

8 July 2020

Our ref: 773-TRGGE276406-AA

Rotorua Lakes Council  
1061 Haupapa Street,  
Rotorua 3010

Attention: Stewart Brown

Dear Stewart,

**Geotechnical Peer Review of Geotechnical Reports for Rotorua Museum Seismic Strengthening**

**1. Introduction**

Rotorua Lakes Council (RLC) have engaged Coffey Services (NZ) Limited (Coffey) to carry out a geotechnical peer review of the documentation provided by Cheal Consultants Limited (Cheal).

The scope of the peer review was presented in a letter<sup>1</sup> to Coffey, which requests that the *“objectives, assumptions, options, engineering rigour, conclusion/s and recommendation/s which support the structural methodology for the underpinning of the Museum Foundation be independently peer reviewed”*.

We understand that the following document by Cheal was used in support of the building consent for the foundation upgrades:

- ‘Rotorua Museum: Seismic Strengthening Developed Design – Stage 2, Geotechnical Review’, report by Cheal reference 16592L1, dated 5 March 2020.

Our peer review has therefore focused on the above Cheal report, which is referred to as “the subject report” in this letter. We have also checked several previous reports<sup>2,3</sup> and supplemental data from Cheal which relate to the proposed seismic strengthening. Peer review comments on these previous

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<sup>1</sup> ‘Request for Service – Regulatory Peer Review’, letter by WSP New Zealand Limited dated 22 June 2020

<sup>2</sup> ‘Museum, Government Gardens, Oruawhata Drive, Rotorua Geotechnical Factual Report’, report by Cheal Consultants Limited reference 16592, dated 15 May 2017

<sup>3</sup> ‘Museum, Government Gardens, Oruawhata Drive, Rotorua Geotechnical Interpretive Report’, report by Cheal Consultants Limited reference 16592, dated 19 May 2017

reports have generally only been provided where they relate to the subject report and/or proposed seismic strengthening.

Our review of the Report has been carried out as a *Regulatory Peer Review* as defined in Engineering New Zealand *Practice Note 2 (version 2 – April 2018)* and fulfils the scope of works as described in the signed authorisation to proceed<sup>4</sup>.

This peer review letter is to address the general contents of the reports only. We have not visited the site nor conducted our own geotechnical investigations.

## **2. Format of the Review**

Our review comments are presented in table format attached to the rear of this letter (a digital version is included in the email transmittal). Some of these comments are provided for information only whereas others require a response from Cheal. Responses should be entered in the table using the spaces provided and the table returned to the undersigned.

Items of significance and our recommendations are discussed in Section 3 below. This section should be read in conjunction with our appended review comments.

## **3. Detailed Comments and Recommendations**

### **3.1. Previous Geotechnical Interpretative Report**

Prior to preparing the subject report, a Geotechnical Factual Report<sup>2</sup> (GAF) and Geotechnical Interpretative Report<sup>3</sup> (GIR) were prepared by Cheal as part of a seismic strengthening assessment. The reports included geotechnical investigations, laboratory tests, and a review of previous geotechnical information for the Museum.

The GIR concluded that the site was not prone to liquefaction under an Ultimate Limit State (ULS) event, and that additional geotechnical work in relation to the seismic strengthening was not required. However, the GIR noted that some cracking and possible foundation movement that was not related to the seismic performance of the ground was observed, and that the reason for the cracking was unclear. The GIR recommended that long term monitoring of the foundations be carried out to assess where the movement may be occurring.

We consider that the investigation methodology and analyses are appropriate for the scope of the report, and we generally agree with the recommendations and conclusions.

We note that Section 6.2.1 of the GIR states that a geotechnical ultimate bearing capacity (GUBC) of 250kPa is available for the bath house based on the Scala results. Although we generally agree with this conclusion, we note that some infrequent low Scala results were recorded (e.g. S12 and S15) and so we recommend that the report be updated to state that the subsoil conditions be checked during construction. We also recommend that restrictions be included on the footing sizes and depths, as there is a potential for the footings to punch into the existing soft soil beneath the grouted improved ground.

We also note that the GIR does not address the potential for lateral spreading. The Museum is situated on ground which slopes gently towards Sulphur Bay to the south, and the liquefaction outputs

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<sup>4</sup> 'Short Form Agreement for Consultant Engagement', ref: P275784, signed on 15 June 2020

in Appendix 2 show lateral displacements being triggered. We recommend that the GIR and the subject report be updated to address lateral spreading.

### **3.2. Subject Report**

The subject report involves a geotechnical review (and Producer Statement 2 – Design Review) of the plans for the proposed upgraded foundations for the Museum. The plans were prepared by GDC Consultants Limited.

The author notes that the subsoil conditions are difficult to anticipate due to the limited “good quality” testing information available. We also note that the investigations which are available show widely-variable strength and composition below the Museum, which the author addresses by reducing the bearing capacity in certain zones and requiring verification testing during construction. We consider this to be appropriate, particularly given the likely access constraints to carry out further investigations beneath the Museum.

As stated in Section 3.1 above, we recommend that the potential for lateral spreading be addressed in the GIR. Once updated, the design review should also address lateral spreading.

It's possible that the mat foundation to be situated beneath the bath house would induce settlements. The author recommended that the settlement induced by the slab be assessed by using “springs” (coefficient of subgrade reaction). This method has been a point of contention previously between geotechnical and structural engineers, and should be used with caution. In this case, we acknowledge that there is limited data available to carry out a settlement assessment and the author has discussed the limitations of this method in an email. We therefore consider the use of the “spring” method to be appropriate.

## **4. Conclusion**

Based on our review of the subject report and the supplementary data, we consider that the assumptions, engineering rigour, and conclusions and recommendations provided in the subject report are generally appropriate. We acknowledge that the subsoil conditions beneath the Museum are difficult to anticipate given the limited investigations and variable lake deposits, and we consider that the methods to address this uncertainty are generally appropriate.

Our review comments are presented in table format attached to the rear of this letter.

## **5. Limitations**

This letter has been prepared solely for the use of our client, Rotorua Lakes Council, and their professional advisors in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity.

This document should always be read in its entirety and is not to be split for further distribution.

Regards,



Scott Higginson  
Geotechnical Engineer  
CPEng No. 1150559



David Sullivan  
Principal Geotechnical Engineer  
CPEng No. 1025183

Attachments

- Important Information about your Coffey Report
- Table 1 – Peer Review Comments Version 1.0

## Important information about your Coffey Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

### **Your report is based on project specific criteria**

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

### **Subsurface conditions can change**

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

### **Interpretation of factual data**

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

### **Your report will only give preliminary recommendations**

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

### **Your report is prepared for specific purposes and persons**

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

### **Interpretation by other design professionals**

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

### **Data should not be separated from the report**

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

### **Geoenvironmental concerns are not at issue**

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

### **Rely on Coffey for additional assistance**

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

### **Responsibility**

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

Table 1 - Geotechnical Peer Review Comments

| No. | Cheal Report Ref.                                 | Coffey Review Comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Cheal Response | Closing Remark | Importance | Action               | Status |
|-----|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|------------|----------------------|--------|
| 1   | GIR - Section 6.2.1                               | The GIR states that a geotechnical ultimate bearing capacity of 250kPa is available for the bath house, based on the Scala results. Some low results were also encountered, as was noted in the report. We recommend the report be updated to include construction recommendations to address these potential soft spots, such as verification testing during construction. This was noted in the subject report.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |                | Moderate   | Response Required    | Open   |
| 2   | GIR - Section 6.2.1                               | We recommend restrictions on the size and depth of the footings be included, due to the potential for punching failure into the existing soft soils which underlie the improved ground.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                |                | Major      | Response Required    | Open   |
| 3   | GIR - Section 6.2.1                               | The report states that the bath house is underlain by cemented sand and gravel, based on the observations from BH02. Additionally, boreholes reference "Holocene River deposits." We note however that the majority of test pits by Terrane in 2009 encountered silty lake sediments, with some occasional sand layers. The report should be updated to mention this and corroborate these. It is suggested that the deposits in this area would be from the past high stand of Lake Rotorua and some of the light silty layers may be diatomaceous deposits from the ancient lake level.                                                                                                                                                                                                                                                                                                                                                                                                         |                |                | Major      | Response Required    | Open   |
| 4   | GIR - Section 6.2.2 and 6.2.3                     | Bearing capacities haven't been provided for the north and south extension areas. Please include bearing capacities for these areas as well as construction recommendations and footing size restrictions as above.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                |                | Major      | Response Required    | Open   |
| 5   | GIR - Section 6.3.2                               | The report states that liquefaction is considered to be within acceptable limits, and that the settlement values would be discussed with the structural engineers. Please confirm whether this was carried out.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                |                | Major      | Response Required    | Open   |
| 6   | GIR - Section 6.3.2                               | The report doesn't address lateral spreading. The site is gently sloping towards Sulphur Bay to the south and the analyses in Appendix 2 show lateral deformation being triggered under a ULS event. Please update to include commentary and recommendations (if any) on lateral spreading.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                |                | Major      | Response Required    | Open   |
| 7   | GIR - Section 7.2                                 | Please confirm that the monitoring of the foundations was carried out.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                | Major      | Response Required    | Open   |
| 8   | Subject Report - Enclosure 2 and 4                | The email dated 25/02/2020 states that a geological model has been drawn up based on su measurements as this is likely to be the critical parameter for bearing capacity. Although this may be the case, the su values appear to be taken from a combination of shear vane measurements from the Terrane test pits, correlations from the CPTs, and correletations from the Scalas. This is not consistent, as the test pits were carried out prior to the ground improvement works, and the CPTs and Scalas were after. We don't consider it to be appropriate to correlate su values from Scalas. Consider that some of the silty soils may actually be diatomaceous and they can perform more similar to a sand than a cohesive clay soil.<br>Despite the above comments, we consider the bearing capacity and recommendations in the email to be appropriate. A reassessment of parameters taken from su (e.g. bearing capacity, coefficient of subgrade reaction) may therefore be required. |                |                | Major      | Response Required    | Open   |
| 9   | Subject Report - Enclosure 2                      | An email dated 25/02/2020 states that the settlement for the slab may be analysed using springs. The coefficient of subgrade reaction is a contentious concept between structural and geotechnical engineers and should be used with caution. We note that the geotechnical engineer lists the limitations of this concept in the email dated 26/02/2020 and require on-site plate load testing. It is important to note that for large footings or rigid mat foundations the edge spring is about 2 times the center spring (which is usually the one measured/calculated). It is difficult to calculate this without doing a finite element analysis though. Also be aware of effects of excavation to the spring calculation. These may be replicated in the field testing proposed. Final note, the mat foundation will have a deep zone of influence that may impact, but it is unclear how much load will be transferred across the entire mat foundation area.                             |                |                | Moderate   | Response Required    | Open   |
| 10  | Subject Report - Enclosure 2 and 5                | The calculations for the coefficient of subgrade reaction in Enclosure 5 appear to use su correlations from scalas which is not appropriate as discussed above. The calculations also include su values from the Terrane test pits prior to the ground improvement, which may not accurately reflect the current ground conditions. The coefficient of subgrade reaction may need to be reassessed to address these comments. In the absence of sufficient data the results of the Terrane test pits could be used, although it should noted that the results may be conservative. It is noted to check the units on the calculations.                                                                                                                                                                                                                                                                                                                                                            |                |                | Moderate   | Response Required    | Open   |
| 11  | Subject Report - Enclosure 3 and 4                | The founding conditions for various subunits (e.g. 3A and 3B) appear to be relatively consistent, given the inherent variability of the lake deposits. The author may wish to consider removing several or even most of the subunits to avoid confusion on site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |                | Moderate   | For Information Only | Open   |
| 12  | Subject Report - Enclosure 4                      | The subunit plan for Zones 4 and 5 should be updated to include a unit description, su value and bearing capacity, as was done for Zone 3 on the previous page.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                |                | Moderate   | Response Required    | Open   |
| 13  | Subject Report - Enclosure 5, Calc Set 1          | We agree with the recommendations that verification testing shall be carried out during construction. In addition to the shear vane and plate bearing tests, we recommend that Scala tests be carried out towards the southern portion of the building where sand and gravel may be more prevalent. A target Scala value should be included.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                |                | Moderate   | Response Required    | Open   |
| 14  | Subject Report - Enclosure 1, Structural Drawings | A general comment out of scope for geotechnical comment. However, has the design team considered epoxy-coated reinforcing due to the aggressive environment that the structure is in?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                |                | Moderate   | Response Required    | Open   |
| 15  | General comment                                   | As a general comment, having digital raw data of the CPT's can help with review. Additionally, providing peer review earlier in the project may prove to provide extra benefit for a project of this nature.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                |                | Moderate   | For Information Only | Open   |
|     |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                |                |            |                      |        |

1. This table shall be read in conjunction with Coffey letter titled 'Geotechnical Peer Review of Geotechnical Reports for Rotorua Museum Seismic Strengthening', dated 8 July 2020  
2. 'GIR' and 'Subject Report' refer to the Cheal documents which are referenced in the attached Coffey letter.