Naenae Olympic Pool Facility - Seismic Assessment

Prepared for Hutt City Council
Prepared by Beca Limited

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Contents

Appendices

Revision History

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Document Acceptance

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Executive Summary

As part of the planning for a refurbishment of the Naenae Olympic Pool and Fitness Centre Facility, Hutt City Council (HCC) engaged Beca Ltd (Beca) to undertake seismic assessments on the existing structures to provide an indication of the likely seismic upgrade works that would be required.

Assessments to date have focussed on the following elements:

- Timber roof arches in Main Pool Hall
- Glazed end walls in Main Pool Hall
- Roof over bleachers
- Unreinforced Masonry (URM) infill façade walls
- Internal URM walls under bleachers
- Elevated Plant Area.

Only a partial assessment has been completed at this stage.

Other elements that have been considered, but not yet assessed in detail, partly due to the absence of available as-built construction information, include the following elements:

- Main roof plywood box structure
- Raking concrete bleacher frame.

The results of the partial seismic assessment for the Main Pool Hall area structure of the Naenae Olympic Pool Facility indicate an overall rating of **less than 20*%NBS* (IL3)** in accordance with the Guidelines for assessing existing buildings dated July 2017.

The partial assessment of key elements in the Main Pool Hall completed to date indicates *%NBS* scores as follows:

- 25-30*%NBS* – Timber roof arches
- < 20*%NBS* – Glazed end walls
- 25-30*%NBS* – Roof over bleachers
- < 20*%NBS* – Unreinforced Masonry (URM) walls.

1 Introduction

1.1 Background

Hutt City Council (HCC) plan to undertake a refurbishment of the Naenae Olympic Pool and Fitness Centre Facility, located on Everest Avenue in Naenae. As part of the planning for this refurbishment, HCC engaged Beca Ltd (Beca) to undertake seismic assessments on the existing structures to provide an indication of the likely seismic upgrade works that would be required.

The facility consists of a number of structures, that have been incrementally constructed since the original pool was built in 1956. There are three main areas in the facility:

- The Main Pool Hall (which includes the 50m pool, main entry, bleachers, plant areas and fitness centre)
- The Hydroslide
- The Learner's Pool.

Beca completed a Detailed Seismic Assessment (DSA) of the Learner's Pool, and issued a report dated 30 November 2018, which indicated that the building had an earthquake rating of 20%*NBS* (IL3) in terms of the expected performance for life safety in an earthquake event.

Following this, HCC commissioned Beca to undertake a seismic assessment on the remainder of the facility. The assessment of this was to be undertaken using a staged approach, initially focused on key structural elements, to give HCC an early indication of the likely result from the seismic assessment.

Figure 1.1 – Site plan of Naenae Olympic Pool Facility

1.2 Scope of Assessment

The purpose of this assessment is to establish the relative seismic risk and vulnerability of the Main Pool Hall at the Naenae Olympic Pool facility. The assessment has been completed, generally in accordance with the guideline document *The Seismic Assessment of Existing Buildings – Technical Guidelines for Engineering Assessments,* dated July 2017 (*Engineering Assessment Guidelines*) with the focus on the life safety of those occupying and those immediately outside the building, rather than building damage and reparability considerations or business interruption. We note, this is a partial assessment of key structural components, not a full assessment of the complete building.

In accordance with our commission with HCC, the specific scope of work is to undertake a staged seismic assessment of the Main Pool Hall, focusing initially on the key structural components noted below:

- Unreinforced masonry (URM) façade and walls under the bleachers, changing rooms and fitness centre
- Glulam timber main roof arches
- Roof over the bleachers
- Glazed walls at north and south ends.

This assessment includes:

- A review of the available construction drawings. From previous work that has been undertaken on the facility, it is known that there is a lack of structural drawings for the Main Pool Hall building structures. Site measurements were taken where possible, and assumptions based on knowledge of the detailing used for structures of this era were made.
- The assembly of an analytical model of the building structure based on the information gained by a review of the drawings and site observations.
- An evaluation of the capacity of the key structural elements of the building and the seismic demands on these elements, as derived from our analytical models.

1.3 Previous ISA Assessment

An Initial Seismic Assessment (ISA) using the Initial Evaluation Procedure (IEP) of the facility was undertaken in 2011 by others. The ISA evaluation determined that the concrete bleacher building had a rating of 55% of the New Building Standard (*%NBS*) which corresponds to a Grade C building, as defined by the *Engineering Assessment Guidelines* building grading scheme. The 1986 timber roof structure was not assessed.

Beca also carried out an IEP of the concrete bleacher building using the latest IEP procedures and current codes. This assessment indicated that the 1956 concrete structure was below the earthquake prone threshold with a score of 25*%NBS* (IL3).

While the ISA assessment process provides a useful indication of a building's potential earthquake rating in an earthquake compared with similar buildings constructed to the current code, it is only a first stage qualitative review.

1.4 Regulatory Environment and Design Standards

The Earthquake-prone Building regulatory framework underwent significant changes during 2016 and 2017 as a result of learnings from the Christchurch earthquakes, and the more recent 2016 Kaikoura earthquake. This resulted in the *Building (Earthquake-prone Buildings) Amendment Act 2016*, the *Building (Specified Systems, Change the Use, and Earthquake-prone Buildings) Regulations 2005* including the Earthquake-prone Building Methodology, and the technical guideline document *The Seismic Assessment of Existing Buildings - Technical Guidelines for Engineering Assessments (Engineering Assessment Guidelines)* all of which were exacted in July 2017*.* The important aspects of this regulatory framework are summarised below.

Earthquake-Prone Buildings (EPBs) are defined in Section 133AB of the *Building (Earthquake-prone Buildings) Amendment Act 2016* as buildings whose ultimate capacity will be exceeded in a moderate earthquake and, if it were to collapse, would likely result in injury or death or damage to another property. A moderate earthquake is defined as approximately one-third as strong but of the same duration as the earthquake shaking assumed in the design of a new building.

The official determination of whether or not a building is Earthquake-prone is the responsibility of the relevant Territorial Authority (TA). The earthquake rating resulting from an engineering assessment is only one, albeit significant, aspect considered by the TA in making their determination. If the TA determines a building to be Earthquake-prone, it will issue an EPB notice for the building and include it on the EPB register. The *Building (Earthquake-prone Buildings) Amendment Act 2016* then defines timeframes within which the owner must carry out building work (i.e. upgrade or demolish) to ensure the building is no longer Earthquake-prone. These timeframes range from 7.5 years to 35 years depending on the building type (priority or normal) and location (high, medium or low risk areas).

The *Building (Specified Systems, Change the Use, and Earthquake-prone Buildings) Regulations 2005* made significant changes to the system for identifying and remediating Earthquake-prone buildings. These include:

- providing an operational basis for identifying earthquake-prone buildings – the *EPB methodology*
- new definitions for key terms including 'Earthquake-prone Buildings' and 'ultimate capacity'
- a requirement to categorise Earthquake-prone Buildings in terms of their earthquake rating
- providing a national-based system in place of individual earthquake-prone building policies for each TA.

The *Engineering Assessment Guidelines* document used by engineers to carry out seismic assessments is an integral part of the July 2017 *EPB methodology*.

In addition, the New Zealand Society for Earthquake Engineering (NZSEE) define a building with an earthquake rating less than 67*%NBS* as an Earthquake-Risk Building (ERB), and recommend a minimum target strengthening level of 67*%NBS*.

It is considered impractical and unaffordable to design every building to withstand the largest earthquake imaginable. Consequently, with respect to the determination of design loads for natural hazards, the New Zealand Loading Standard (NZS 1170) adopts a probabilistic approach that takes into accord the exposure hazard at a given location, along with factors such as building importance. Thus, the Loading Standard may be said to adopt a risk management approach in setting the loading levels that a given new building is required to withstand.

For new Importance Level 3 (IL3) buildings, the "design" earthquake load is set at the 1-in-1000 year return period earthquake event. This event has approximately a 5% probability of exceedance over the assumed 50-year life of a building. This level of load has been used in the calculations of the earthquake scores quoted in this report.

2 Building Description

2.1 General

The Main Pool Hall consists of a number of structures that have been built over time.

When the pool was originally constructed in 1956, it was an outdoor pool with reinforced concrete (RC) and unreinforced masonry (URM) infill bleachers. The bleachers now house the main reception, changing rooms and fitness centre. In 1986, a plywood roof with glulam timber arches was constructed to enclose the pool. As part of this, significant building services were installed above the main pool on an elevated plant platform.

The initial key structural elements that make up the scope of this assessment are predominantly elements from the roof structure and the URM infills. Table 2.1 presents a summary of the building information for the structure.

Table 2.1 – Main Pool Hall Summary Information

System	Direction
Building name	Main Pool Hall, Naenae Olympic Pool Facility
Address	Everest Avenue, Naenae, Lower Hutt
Date of design	1956 (bleachers)/1986 (arched roof)
Description / Building Occupancy	Swimming Pool
Importance Level	Importance Level 3 HCC advised that the Main Pool Hall regularly contains crowds of approx. 500 people and therefore the structure is considered Importance Level 3 (IL3), in accordance with AS/NZS 1170.0:2002.
Building Footprint/ Floor Area	48m x 62m/3,000m^2
Nº of storeys/ basements	2 storey (bleachers)/1 storey (arched roof)
Structural system	The roof consists of lightweight metal cladding supported on plywood boxes and glulam arches. Sections of the roof structure connect to the concrete bleachers that then transfer the load to the ground.
Earthquake resisting system	The lateral load resisting system is glue-laminated timber arches in the east-west direction and in the north-south direction, the building relies on the plywood boxes to act as a diaphragm to transfer the loads in to the concrete bleachers. The concrete bleacher structure has concrete frames in both directions, with the bleachers themselves acting as a diaphragm to transfer the loads to the frames.
Foundation system	The foundations generally consist of shallow foundations, below the concrete bleacher structure
Other notable features	Elevated Plant Platform suspended from glulam arches above the main pool,. Full height glazed end walls at both the north and south ends of the building.
Construction information	Limited architectural/structural drawings

Figure 2.1 shows a 3D model of the Naenae Olympic Pool Facility.

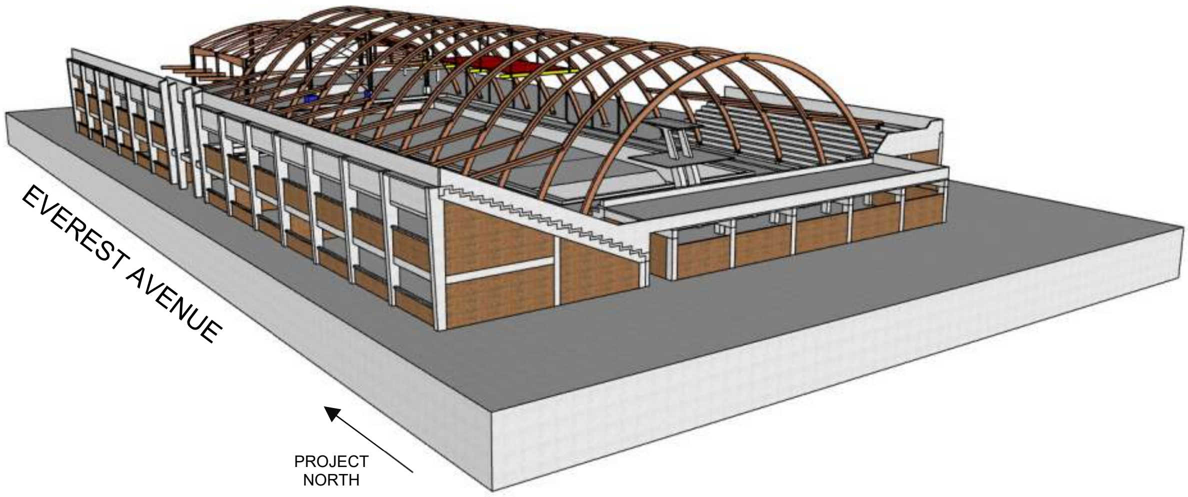

Figure 2.1 – 3D Model of the Naenae Olympic Pool Facility

2.2 Site Conditions and Potential Geohazards

Based upon Beca information available and referring to Table 3.2 in NZS 1170.5, the site can be classed as D (Deep or Soft soil site). Whilst a specific site investigation would reveal the specific stratigraphy at the site, it is unlikely (based upon data available to Beca) that soil composition would differ significantly enough to affect a change in soil class using the NZS 1170.5 definitions.

Geohazards have not been specifically identified or assessed as part of this report.

2.3 Structural Systems

The lateral load resisting systems for the timber roof structure over the main pool at the Naenae Olympic Pool facility are identified to be:

Transverse (East-West direction)

- The seismic loads are resisted predominantly by the glulam timber arches.
- There are three main types of arches with varying capacity for lateral-load resistance – a plain arch at each end of the building, an arch with one 'prop' to the bleachers, and an arch with a 'prop' to the bleachers on each side.
- It is assumed, that the arches resist loads based on the tributary area associated with each.
- The end arches are quite flexible and have limited lateral-load resistance.
- The elevated plant platform adds additional mass and load to the arches that it is suspended from.
- It is assumed, that the arches transfer the load in to the concrete bleachers which then transfer it to the ground.

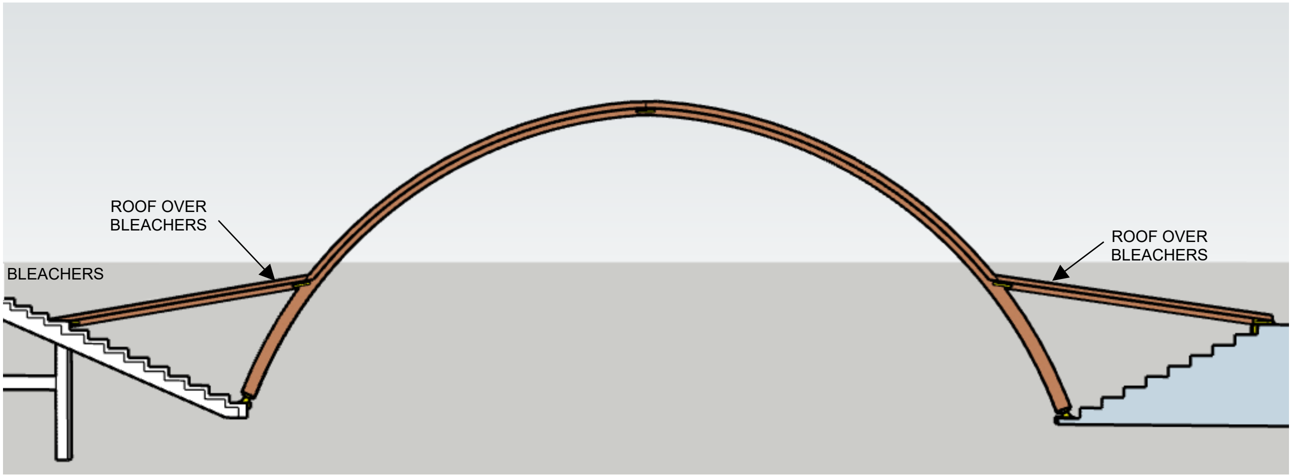

Figure 2.2 – Transverse section showing typical timber arch with props (looking north)

Longitudinal (North-South direction)

- The seismic loads are resisted predominantly by the plywood roof structure. At the time that the assessment was undertaken, the construction details for the plywood structure were unknown and it was assumed that these could act as a diaphragm. Further investigations have now concluded that these are not reliably fixed to the arches as required to provide a dependable transfer of seismic loads.
- The load is distributed to the concrete bleachers through the 'roof over the bleachers' which runs most of the length of the building on the western side, however is only over half the length of the building on the eastern side.

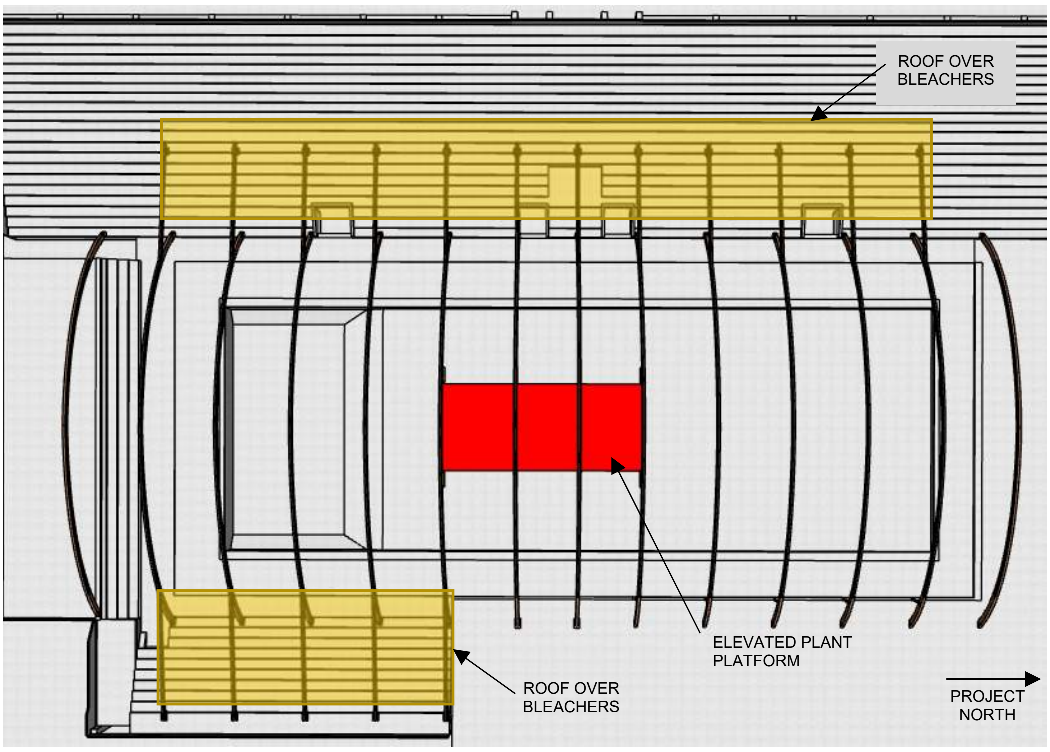

Figure 2.3 – Plan of building

3 Results of Seismic Assessment – Initial Findings

The results of the partial seismic assessment for the Main Pool Hall structure of the Naenae Olympic Pool Facility indicate an overall earthquake rating of **less than 20%*NBS* (IL3)** in accordance with the Guidelines for assessing existing buildings.

Our partial assessment of key elements in the Main Pool Hall completed to date indicates *%NBS* scores as follows:

Table 3.1 – Results of Seismic Assessment

System	Direction	Seismic Performance in *%NBS*	Notes
Timber Roof Arches	Transverse	25-30%*NBS*	Governed by the flexural capacity of the arches that do not have a prop on both sides
Roof over Bleachers	Longitudinal	25-30%*NBS*	Governed by the plate connection between the timber arch and the timber beam that supports the roof over the bleachers
Unreinforced Masonry Infill façade/walls	Both directions	**<20%*NBS***	Governed by out-of-plane loads on the URM infills, in particular, the façade along Everest Avenue and the part height wall in the changing rooms
Glazed End Walls	Transverse	**<20%*NBS***	Governed by the seismic separation between the flexible end arches and the glazed end walls. The deflection is such that the glazed end walls will be loaded by the arches which could lead to failure of the glazing.

Other elements which have not yet been assessed in detail, which would present a significant hazard in the event of failure and, could also potentially score around 34%*NBS* (IL3) include the following:

Table 3.2 – Main Pool Hall Other Elements

System	Direction	Seismic Performance in *%NBS*	Notes
Plywood Roof Structure	Both directions	-	The construction details for the plywood roof structure and its connection to the arches was unknown at the time of the assessment. Further investigations have now concluded that these are not reliably fixed to the arches as required to provide a dependable transfer of seismic loads.
Elevated Plant Platform	Both directions	-	The capacity of the elevated plant platform has not been assessed, however if it were to collapse, it would pose a significant life safety hazard
Short columns in bleachers	Transverse	20-25%*NBS*	Governed by shear capacity of the columns that due to stiffness, attract more load than the longer more flexible columns. High level calculations undertaken on the columns only.

4 Commentary on Associated Seismic Risks

4.1 Risks from Adjacent Buildings – Learner's Pool

The Learner's Pool Building has been assessed to have an earthquake rating of 20%*NBS* (IL3). This is due to the absence of a reliable roof diaphragm and wall bracing system when considering an earthquake in the east-west direction, i.e. the transverse direction across the Main Pool Hall.

There is a link between the Learner's Pool portals and the wind columns on the end glazed wall of the Main Pool Hall. Some of the lateral load from the Learner's Pool may be transferred through this link and into the wind columns on the end glazed wall of the Main Pool Hall. It does not appear, that these columns were designed for this lateral load.

When both buildings deflect, this connection may rack and cause damage to the ceiling/roof that it supports, and it may also cause the wind columns to twist. The twisting and movement of this column will further load the top connection that is already under capacity. Refer 4.2 below.

4.2 Risks from Non-structural Building Elements

From our experience in evaluating similar buildings following the recent earthquakes in the Christchurch and Wellington regions, non-structural building elements (façade glass, URM and overhead services) constitute a significant portion of the repair/reinstatement cost following an earthquake. In a moderate seismic event, non-structural element damage will likely contribute heavily to downtime and the repair costs.

For a new building, glazed façades are normally designed to accommodate the building's deformations. The connections of the glazed end walls of the Main Pool Hall indicate that some thought was given to separate the façade and there are slotted holes at the top of the wind posts that allows movement. However, the movement allowances are not adequate to accommodate the required earthquake displacements. In places, the connections are already hard up against one side of the slot. At one location, the pin has bent as it has run out of travel before the required amount of movement has been accommodated. As a result, movement of the main arches cannot be accommodated, and the seismic load will be transferred directly to the glazed walls. Displacement of the main arches could also result in loss of contact of the top post pins, and therefore loss of restraint at the top of the façade wind posts.

Figure 4.1 – Glazed End wall top connection with little to no travel room

5 Assessment of Seismic Risk

5.1 Seismic Risk and Performance Levels

The partial quantitative seismic assessment we have recently completed of the Main Pool Hall building at the Naenae Olympic Pool Facility indicates an earthquake rating of **<20%*NBS* (IL3).** The building has been assessed in accordance with the guideline document *The Seismic Assessment of Existing Buildings - Technical Guidelines for Engineering Assessments*, dated 2017 (*Engineering Assessment Guidelines*). The earthquake rating is based on an Importance Level 3 (IL3), in accordance with the joint Australian/ New Zealand Standard – Structural Design Actions Part 0, AS/NZS 1170/0:2002 as being deemed appropriate for this building.

Therefore, the building is a Grade E building following the *Engineering Assessment Guidelines* building grading scheme. Grade E buildings represent a life-safety risk to occupants at least 25 times that expected for a new building, indicating a very high risk exposure.

The New Building Standard requires an IL3 building to have a low probability of collapse in a 1-in-1000 year "design level" earthquake, i.e. an earthquake with a probability of exceedance of approximately 5% over the assumed 50-year design life of a building.

Table 5.1 – Relative Earthquake Risk (adopted from the Guidelines)

Building Grade	Percentage of New Building Strength (%*NBS*)	Approx. Risk Relative to a New Building	Relative Risk Description
A+	>100	<1	low risk
A	80 to 100	1 to 2 times	low risk
B	67 to 80	2 to 5 times	low to medium risk
C	33 to 67	5 to 10 times	medium risk
D	20 to 33	10 to 25 times	high risk
E	<20	more than 25 times	very high risk

A building with an earthquake rating less than 34%*NBS* fulfils one of the requirements for the Territorial Authority to consider it to be an Earthquake-Prone Building (EPB) in terms of the Building Act 2004. A building rating less than 67%*NBS* is considered as an Earthquake Risk Building (ERB) by the New Zealand Society for Earthquake Engineering. The Main Pool Hall at the Naenae Olympic Pool Facility therefore meets one of the criteria that could categorise it as an Earthquake Prone Building by Hutt City Council.

6 Explanatory Statement

- This report has been prepared by Beca at the request of our Client and is exclusively for our Client's use for the purpose for which it is intended, in accordance with the agreed scope of work. Beca accepts no responsibility or liability, to any third party for any loss or damage whatsoever arising out of the use of, or reliance on this report by that party, or any party other than our Client.
- The inspections of the building discussed in this report have been undertaken to assist in the structural assessment of the building structure for seismic loads only. This assessment does not consider gravity or wind loading, or cover building services or fire safety systems, or the building finishes, glazing system or the weather tightness envelope.
- This assessment does not include an assessment of the building condition or repairs that may be required.
- No geotechnical ground investigations, subsurface or slope stability assessments have been undertaken. The geotechnical investigations were limited to a desktop review based on information we have about the site and general area (refer Appendix A).
- Beca is not able to give any warranty or guarantee that all possible damage, defects, conditions or qualities have been identified. The work done by Beca and the advice given is therefore on a reasonable endeavours basis.
- Except to the extent that Beca expressly indicates in the report, no assessment has been made to determine whether or not the building complies with the building codes or other relevant codes, standards, guidelines, legislation, plans, etc.
- The assessment is based on the information available to Beca at the time of the assessment and assumes the construction drawings supplied are an accurate record of the building. Further information may affect the results and conclusion of this assessment. The information used to undertake the seismic assessment is listed in Appendix A.
- Beca has not considered any environmental matters and accepts no liability, whether in contract, tort, or otherwise for any environmental issues.
- The basis of Beca's advice and our responsibility to our Client is set out above and in the terms of engagement with our Client.

A

Appendix A – Sources of Information

Sources of Information

The following information was used to undertake the seismic assessment:

- Documents obtained from Hutt City Council archives comprising a partial set of scanned original Architectural/Structural drawings (from 1956 and 1986) and some original construction photographs.
- Loughnan Hall Thompson's Initial Seismic Assessment summary on the Naenae Olympic Pool Original Building dated 2010.
- External and internal visual inspections of the building carried out on 6 March 2019 and 7 May 2019.

The following documents and references were available to undertake the seismic assessment:

- New Zealand Standard NZS1170 "Structural Design Actions".
- New Zealand Standard NZS3603:1993 "Timber Structures Standard".
- New Zealand Standard NZS3101:2006 "Concrete Structures Standard".
- *The Seismic Assessment of Existing Buildings - Technical Guidelines for Engineering Assessments*, dated July 2017.

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