Appendix 8.03 – Structural Engineering; Westpac Stadium Concourse

Wellington City Council

Report for Independent Review of the WCC Indoor Sports Centre Project

Engineering Assessment – Executive Summary

Westpac Stadium Trust Concourse Proposal

April 2009

1.0 Executive Summary

1.0 This report provides an engineering assessment of the proposed community indoor sports centre to be constructed over the concourse to the Westpac Stadium. The assessment is a conceptual review and does not extend to an in depth technical review of the project.

1.2 At the time of reporting, the Consultants had not developed the concept for the Indoor Stadium above the concourse beyond that presented to the Wellington City Council in 2006.

1.3 The site is that portion of the concourse to the Westpac Stadium immediately south of the Westpac Stadium. The site is irregular in plan view and varies in width from 95 metres at the north end to 38 metres in width at the south end. The majority of the concourse above which the indoor stadium is to be constructed is a 2 storey structure with carparking on the first floor level.

1.4 The site is exposed to the prevailing north to northwest winds in the Wellington area; wind affects being influenced by the presence of the Westpac Stadium. The site is also in the coastal zone on the fringe of Wellington Harbour. Durability considerations need to extend beyond Building Code requirements and include whole of life costs.

1.5 The existing concourse is a reinforced concrete framed structure supported on piles. The floors are constructed with hollowcore (spiroll) with timber infills. That portion of the concourse over which the Indoor Stadium is to be constructed is two separate buildings with a seismic isolation joint at each end and along the south side of the railway corridor underneath the concourse. The seismic joints have primarily been provided to reduce the affects of shrinkage and temperature on the elevated concourse.

1.6 The concourse superstructure has been designed for a live load of 5 kPa with a further 1 kPa allowance for asphaltic concrete paving which was never applied. The floor has also been designed to support a 40 kN point load in the absence of any uniformly distributed load. A heavier floor construction is used for the longer spans over the railway corridor. The access ramp along the eastern side of the concourse has been designed for HN loading.

1.7 At the time the concourse was designed, the brief included no requirement for future vertical extension.

1.8 The concept for the Indoor Stadium proposes a structural steel framed building with lightweight cladding. The Indoor Stadium is a portal framed structure, spanning the courts in the north- south direction and a braced structure in the east-west direction. At roof level the concept involves the use of long span roofing materials between heavy steel purlins and girts. The floor for the Indoor Stadium is to be of timber construction with timber joists spanning between a grillage of structural steel beams. The structural grid for the Indoor Stadium is dictated by the structural grid for the existing concourse, in order that gravity loads can be transferred directly to

existing columns within the concourse structure. Longer span roof elements within the Indoor Stadium reduce the number of the columns within the Indoor Stadium

1.9 The Indoor Stadium is supported on transverse structural steel frames above the concourse and K braced elements along the east and west walls of the concourse. Egress requirements from the Westpac Stadium prevent the use of bracing elements in the east-west direction. A lightweight structural system was adopted to reduce the extent of strengthening required to the existing concourse.

1.10 To accommodate the independent movement of the two separate structures supporting the Indoor Stadium, the proposal provides pin ended columns between the concourse and the floor of the Indoor Stadium over the building north of the railway corridor seismic joint. This is an unfortunate feature of the concourse proposal and is considered to be inappropriate for a major community facility over the emergency egress from the Westpac Stadium. Integration of the two structures supporting the Indoor Stadium may be possible and should be investigated.

1.11 Strengthening of the existing concourse structure is necessary to carry the additional gravity and lateral loads imposed from the Indoor Stadium. At locations where existing columns carry the roof loads from the Stadium as well as the Stadium floor, additional screw piles are necessary to enhance the strength of the existing concrete piles. Preloading of the screw piles would improve the performance of the composite piling system.

1.12 Lateral load resistance of the concourse structure is to be enhanced by the introduction of K braces within some of the reinforced concrete frames beneath the concourse level. These K braces are to be located on the east and west walls of the concourse and in bays within the carpark which do not restrict access to existing carparks. The K braced elements will be exposed to salt laden air, often in the unwashed zone, and will require high quality protective coatings and an ongoing programme of maintenance. The position of reinforcing steel at connection points within the existing reinforced concrete frames will need to be located and each connection is likely to be required to be individually detailed.

1.13 New Zealand Building Code requirements have changed since the concourse was designed in 1997. The load resistance of the structural system incorporated in the concept design will need to be increased by approximately 20% to meet the increased requirements of the Building Code. In addition, the Wellington City Council has indicated that the concourse structure itself will need to be upgraded to current Building Code requirements. These requirements will result in a further increase in the cost of strengthening the existing concourse structure.

1.14 A further Building Code change since the concourse was designed relates to requirements for the use of hollowcore flooring systems in buildings. Additional seating will be necessary for the existing hollowcore flooring units to the concourse and carparks and some localised additional strengthening may be necessary in areas of high deformation under seismic loading.

1.15 Uncertainty exists as to the ability of constructing a DIN rated indoor sports floor on the proposed timber floor construction supported on a grillage of beams.

Typically, DIN rated sports floors are constructed on a concrete slab and no precedence of a DIN rated sports floor having been constructed on timber construction has been identified.

1.16 Construction of the Indoor Sports Stadium 3 storeys above ground level over a fully developed site operated as a carpark, a concourse providing access to Westpac Stadium and adjoining the railway yards provides significant challenges. The limited load capacity of the concourse for heavy vehicles and larger cranes places limitations on the construction methodology. The concept design does incorporate concepts, which will assist the Contractor construct the facility. The adoption of pre-fabrication of timber components and bolted spliced connections for steel work, will aid the speed of construction on site. However access for heavy cranage is likely to require back propping.

1.17 The use of tower cranes and or large mobile cranes on the concourse will affect egress from the Westpac Stadium. The challenges of maintaining public access and safe emergency egress through the site to the Westpac Stadium are substantial. The maintenance of safe emergency egress from the Westpac Stadium will require progressive compliance approval as construction alters the egress progressively throughout the construction period. Measures needed to maintain safe public access to and from the Westpac Stadium as well as emergency egress requirements from the Westpac Stadium are likely to result in a significant extension of the construction programme forwarded in support of the proposal. The requirements of the Rugby World Cup alone are expected to have a significant affect on programming of the works.

1.18 Absence of areas for storage of materials and positioning of cranes and other construction equipment around the perimeter of the site significantly add to the logistics of constructing the Indoor Stadium above the concourse. Construction of the cladding to the west wall of the Indoor Sports Centre, 3 storeys above the rail yards on a windy and exposed site is a challenging construction feat requiring experience and resourcefulness.

1.19 Installation of K braces and pile foundations within the carpark will disrupt the operation of the carpark and result in the loss of carpark spaces for rental during the construction of these works. The lost revenue to the carpark is an added cost to the project.

1.20 There is a need to maintain a safe and publically acceptable access on the concourse during the construction of the building. The public are not experienced in accessing a construction site and many will find the experience foreboding. In wet weather, the concentrations of storm water flowing from structural elements erected, but not enclosed, above the concourse will provide a relatively hostile environment to the public and is likely to deter patrons from using the concourse as a means of entry to the Westpac Stadium. Fire engineers will need to give careful consideration to the human response to egress through a partially completed construction site. At the very least an acceptable standard of lighting will be necessary for all night events at the Westpac Stadium.

1.21 The challenges arising from the construction of an Indoor Stadium above a public access way forming the emergency egress from the Westpac Stadium, will restrict cranage and storage on the concourse. The project will require an experienced Contractor with substantial resources to coordinate both compliance issues and construction logistics during the contract period.

1.22 The proposed use of light weight metal cladding with a 15 to 20 year life on a site exposed to salt air will add significantly to maintenance costs over the life of the structure. Once the Indoor Stadium has been constructed, the even more restricted access for cranage will significantly increase the cost of replacing the cladding. Maintaining the cladding free of salt deposits will require appropriate access to allow regular washing of the exterior surface.

1.23 There are many aspects of the proposal that are unresolved and that require substantial work in order to establish that the risks associated with the project are acceptable to the Wellington City Council.