Appendix 2 STRUCTURAL ISSUES REPORT

RobertBirdGroup

Structural Issues Report

Store 1, Store 2, Store 3, Store 4 and Carriage Shop Extension

North Eveleigh Rail Yards Site

Prepared For: Redfern-Waterloo Authority

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EXECUTIVE SUMMARY

Visual structural inspections were carried out on Store 1, Store 2, Store 3, Store 4 and the Carriage Shop Extension at the North Eveleigh Development Site. The structures can be separated into two group types based on their constituent construction materials, timber (Store 1, Store 2 and Store 3) and steel (Store 4 and the Carriage Shop Extension).

Inspections revealed that patterns of deterioration, wear and likely Code non-compliance were similar across the building group types. Forests NSW also carried out preliminary investigations to determine the extent of termite damage and decay in the timber structures. The information from their preliminary report (dated 13 March 2008) has been drawn on in this Structural Issues Report.

The general observation made from the inspections of the timber structures was that termite infestation has impacted significantly upon the capacity of the structures to meet current Code requirements. It is recommended that access by the general public or otherwise to Store 1, Store 2, Store 3 and the adjoining Store 4 is prevented. Cordoning-off the perimeter of the buildings a safe distance from the Stores is also recommended.

The timber buildings' future use is therefore not recommended without an exhaustive detailed investigation, examination, analysis and remediation of the affected structural members. A preliminary report from Forests NSW has been made available and it is clear that the degree of termite presence is extensive, affecting a high proportion of critical structural members. Demolition of these timber structures appears to be the most appropriate option in light of safety and cost implications of remediation.

Visual inspections on the steel structures revealed that considerable corrosion had advanced in one particular connection in the Carriage Shop Extension building. It is recommended that this member is temporarily supported. It is also recommended that access is shut-off to the Carriage Shop Extension building and adjoining Boilermakers' Shop. Cordoning-off the perimeter of the building (at a safe distance) is recommended.

Considerable strengthening could be required subsequent to a further detailed structural analysis and checking of the existing steel buildings' structural framing. Corrosion was noted to have advanced to different stages in the two buildings investigated. Both steel structures would require extensive remediation and protection works to ensure longevity if the structures are to be used for future commercial or residential purposes.

Where demolition is to be carried out on the reported structures, further structural engineering advice is recommended for the preparation of a demolition plan for these structures.

1.0 Introduction

The Redfern-Waterloo Authority has requested that the Robert Bird Group provide a preliminary assessment describing the structural suitability of a number of railyard buildings at North Eveleigh site that are currently in the site of the North Eveleigh Concept Plan.

The existing buildings inspected and included in this report are referred to as "Store 2 and Store 3", "Store 1", "Store 4" and the "Carriage Shop Extension".

A heritage map was issued to Robert Bird Group, listing the historic store names. It is clear from the plan that there have been modifications to the layout of the stores, possibly with additional partition walls which have subsequently been removed. As such, the stores have been named as closely as possible to those which have been labelled on the heritage map.

A site reference map (refer Appendix A) has been included indicating the location of each of these buildings on the site and the name which was adopted.

2.0 Inspections

Preliminary visual inspections were carried out on the exterior and interior of the existing structures at the North Eveleigh Site by James Prineas of the Robert Bird Group on the following dates.

- Store 2 and Store 3 – Tuesday, 4th March 2008
- Store 1 – Wednesday, 5th March 2008
- Store 4 – Wednesday, 5th March 2008
- Carriage Shop Extension – Wednesday, 12th March 2008

It should be noted that Store 1, Store 2, Store 3 and Store 4 form one enclosed building comprising three separate sheds. These structures are separated internally by party walls clad in various materials (e.g. timber boarding and corrugated metal sheeting). A number of major openings allow access between the stores.

The setout of structural framing is consistent in each store; 15 roof trusses were counted from the northern end to the southern end, typically. However, the materials used in the stores structures vary – Stores 2 and 3 and Store 1 are of timber construction while Store 4 is of what appeared to be steel construction.

The following section provides a structural description of the buildings and the observations made during the inspections.

Based upon the aforementioned inspections, we provide the following comments regarding the structural suitability for re-use of these buildings.

2.1 Store 2 and Store 3

The typical structural frame of Store 2 and Store 3 consists of a two-span timber truss roof supported by timber columns (typically 190x190 in cross section). The eastern span (Store 2) is of very similar construction and proportion to that of Store 1. The western span (Store 3) is slightly smaller than the eastern span. The roof trusses are of gable profile with timber vertical and diagonal web members. Herein, "eastern span" refers to Store 2 and "western span" refers to Store 3. The two stores form one enclosed shed with an access ramp to Store 1.

With respect to lateral stability, the building was noted to have diagonal timber bracing within the eastern perimeter wall. The western wall is clad both sides, concealing the structure within. Roof bracing was noted towards the north and south ends of the western span (in the end bays). Diagonal bracing members were also noted in the southern end-wall of the building. Timber haunches at every second column-truss connection also appear to have been installed to increase the lateral stability of the structure. The haunches are reinforced with what appeared to be steel plate and rivets.

A platform structure is located on the eastern side of the building (Store 2), consisting of a steel angle frame bolted to the original timber columns.

From preliminary inspections carried out by Forests NSW, it was noted on site that the timber structure generally consists of softwood timber of Oregon species. On inspection, the most prominent issue of concern was the large number of visible insect nests (confirmed by Forests NSW as termite nests) that were visible in a number of structural elements. The most prominent signs of nesting appeared in the perimeter columns located on the eastern side of the building (Store 2). These columns exhibited various stages of visible decay. One particular column was noted to have lost approximately 85-90% of its cross-section at its base.

In general the full extent of damage from insects was not visible due to the nature of the nesting and the fact that the nests themselves concealed the timber.

Insect nesting was also noted at a number of rafter-column junctions. As noted with the columns, most of these instances were noted on the eastern perimeter of the building (Store 2). A rafter top chord was noted to have a hole (approximately 150mm in diameter) gouged through the member at the top-chord bottom-chord junction. Other similar truss junctions appeared to show similar signs of decay. In light of these findings, the building may not be safe to enter.

Evidence of water damage was also present in various structural elements, most notably, columns and rafter ends. The most severe water damage occurred in areas where valley or eaves gutters had been breached. Rotting of timber in structural elements was noted across the two stores.

Warping was noted in a number of structural elements, possibly a result of water ingress. This was evidenced in a number of timber trusses showing considerable lateral deflection (in the order of 50-70mm). Column crookedness was also noted in one particular instance where there was evidence of the valley gutter having been breached.

Not all structural connections were visible from the ground on inspection, but the fixings typically consist of what appeared to be steel rivets, through-bolts and tie rods. All connections viewed showed signs of surface rusting.

The walls to the east and west are of timber stud infill (between perimeter structural columns) with horizontal battens supporting corrugated metal sheeting. Numerous studs and battens showed significant signs of water and insect nesting damage. The roof is clad with corrugated metal roof sheeting attached to timber purlins spanning between the main trusses. The sheeting was noted to have numerous holes throughout the roof, another possible cause of the notable widespread water damage in the timber members.

The flooring to Store 2 and 3 consists of a jointed concrete slab. It appeared that the slab was of slab on ground construction due to the relative level of the slab to the surrounding natural ground line. The slab panels appeared to be worn, presumably from the likely heavy loading which the floor had previously been subjected to. Cracking was noted across a number of panels.

The foundations to the timber columns were not visible at the time of the inspection. The central columns were noted to have a half lap joint approximately 1.5m from ground level.

2.2 Store 1

The structural frame of Store 1 is similar to Store 2. Its eastern wall is common to the adjacent Store 3. The eastern wall top plate acts as a support to the main truss of Store 3. It should be noted that the floor of Store 1 is approximately 600mm higher than that of Store 2 and 3 and can be accessed via an internal concrete ramp between the two stores.

One significant difference between the two stores is the floor structure. The floor appeared to be suspended, an observation made through the vibration felt from a

heavy footfall. The wearing surface of the flooring for the majority of the building consists of timber boarding, with steel chequer floor plate located towards the southern end of the building. The timber flooring appeared to be very worn, with a number of splits and holes throughout the surface. The chequer plate also showed significant signs of surface rust. Water ingress/ponding was also noted.

The timber trusses, their connections and supporting columns are of similar construction and setout to Store 2. The condition of the timber trusses appeared better than that of Store 2 in that there were no obvious signs of insect nesting. However, in subsequent investigations by Forests NSW, evidence of termite nesting was noted here also. A number of structural timber elements also appeared to show significant signs of water damage. Numerous truss members showed horizontal splitting and much of the paint coatings had deteriorated.

A number of riveted steel tie-down connection plates between the rafter and columns were noted to have corroded significantly, probably due to water ingress from the valley gutter. Also, the steel plate connections between the haunches and timber columns were noted to have corroded.

The roof bracing consists of timber cross-bracing towards the centre of the roof structure (in plan). Diagonal wall bracing is located in the eastern wall. The western wall is fully clad in what appeared to be plywood boarding.

It was advised that the roof cladding to Store 1 was asbestos sheeting. Vents were noted spaced evenly along the north-south direction of the roof. The sheeting was observed to have a number of holes throughout its surface.

2.3 Store 4

The typical structural frame for Store 4 consists of single-span steel roof trusses supported on steel columns. All structural elements appeared to be steel. The vintage of the building (circa 1930s) and the confirmed use of steel for other surrounding Carriageworks buildings supports the assumed material type. The column cross-sections are tapered flange beam type. Columns were typically marked with the letters "BHP".

The majority of flooring to Store 4 is concrete, with a small portion towards the south consisting of suspended timber floorboards. The jointed concrete flooring felt solid to footfall and it was noted through a hole in the timber flooring that the concrete slab was suspended. This was confirmed by the fact that when viewed externally, the first 600-800mm height of the Store 4 perimeter was seen to consist of approximately 9 courses of clay brick.

Water was noted to be ponding in the concrete slab towards the southern end of the building. Deflection and sagging in the order of 5-10mm was noted towards the central areas of some of the slab panels. This suggested that the slab panels may be seated on deep beams or brick dwarf walls. The slab also appeared worn, due to the likely heavy loadings it has been subjected to in the past.

A column foundation was visible through a penetration in the timber flooring. The column appeared to bear on a concrete pad which was seated on a brick pier engaged with the perimeter wall. Columns were typically noted to be painted, but the degree to which they were coated varied significantly. Some columns were partially painted while others showed no signs of painting at all.

The typical truss to the Store 4 structure consists of a welded double-angle truss of gable profile. Some riveted connections were noted, presumably to allow for tolerance during the erection process. Metal equal angle purlins span between trusses, supporting what was advised to be asbestos sheeting. The roofing was noted to be vented along the length of the Store. All structural members visible exhibited surface corrosion. A number of holes were noted throughout the roof sheeting.

With respect to lateral stability, vertical cross bracing was noted in the corner bays of each face of the building. Horizontal roof bracing was noted towards the north and south ends of the roof. All bracing appeared to be of equal angle cross-section.

Exterior wall cladding was noted to be corrugated metal sheeting spanning over horizontal tapered flange channel girts. These girts span between the perimeter columns.

2.4 Carriage Shop Extension

The Carriage Shop Extension building consists of a steel sawtooth roof structure supported by steel columns. The primary roof trusses are located in the plane of the clerestory and these support the secondary 'sawtooth' profiled trusses. There is a masonry wall located at the southern side of the building which supports the southern ends of the clerestory trusses. This wall appears to be part of the original building structure. At the northern side, a timber stud wall was noted. This separates the Carriage Shop Extension from the adjacent Boilermakers' Shop. It is possible that the adjacent newer steel structure supports the northern ends of the Carriage Shop Extension clerestory trusses. The Boilermakers' Shop was not accessible during the inspection.

The flooring to the Carriage Shop Extension consists of a slab on ground. This was confirmed through a corehole which was located towards the eastern end of the building. The slab appeared worn and showed obvious signs of abrasion.

Columns to the Carriage Shop Extension typically consist of tapered flange beams. These columns act as the central structural support to the clerestory trusses. Downpipes were noted nestled between the flanges of the columns running from roof to floor. Several columns were noted to be corroding heavily and this was evidenced by the accumulation of corroded metal having fallen to the base of the columns. This appeared to be related to the downpipe connections at the top of the columns having deteriorated.

The primary and secondary roof trusses consist generally of single and double equal angle members. The exception to this is the bottom chord to the secondary trusses which is of single plate cross-section. Truss members were noted to have corroded to various degrees. Several primary trusses exhibited a high degree of corrosion, particularly in areas where valley gutters and downpipe connections had rusted through. One particular clerestory truss connection to the southern masonry wall showed severe loss of cross-section. The reader is directed to the discussion in Section 3.2 of this report where safety implications are raised.

A number of trusses showed signs of severe buckling to the secondary truss top and bottom chords. It is not clear as to how this has occurred. It may have been related to a construction mishap during the building of the lightweight shed structure positioned in the area below the trusses. Another possibility is chord failure due to wind uplift.

The lateral stability of the structure was visually noted to be very lightweight, especially in the eastern and western walls which contain large openings. It is likely that the building depends on the Boilermakers' Shop for lateral stability in the "north-south" directions. The clay brick masonry wall to the south provides some degree of bracing in the "east-west" direction. The stud wall to the north did not consist of any cross bracing and was only sheeted on one side.

3.0 Discussion on Building Re-Use

The following section addresses the issues concerning suitability of the existing structures for commercial re-use. Stores 2 and 3 have been grouped together as have Store 4 and the Carriage Shop Extension. This is due to their similar structural qualities and required remedial works.

3.1 Stores 1, 2 and 3 - Timber Framed Structures

While Robert Bird Group's (RBG) structural inspections found extensive evidence of what was confirmed on site as obvious termite nesting, RBG itself is not a termite specialist and thus has based its advice upon Forests NSW's preliminary report which comments on the extent of termite damage. It is also noted that Forests NSW's report is based on a relatively limited investigation and that further inspections would likely find considerably more termite damage and decay than reported to date.

Forests NSW has reported that most trusses within Stores 2 and 3 have been affected significantly by termite damage. Twenty seven of the thirty trusses (i.e. 90% of the trusses in the stores) have been marked as exhibiting either extensive or moderate damage. The extent to which termites have affected these members is such that the timber cannot be graded to meet any Code. A high proportion of the affected members are top or bottom chord members – i.e. critical to global stability of the roof structure.

A number of columns in Stores 2 and 3 have also been noted as having extensive termite damage.

The angle-framed platform structure in Store 2 should not be removed prior to the roof structure being either propped or removed. The steel angle posts (bolted to the columns) appear to be carrying load where the timber columns have been damaged by termites. If Store 2 is to be demolished, further structural engineering advice is recommended in the formulation of the demolition plan.

Store 1 has been reported by Forests NSW as exhibiting similar damage to the structures of Stores 2 and 3. All frames within Store 1 were reported to have some form of extensive termite damage or decay. The patterns of damage and decay appear similar to that of Store 2 and 3.

The volume of instances in Stores 1, 2 and 3 where severe termite damage and decay has been noted in critical structural members is high. Due to the number members affected, it is possible that there is some risk of structural collapse. The risk however, can not be quantified based on the preliminary investigations made at this stage.

Demolition of the timber stores therefore appears to be the most appropriate action (based on safety and cost criteria) and should be investigated further.

At this stage, it is recommended that access to all Stores is shut-off in order to prevent anyone [general public or otherwise] entering the buildings. Access should also be prevented to the steel Store 4 structure as this may be structurally connected to the adjoining timber Stores. Cordoning off the perimeter of the buildings a safe distance from the Stores is recommended. These actions should be carried out as soon as possible.

3.2 Store 4 and Carriage Shop Extension - Steel Framed Structures

Corrosion has advanced to various stages in both structures. The Carriage Shop Extension showed the most concerning signs of corrosion, with one particular critical truss connection having corroded extensively (Refer Appendix B photos 78 – 81). It is recommended that as with the timber stores, access be shut-off in order to prevent any person entering the Carriage Shop Extension or the adjoining Boilermakers' Shop.

Temporary support to the affected truss is recommended to ensure the vertical and lateral stability of the truss is maintained. Cordoning off the perimeter of the building at a safe distance is also recommended. These actions should be carried out as soon as possible.

From visual observations made during the inspections of both buildings and from an understanding of the remedial works required for the surrounding structures at North Eveleigh, the structure to Store 4 and the Carriage Shop Extension can be described as relatively lightweight. It is understood that nearby buildings of similar vintage (e.g. the Carriageworks structures and Blacksmiths Workshop) required significant structural strengthening in order for their roof trusses to comply with the current Codes.

It is envisaged that the existing structural elements to both steel structures would likely need retro-fitted strengthening details. The truss members appear similar in proportion to those of the Blacksmiths Workshop typical truss. In order for the buildings' trusses to comply with current Standards, it is likely that the truss bottom chords (which consist of either light double angles or plate) would need to be strengthened.

Full inspections on the framing (e.g. roof trusses, columns, bracing, connections etc.), measurement of member sizes and metallurgical investigation would be required to proceed with detailed design calculations. A full structural analysis would need to be undertaken on the structural frames, in particular on the typical trusses to confirm their capacity to meet current Codes.

It would also be necessary to carry out a detailed mechanical surface preparation for the members and apply a protective paint coating to all truss elements. This can be a very labour intensive and therefore costly process.

The overall stability of the structures to meet current Code requirements in terms of earthquake, wind and robustness lateral loadings will need to be assessed. The Store 4 structure appears to be robust but may require some additional bracing to meet current requirements. The addition of new bracing elements such as steel diagonal bracing may need to be provided, especially in the Carriage Shop Extension north, east and western walls.

The existing slabs to both structures, while worn, appear suitable for commercial use. However, intrusive investigation would be necessary in order to confirm whether the as-built reinforcement quantity within the slab is adequate for the proposed design loads, particularly with regards to the suspended slab of Store 4.

The condition of the roof sheeting in both buildings is such that it would need to be replaced.

4.0 Report Limitations

This report has been prepared specifically for the Redfern-Waterloo Authority to provide preliminary comment on the structural condition, opportunities and constraints for the North Eveleigh site. All other aspects of the buildings such as contamination, services, termite inspections etc. are outside the scope of this report.

The observations, discussion and conclusions within this report are based solely on the visual inspections listed in Section 2 and reference photographs attached. The inspections were preliminary in nature and not an exhaustive dilapidation survey of the structures. Many aspects of the buildings were not accessible or visible at the time of inspection and the comments provided above are based on reasonable judgements of the condition of the buildings based on what was inspected. No calculations or further analysis of the buildings has been carried out beyond the visual inspections.

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