline flood extent and underestimate the incremental effect due to dam breach. Therefore, we recommend undertaking a sensitivity analysis by using the natural flood estimates from NIWA GIS Portal.	Important Issue	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) uses flood estimates from the NIWA GIS portal for the rainy day baseline flood.	01/09/2021	Accepted.	Closed
2	1	16/08/2021	Figure 3	Steady inflow hydrographs were adopted for the base flow in the rainy day scenario instead of a temporal distribution pattern. This assumption is simplistic and conservative. In an extreme rainfall event, the hydrographs of run-off from the catchment would have a similar pattern to the rainfall temporal distribution excepting the case where there is a major attenuation in the catchment.	Important Issue	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) uses the temporal distribution of the flood of record at the Waitangi at Wakelins flow gauge for baseline flood event.	01/09/2021	We concur with the adoption of the recorded temporal distributions. We note that the rainy day breach was initiated to align the peak breach flow with the peak baseline flow. We concur with the breach initiation.	Closed

				In the rainy-day dam breach analysis, a conservative assumption of base flow would overestimate the baseline flood extent and underestimate the incremental effect due to dam breach. Therefore, we recommend undertaking a sensitivity analysis with the consideration of a more realistic pattern for the base flow hydrograph.						
3	1	16/08/2021	Section 4.0 and 6.0, Table 6 and Drawing 200240/5-201 to 224	In the flood routing analysis, the extent of modelling terminated at about 1 km downstream of the confluence of the Waitangi River and Waiaruhe River. The downstream extent of the flood routing should be properly defined to make sure that the incremental consequences are minimal. The basis is unclear in the report. We recommend justification for the downstream extent of hydraulic model be included in the report. FEMA (2013) recommends an incremental increase in depth of 0.3 to 0.6 m or 24 hours flood travel for the rainy-day scenario. For the sunny day scenario, FEMA (2013) indicates the flows should be within the river channel which is normally a 2-year flood (i.e., bankfull flood) or a large water body is intercepted. As discussed in Section 6.5, the dam breach model does not extend as far downstream as the most popular fishing and swimming areas, e.g., the reach between SH10 and Haruru Falls and the “Lily Pond”. The recreational area is assumed to be affected by the dam breach flood. A detailed population at risk count was not carried out. The downstream extent of the existing hydraulic model and conservative assumptions on recreational areas could be sufficient for the assessment of PIC. Reference: Federal Emergency Management Agency (FEMA). (2013). Federal Guidelines for Inundation Mapping of Flood Risks Associated with Dam Incidents and Failures. First Edition, FEMA P-946, July 2013.	Important Issue	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) uses a flood model that extends to the coastal estuary at Haruru.	01/09/2021	Accepted.	Closed
4	1	16/08/2021	Appendix A	The inundated maps in Appendix A show the extent of flood with depth of water greater than 0.5 m and that in a range of 0 m to 0.5 m. The downstream extent of these maps does not extend far enough to demonstrate the potential impact on the recreational area. The inundated maps are sufficient for PIC assessment, but not for emergency planning. We suggest extending the hydraulic routing model while preparing the inundation maps for Emergency Action Plan. The inundation maps should include flood front and peak flow arrival times, peak flow depth, as well as peak D*V at locations of interest.	Note	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) uses a flood model that extends to the coastal estuary at Haruru. We will revise the flood map drawings to include the required information for the EAP. The error in the previous drawings has been corrected.	01/09/2021	Accepted.	Closed

				We note that the legend of Drawing 200240/5-207 should be corrected to “flood depth”. Flood depth velocity product (D*V) is shown in the current version.						
5	1	16/08/2021	Section 5.3	There are two SH10 Bridges that may be affected by the dam breach flood. To distinguish these two bridges, bridge numbers can be added, i.e., Bridge No. 84 for the SH10 Waitangi River Bridge and Bridge No. 77 for the SH10 Waiaruhe River Bridge. The assessment on Bridge No. 84 for the SH10 Waitangi River Bridge is provided in the report. In the sunny day event, the peak water levels immediately upstream of the bridge are above RL 48.5 m, which is 1.5 m lower than the bridge deck (RL 50.0m). Comparison of peak water level and deck level in the rainy day event was not given. No assessment on Bridge No. 77 for the SH10 Waiaruhe River Bridge was provided in the report. Our review on the inundated maps indicates that the bridges are unlikely to be overtopped by the sunny day breach flood and rainy day baseline flood. They would be overtopped by the breach flood in a rainy day event. We consider that it is appropriate to assess the damage level for infrastructure to be minimal for sunny day scenario and moderate for rainy day scenario. Additional discussion and justification on infrastructure in the report is recommended.	Important Issue	25/11/2021	We have revised the text within RILEY Ref: 210038-OTA-D v1.0, to include separate discussion for each bridge. It also includes both sunny day and rainy day levels upstream of the bridges. We note that the derived damage level remains as Major.			
6	1	16/08/2021	Section 5.4	A Minimal damage level for time to restore operation to critical or major infrastructure was assessed in the section. However, “Moderate” was highlighted in Table 11. Please revise.	Note	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) corrected this error.	01/09/2021	Accepted.	Closed
7	1	16/08/2021	Section 5.0	We would expect differences between the consequences from a sunny day and rainy day dam breach. The difference in the effect on residential houses, PAR and PLL due to sunny day and rainy day breach are discussed in the report. However, the difference in consequences/ damage levels for the other items are not discussed. We believe the text is related to rainy day failure. Table 14 indicates similar damage levels for sunny day and rainy day failures (i.e. moderate) except for residential houses. Can you confirm the assessment of moderate damage for both sunny day and rainy day for all damage categories, except residential houses, is correct? We recommend assessing the PIC for a sunny day and rainy day independently. The design of dam should be based on the most critical scenario.	Important Issue	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) includes Table 1 which summarises the damage level assessment for both the sunny day and rainy day scenarios. The assessment concludes that the Main Dam has a High PIC based on the critical rainy day scenario.	01/09/2021	Accepted.	Closed
8	1	16/08/2021	Section 6.6	The PAR due to the inundation of the road was estimated to be 0 to 2 for both sunny day and rainy day scenarios. The basis for this assessment is unclear.	Important Issue	25/11/2021	We have added discussion and technical calculations, applying the Campbell (2014) method,	3/12/2021	Accepted	Closed

				Assessment on PAR for itinerant road users can be carried out according to methods given in literatures, such as Campbell et al. (2013). In these methods, various factors that may affect PAR, including severity of flood, length of inundated road, duration of inundation of the road, traffic volume, vehicle speed, etc., can be taken into account. According to the State Highway Traffic Monitoring system of NZTA, the Annual Average Daily Traffic (AADT) volumes on SH10 and SH11 are high. The AADT volumes are 9001 and 4954 vehicles for the northern and southern section of SH10, and 5263 vehicles for SH11. As shown on the inundation maps, the sunny day flood and the rainy day baseline flood did not overtop the state highways, and the PAR for itinerant road user is likely to be low. However, the rainy day flood could result in the inundation of SH10 over a length of about 2.5 km and SH11 over a length of about 0.5 km. PAR for the rainy day scenario is potentially greater than of 0 to 2, and the current assessment may underestimate the PAR. Reference: Campbell, J., Barker, G., Southcott, P., and Wallis, M. (2013). Flooded cars: estimating the consequences to itinerants exposed to dambreak floods on roads. IPENZ Proceedings of Technical Groups 39 (LD).			within appendix C and D of RILEY Ref: 210038-OTA-D v1.0. Please refer to appendix C and D for details of the assessment (changes are highlighted in yellow). The most significant change is an increase in the potential loss of life, for both the sunny and rainy day scenarios. This has increased to be between 2 and 10, and we have therefore increased the inflow design flood accordingly.			
9	1	16/08/2021	Table 18 in Section 6.7	The PAR for the sunny day scenario includes 4 for residential houses, 0 to 50 for recreational users, and 0 to 2 for road crossings. The total number of PAR in the sunny day scenario should be 4 to 56. Please revise the number in Table 18.	Note	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) corrected this error.	01/09/2021	Accepted.	Closed
10	1	16/08/2021	Table 19 in Section 7.0	In the assessment of PLL for the sunny day scenario as shown in Table 19, the PAR for residential houses and for recreational users are 0 and 54, respectively. This is inconsistent with the PAR estimation in Table 18 (e.g., 4 for residential houses, 0 to 50 for recreational users, and 0 to 2 for road crossings). Please revise. The RCEM method was adopted to estimate potential loss of life, which requires the input of D*V value. The maximum D*V at each location of interest should be derived. In Table 19, D*V value for recreational users of 15 m^2/s was assumed. The basis for this assumption is not clear.	Important Issue	27/08/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D v1.0) corrected this error. We have also assumed what we consider to be conservative DxV products for each of the PAR type, and the PLL is still less than 1.	01/09/2021	Accepted.	Closed
11	1	16/08/2021	Section 7.0	The potential loss of life associated with the rainy day scenario was assessed to be less than 1. In the rainy day scenario, there are 16 PAR due to the inundation of residential houses. It appears that the potential loss of life for residential house was not assessed. However, we concur with the conclusion that it is not	Note	27/08/2021	Noted. The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D Issue 0.1) has revised the PIC of both dams	01/09/2021	Accepted.	Closed

<table>
<tr><td></td><td></td><td></td><td></td><td>highly likely that two or more lives will be lost for both the sunny day and rainy day scenarios. The assessed PIC of Medium is considered appropriate.</td><td></td><td></td><td>to High, although the potential loss of life remains likely to be less than 1.</td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>2</td><td>01/09/2021</td><td>Tables 2 in Appendix B</td><td>The addresses of residential houses affected by the dam breach flood should be included in the Emergency Contact List in EAP. We suggest adding house addresses in the table.</td><td>Note</td><td>25/11/2021</td><td>We have revised RILEY Ref: 210038-OTA-D v1.0 to present house addresses.</td><td>3/12/2021</td><td>Accepted</td><td>Closed</td></tr>
<tr><td>13</td><td>2</td><td>01/09/2021</td><td>Tables 2 and 3 in Appendix B</td><td>The damage of residential houses was assessed based on the depth of inundation and D*V values. As summarised in Table 1, the D*V threshold for damage is 1.5 m^2/s and that for destruction is 3 m^2/s. The results of assessment are summarised in Tables 2 and 3.

The number of houses that would be destroyed by rainy day breach flow appears to be over-estimated in Table 2. It appears that houses with DV products larger than 1.5 m^2/s were assessed as destroyed, which is inconsistent with the Table 1. Based on Table 3, the incremental number of residential houses that would be destroyed in the critical rainy day scenario is two and the damage level to residential house should be assessed as Moderate.

It appears that the number residential houses which would be damaged and destroyed in Table 2 and 3 are inconsistent. A comparison is given below.
<table>
<tr><td colspan="2"></td><td>Table 2</td><td>Table 3</td></tr>
<tr><td rowspan="3">Baseline</td><td>No damage</td><td>12*</td><td>8</td></tr>
<tr><td>Damage</td><td>0</td><td>0</td></tr>
<tr><td>Destroyed</td><td>8</td><td>0</td></tr>
<tr><td rowspan="3">Breach</td><td>No damage</td><td>0</td><td>12</td></tr>
<tr><td>Damage</td><td>4</td><td>5</td></tr>
<tr><td>Destroyed</td><td>16</td><td>3</td></tr>
<tr><td rowspan="3">Incremental</td><td>No damage</td><td>-</td><td>4</td></tr>
<tr><td>Damage</td><td>4</td><td>5</td></tr>
<tr><td>Destroyed</td><td>8</td><td>3</td></tr>
<tr><td colspan="4">Note:
*The number of houses with no damage has not been separated for the houses with and without inundation in Table 2.</td></tr>
</table></td><td>Major Issue</td><td>25/11/2021</td><td>We refer the reviewer to the following paragraph (Appendix B, Page 2, Paragraph 1) “An alternative conservative approach is to consider the number of houses that are surrounded by greater than 0.5m of water (above surrounding ground levels). Such inundation could render a house uninhabitable (and therefore destroyed) due to static water damage. Overall, we consider, in the context of a PIC assessment, that it is appropriate to assume that a house will likely be destroyed if the inundation depth is greater than 0.5m.” i.e. we have not used the NIWA Riskscape method.

Table 1 outlines the depth and velocity points from the NIWA Riskscape method. As outlined previously, we have not used this method for determining the number of houses destroyed by the rainy day breach scenario. We note that the model results indicate, that majority of houses are affected by water depth, not velocity. We do not consider that strictly applying the NIWA Riskscape method (Table 1) would be suitably conservative, as we believe there is potential for these houses, standing in static water, to be rendered uninhabitable and therefore destroyed.

We have reviewed tables 2 (Residential Houses Damage Level Assessment – Main Dam) and 3 (Residential Houses Damage Level Assessment – Summary), and consider that they are consistent.</td><td>3/12/2021</td><td>We consider the alternative approach is conservative because although inundation depths of greater than 0.5m could make a house inhabitable for a period it does not mean the house would be destroyed. Also, the assessment has assumed that inundation depth is measured from typical ground level rounded up to the nearest 0.1m. For houses on pile foundations the floor levels could be greater than 0.5m above existing ground level. However, we note that a more conservative assessment of PAR does not affect the assessment of PLL or PIC.</td><td>Closed</td></tr>
</table>

14	2	01/09/2021	Table 2 in Appendix C	Riverside Lodge Paihia was estimated to be inundated, but no PAR is assessed. Please clarify.	Important Issue	25/11/2021	RILEY Ref: 210038-OTA-D Issue 0.1 incorrectly stated that the Riverside Lodge Paihia was inundated by > 0.5m. The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D v1.0) has corrected the error.	3/12/2021	Accepted	Closed
15	2	01/09/2021	Tables 1 to 2 in Appendix D	According to Table 3 in Appendix B, the DV products for residential houses are various with only two residential houses having a DV product larger than 3 m^2/s. However, Table 2 in Appendix D adopted a uniform value of 3 m^2/s for 11 residential houses. The potential loss of life assessment should be revised accordingly. According to Figure 1 in Appendix D, various fatality rates can be assessed according to DV: • 0.000 to 0.002 for DV of 3 m^2/s; • 0.0001 to 0.004 for DV of 7 m^2/s; • 0.0004 to 0.01 for DV of 15 m^2/s; However, the fatality rates adopted in Tables 1 to 2 in Appendix D are not consistent with the values shown in the figure. Please revise the fatality rates. However, the total incremental potential loss of life is less than 1 with the fatality rate as shown in Figure 1.	Important Issue	25/11/2021	We have revised the text within RILEY Ref: 210038-OTA-D v1.0, to clarify that "We have conservatively adopted a value of 3m^2/s for all 11 residential houses which were identified to possibly be damaged.". RILEY Ref: 210038-OTA-D Issue 0.1 had rounded the fatality rates up to 3dp. We have revised the fatality rates, noting that this reduces the calculated potential loss of life. Refer to item 8 where the potential for loss of life has now been estimated to be greater than 1.	3/12/2021	Accepted	Closed
16	2	01/09/2021	Appendices H and I	No information is provided in Appendices H and I.	Important Issue	25/11/2021	The latest hydrology and hydraulics assessment (RILEY Ref: 210038-OTA-D v1.0) includes the Freeboard and PMP calculations.	3/12/2021	Accepted	Closed
17	2	01/09/2021	Appendix J	Labels shown in the drawings for the inundation maps are not consistent. For example, drawings 210038-221 to 239 use house numbers, drawings 210038-252 to 269 have no labels for inundated houses, and drawings 210038-301 to 339 use house addresses. We suggest using house addresses for all drawings.	Important Issue	25/11/2021	We have revised RILEY Ref: 210038-OTA-D v1.0 (also refer to item 12) and the enclosed drawings, to present house addresses.	3/12/2021	Accepted	Closed