REPORT ON THE STRUCTURAL FAILURE OF THE PALACE HOTEL 75 Victoria Street West, Auckland

To: His Worship the Mayor

From: Ian McCormick, Manager Building Control

Date: **21 February 2011**

1.0 Introduction

This report summarises the findings of an investigation into the cause of the structural failure and collapse of the Palace Hotel, 75 Victoria Street West on 18 November 2010. It also provides an overview of the circumstances leading up to the controlled demolition, our subsequent investigation and conclusions, actions in progress and associated matters.

The following attachments are included:

- Tonkin and Taylor Report dated 26 November 2010
- Tonkin and Taylor Report dated 13 January 2011
- Marriott Consulting Engineers Report dated 2 February 2011
- Fraser Thomas Report dated 21 February 2011

2.0 Summary and Conclusions

Three separate and independent engineering consultancies were engaged by Council to investigate the cause of the Palace Hotel collapse.

Their collective findings indicate that the structural failure of the Palace Hotel arose as a result of the foundations of the boundary wall on Victoria Street West sliding in towards the excavation at the basement floor level of the building while it was under refurbishment [Refer Figure 19]. The inwards movement of the bluestone foundation blocks at that location, in turn led to the consequential failure of that boundary wall on Victoria Street West. The loss of vertical and lateral support in that area caused the extensive damage observed in other parts of the building prior to its collapse.

The movement of the basement wall foundations is attributed to a loss of lateral support caused by the removal of the timber ground floor, an over excavation of the foundations and the removal of a portion of the existing basement concrete floor designated to be retained in the approved plans [Figure 17]. It was this combination of factors, rather than any of them individually, that caused the building structure to collapse.

Our investigation indicates that the stability of the basement retaining wall does not appear to have been adequately addressed in the building design calculations submitted for the most recent building consent.

The extent to which the owner's site engineers and architect should have recognised that they were placing the building at risk by not replacing sufficient lateral support as the works progressed to compensate for structural elements they were removing are matters for review by the relevant professional bodies.

3.0 Actions and Recommendations

In this investigation, the Council's focus was to understand how the owners and their project team failed to sufficiently recognise and mitigate the removal of structural elements from the building during the course of construction.

Throughout this construction project, Council relied on producer statements from the independent engineers engaged by the owners to satisfy requirements that the development complied with both the building code and the approved plans. Such an approach is accepted practice for developments of this type, and is legislatively compliant. It is an approach that recognises that special competencies are required to understand loadings and bearing points in certain types of structures. It also recognises that qualified architects and engineers have robust professional codes of practice that they are required to adhere to. Significant oversights resulting in structural or other failures by appropriately skilled experts are rare.

In its approach, a Council assesses each project and determines, based on risk and complexity, the aspects of the construction it is appropriate to receive reports on and aspects it will inspect itself. The experts are pre- approved by the Council, in order for them to be able to provide designs and calculations, to conduct peer reviews of work by other professionals and to conduct on-site inspections on works as they progress, which will then be accepted by the Council. The nature of Council's reliance on chartered professionals is standard industry practice for such complex developments. These engineers sign off their work by producer statement.

Structural failure on this scale is almost unheard of in New Zealand. It is therefore important for Council to closely examine this incident for opportunities to improve both established professional practice and to decide what actions the Council should take to ensure that the potential for similar risks is appropriately and robustly managed.

Taking all of this into account, we recommend as follows:

- 'Tag' applications for heritage buildings when consent applications are received for lodgement and consider what additional requirements should be imposed. This could include requests at the building consent processing stage for:
 - o methodologies for dealing with the 'heritage fabric' of buildings
 - o in-situ testing of any un-reinforced aged masonry
 - details of the proposed contractors and their experience working with heritage buildings.
- Initiate a 'standing' requirement for a pre-construction site meeting for heritage projects with the applicant and their construction team. Such meetings would also involve a Council heritage specialist and any monitoring officer associated with a related resource consent. This would provide an opportunity to discuss the items referred to in the first bullet point.
- Review Council's current practice in relation to its examination of the actual methodology of construction for high risk/high complexity developments. For example, Council may include a requirement to provide a sequence of works plan and methodology detailing how building loads will be managed through transition and confirmation the engineer is managing this aspect.
- Require the protection of this type of building during alteration. Ensure any building/ resource consent incorporates requirements to develop/maintain a construction methodology and consider if the methodology should be peer reviewed. Ensure any monitoring of the consent picks this requirement up [Note: because the temporary works are generally provided by the project builder after the approval of the building consent this requirement would generally need to be couched in performance terms].
- Work with the New Zealand Historic Places Trust, Cultural and Built Heritage Group and professional bodies to review any existing codes of practice in respect of reconstruction works on older buildings and consider their efficacy in the light of this failure. This may assist with identifying other issues that need to be addressed in bullet point #1.

- Provide a greater level of communication between the Cultural and Built Heritage group and consent monitoring staff to ensure that situations are identified where additional input from a heritage specialist may be required.
- Ensure that external consultants receive details of any related consents affecting the proposed development along with the consent documents.
- Increase awareness of heritage issues through targeted training for building and planning staff.
- Promote a review of current site supervisory practice and consider the benefits of a full-time approved clerk of works inspection regime for selected projects.
- Advocate for legislative change, as part of the Building Act review. Council is concerned that legislation ensures that appropriate levels of overview are maintained in any future monitoring regime, enabling the risks associated with heritage construction/development types to be appropriately managed. In particular, enabling Building Consent Authorities to impose 'process related' conditions on building consents such as a requirement for a construction methodology.
- Provide a copy of this report to the Crown Solicitors office for advice on whether the landowner, any of its representatives and/or any other persons may be prosecuted under the Building Act or any other legislation.
- Provide a copy of this report to relevant professional bodies for the investigation of potential breaches of relevant professional codes of practice and/or industry regulation.

4.0 Narrative

4.1 Background

The Palace Hotel was located at 75 Victoria Street West at the intersection with Federal Street. It was built circa 1886 and was scheduled as a category B heritage item by the Auckland City Council. The building was also recognised by the New Zealand Historic Places Trust [NZHPT] as a category 2 historic place.

For most of its life, it was operated as a hotel, providing accommodation and refreshments under a liquor licence. In more recent times, it was operated solely as a licensed bar and gaming venue.

Figure 1: A representative view of the Palace Hotel in late October 2010.



Figure 1

The building was constructed of un-reinforced masonry. It was three stories high with a basement. It featured two, two-storey annexes on either side of the main structure. Figure 2 is an aerial view of the building taken in 2008. The picture reveals the main building in relation to the Federal Street annex on one side and the Victoria Street annex on the other. As may be seen, the Victoria Street annex boundary wall lies directly against the wall of number 71 Victoria Street.

Figure 2 also reveals the important infrastructural services that exist under the Federal Street and Victoria Street West footpaths.



Figure 2 Green = Water main Blue = Stormwater

In 2006, the then owner submitted the first of a series of resource and building consents. Subsequently, the building was purchased by the Chow Group. The Chow Group submitted additional applications to convert the building into an adult entertainment venue. These

applications included elements of demolition work. A summary of these consents may be found at *4.5.2 Council Regulatory Processes*.

The building work comprised extensive remodelling of the entire building and included limited excavation and redevelopment of the basement area. These changes had been approved by the Heritage team of Auckland City Council and the NZHPT. The construction works were being actively monitored by that Council's heritage team from a historic places and resource consent / district plan perspective and by the building control team in accordance with the agreed programme of inspections as required by the building consent.

The project was being managed for the owner by Clearwater Construction. Spencer Holmes (Wellington) were the design engineers. Kibblewhite Consultants appear to have been subcontracted by Spencer Holmes [albeit they dispute this] to provide construction monitoring related services for the development. Kibblewhite were also engaged by Clearwater Construction Limited separately to undertake temporary works design at Clearwater's request. Part of this construction monitoring work was sub-contracted out to Bruce Tricker of BMT Design by Kibblewhite Consultants.

At the time of its collapse, reconstruction works were well advanced and the building had already been substantially modified. The first and second floor structural diaphragms had recently been installed with these floors bolted to the external masonry walls. All the internal walls on the second floor had been removed. A concrete structural frame had also been constructed at the rear of the building parallel to the rear entrance off Federal Street. The ground floor had been removed and the basement was in the process of being excavated.

4.2 The Collapse

At approximately two o'clock on Thursday afternoon 18 November 2010 [timings vary depending on the witnesses] members of the owner's project team reported becoming aware of large cracks developing on an internal wall on the Federal Street annex. Immediate inspection of the outside facade of this annex, revealed additional cracking occurring in the masonry walls [Figure 3]. Staff noted that the cracks were continuing to open and became immediately concerned for the safety of workers on site. All staff on the site were alerted and the site was evacuated.



Figure 3

Over the next ten minutes, witnesses reported that the building subsided towards the southeastern side of the site accompanied by substantive deformation of the northern facade [Figure 4] together with cracking to the masonry walls [Figure 5] extending across to the Victoria Street annex.



Figure 4

Figure 5

The site supervisors apparently alerted their respective management teams along with emergency services. At about 3.35pm, the owner's architect Graham Crust, contacted Ian Grant, the Council heritage specialist monitoring the site, and alerted him to the building failure. On arrival, Mr Grant contacted the resource consent monitoring officer allocated to the site and as a result, Chris Horan, the team leader and two members of Council's incident response team immediately went to the site. They were closely followed by members of the building control team including Bill Vautier, a Council structural engineer, members of the building inspections team, and the building control manager [author]. When Council staff arrived at the site, the owner's representatives, John and Michael Chow, were already present accompanied by a large contingent of Clearwater Construction personnel. This contingent included one of their directors, Martin Fahey; Gordan Brkic of DHC Consulting one of their engineers; architect Graham Crust accompanied Bruce Tricker from BMT Design apparently representing both Clearwater Construction Limited and Spencer Holmes.

At approximately 6.30pm, Councillor Sandra Coney arrived on site along with the Council's principle heritage advisor, George Farrant and representatives of the Historic Places Trust, Sheny Raynolds, Robin Byron and Martin Jones. They were subsequently joined by Doug McKay, the Council's chief executive officer and Clive Manley, Council's civil defence and emergency manager. His Worship the Mayor arrived shortly thereafter. Mr McKay upon his arrival ensured the attendance of Tonkin and Taylor's structural engineer, Geoff Radley and the Council's legal advisor, Brigid McDonald.

4.3 Actions on site

The area was cordoned off to all pedestrian and vehicular traffic from approximately 4.30pm. The occupants of buildings from 51-71 Victoria Street were evacuated; likewise, the occupants of a residential unit at 66 Victoria Street. A monitoring regime was established on the Palace Hotel using digital survey equipment to track its continuous movement. The hotel was found to have rotated and was continuing to move at approximately 5mm per hour in a southerly direction towards Victoria Street and number 71 Victoria Street. This movement opened a gap with the Federal Street annexe [Figure 3].

Council staff inspected the site on arrival. We observed that some localised settlement had occurred at the front corner with the Victoria Street annexe causing heavy cracking to the boundary wall from ground to first floor level [Figure 6].



The annexe at this end showed signs of differential settlement as a result of the movement of the main building [Figure 7].





The surveyor advised that the building boundary wall on Victoria Street was approximately 90mm out of plumb (with the top of the wall leaning out over the footpath) [Figure 9]. The wall on Federal Street was out of plumb by about 50mm and both were still moving. During the time it was being measured, there was no sign of settling. There was also a noticeable 'bow' in the front wall on Victoria Street with horizontal cracking around nearby pilasters [structural columns] that became wider as the evening progressed [Figure 8 and 9].



Figure 9

Throughout the afternoon and early evening, Council staff consulted with John and Michael Chow, and their site engineering, architectural and project management personnel present on site. The Chow Group and its contractors and consultants were unanimously of the opinion that the site was too dangerous to enter, due to a likelihood of imminent collapse (and declined to do so). It was evident to all present that the building was progressively collapsing towards Victoria Street West and that "the situation was deteriorating rapidly."**p1 Tonkin and Taylor November 2010**.

In addition, the owner's consultants advised that testing previously performed on the condition of the brickwork revealed very low compressive strength levels [1-1.5 mpa]. This is significant as modern brick is required to exceed 20mpa. The information elevated concerns for the stability of the building still further.

The owner's on-site contractors attributed the situation to the failure of foundations associated with the boundary wall on the Victoria Street side of the development. They were unable to provide any constructive means of recovering the situation.

Council offered the owners the option of undertaking emergency works to make the building safe, should an appropriate methodology be agreed with their project management team. The owners initially agreed to a solution that would involve a controlled demolition of some scale, but this was on the proviso that the building could be entirely demolished and the site cleared. At this stage, the Council's advisors wished to explore whether only a partial demolition might arrest the progressive collapse. In another of several discussions with John and Michael Chow that occurred that evening, the brothers informed the Council's chief executive officer and legal adviser that as owners of the building they would agree to the demolition of the building if liquor, brothel and gaming licences and consents could be guaranteed.

When advised that the Council could not offer any guarantees that new licences would be issued for any new premises or business, the owners left the site to obtain further legal advice. As the situation deteriorated in their absence, they were located by telephone and advised that the building was continuing to collapse and would have to be demolished to avert it collapsing onto the adjoining Fiddlers Building and Victoria Street. Upon their return to the site, John Chow advised the Council's CEO that they would not be taking any remedial action on their building nor would they consent to any action being taken by the Council.

Geoff Radley, the independent structural engineer from Tonkin and Taylor [engaged by the Council to provide a professional assessment on the situation and advise on any remedial action that could be taken] had arrived on the site at approximately 8.00 pm. He undertook a detailed examination of those parts of the building that could be safely observed. He also interviewed the owner's structural engineers and architects associated with the project and reviewed evidence of ongoing movement from the on site surveyor. He subsequently formed the opinion that:

There was concern for the safety of the public and adjoining buildings at 71-73 Victoria Street West if it was allowed to remain in its current condition. There were no mitigation measures available that could stabilise the wall and avert the immediate danger. Our decision to advise Auckland Council to demolish the building was based on our professional judgement of the extreme risks the situation presented. 'p1 Tonkin and Taylor November 2010

By approximately 10.00pm, the building was continuing to collapse and rotate with glass windows beginning to break spontaneously. As it was clear that the building was likely to fall onto both the Fiddlers Building and Victoria Street West, Council's advisers agreed that powers under s129 of the Building Act 2004 had to be invoked. This involved the issue of a Warrant to Avert Immediate Danger, for the purpose of reducing the building to the point where it would no longer pose a danger to public or adjacent properties.

The warrant was prepared on site by Council's legal adviser and subsequently signed by Mr McKay as the chief executive officer. Ms McDonald presented the warrant to Mr John Chow and explained the effect of the warrant to him. He confirmed on behalf of the owner that he did not consent to the Council carrying out any remedial actions on the site or to the controlled demolition of the building.

At about 1.00am, demolition was commenced refer Figure 10, concluding at 3.00am. The Council retained control of the site until an inspection could be made the next day to confirm the site was safe. At that subsequent inspection, a number of hazards were identified and arrangements were made in conjunction with Clearwater Construction to have these structures reduced. Council also advised the owners that it would retain possession of the site until the immediate public safety

concerns and risks (including risks to the public services within the road reserve around the site) could be mitigated.

The next morning (19 November) Council staff visited the site and requested a copy of the site records, including the engineer's inspection observations for the project. Council was advised by Clearwater personnel that the documentation had been removed and was unavailable. Council's requests to interview members of Clearwater Constructions Limited staff and obtain copies of its site records have been formally declined by Clearwater Constructions Ltd's ' insurer.



Figure 10

4.4 Post-collapse Site Instability Issues

On 21 November 2010 (two days after the collapse of the hotel), a number of fresh cracks were discovered on the roadway at Federal Street adjacent to the site. Upon examination, a further crack was found on part of the Victoria Street footpath. A geo-technical engineer from Tonkin and Taylor, Cliff Edwards was engaged to examine the area and a monitoring regime initiated to identify signs of any further displacement. Mr Edwards was of the view that the cracks were caused by relaxation of the ground in those areas, potentially associated with a loss of integrity in the basement walls supporting the road reserve.

Council's technical experts were also of the view that the cracking, when placed in the context of the observations of the basement area prior to the collapse of the Hotel, represented a potential threat to the wall at 71 Victoria Street, the road reserve at Victoria and Federal Streets and the services embedded therein. As a result, a further section 129 Warrant to Avert Immediate Danger was issued by the Auckland Council to ensure that the situation was understood and that appropriate remedial action was taken to remove the immediate danger.

Council's advisers also recommended a controlled excavation of seven pre-determined points (later reduced to three) around the boundary wall to enable structural and geo technical engineering staff to assess the risk of failure and determine an appropriate stabilisation

methodology for the wall. It was proposed that debris would be removed from small sections of the site to reveal the basement floor and walls, whilst not compromising any structural support site debris might be lending to the walls. To enable the safe assessment in these partially excavated areas by the engineers, the manufacture of two steel inspection cages was commissioned.

The excavation commenced on 25 November 2010. On 2 December, the site owners John and Michael Chow arrived at the site and blockaded it. In the interests of site safety, work on the site was halted. Over the next few days, Council staff spoke to the Chow Group's legal adviser. The Chow brothers subsequently discontinued their obstruction of the site and the site clearance and investigation work was able to continue.

On 10 December, debris covering the Victoria Street footpath was removed uncovering evidence of slumping on the pavement [Refer Figure 11].



Figure 11

Watercare engineers were requested to attend at the site to examine this new evidence. They expressed concern over the risk this slumping posed for their 375 mm diameter water main. As a result, the pipe adjacent to the site was temporarily disconnected from the network. Shortly thereafter, when Council was satisfied that all the immediate risks to public safety had been averted, the site was handed back to the Chow Group.

On 15 December, the owner gave Council permission to continue an examination of the Victoria street boundary wall in conjunction with their engineers. The controlled excavations at the boundary walls at 71 Victoria Street and the Victoria Street frontage were subsequently conducted enabling an examination by structural and geo technical engineers working on behalf of the owner, insurer and Council. Council also engaged Barry Satchell a chartered surveyor to conduct a full survey of the site to determine the degree of basement wall deformation. Council is currently awaiting the submission of plans for temporary propping of the site prior to further excavation of demolition material and repair to the Council footpath.

4.5 Investigation

4.5.1 Overview

Immediately following the collapse, an operation was initiated with three principle objectives:

- to determine the cause of the structural failure of the hotel;
- to identify and resolve any site related issues;
- ascertain if there had been any deficiencies in Council's consenting processes that required review or amendment.

In order to ensure objectivity and independence, Council engaged three engineering consultancies to assist with the inquiry. The briefs given to each consultancy varied to reflect their respective areas of recognised expertise. All three consultancies were requested to conduct a forensic examination of the site and determine any risk poised by the excavation, together with any evidence that would enable them to form a view as to the cause of the failure. This included the examination of the documentation and plans received by the Council as part of the consenting process along with the interview of any Council or project staff necessary to form that view.

The three consultancies engaged were:

- Tonkin and Taylor
- Fraser Thomas
- Marriott Consulting Engineers.

Tonkin and Taylor were able to bring their insights from having examined the building as it was collapsing. Fraser Thomas regularly reviews and performs investigations for territorial authorities, IPENZ and the Department of Building and Housing. They were requested (in addition) to focus their attention on the actual construction methodology; determining what part, if any, this had on the failure. Finally Marriott Consulting, with their recognised expertise in working with heritage buildings were asked to focus on Council's consenting and monitoring processes.

As part of their investigation, they interviewed all Council staff who had been involved in the project. They then reviewed the plans, reports, engineering calculations and product specifications submitted with the consents. They sought information where required from external parties together with the review of meeting minutes and inspection records Council had created as part of their monitoring obligations.

4.5.2 Councils Regulatory Processes

4.5.2.1 Overview

Auckland City Council maintained a separate heritage team, which focused on the identification and preservation of material of historic significance. Following the processes in place at the time, that team was notified when the initial resource consent application was submitted by the Chow Group (in order for them to be able to provide input into the consenting process.)

Heritage re-developments are by their nature, often complex as they involve a significant amount of specific design. 'Specific design' describes architectural or engineering solutions that are tailormade for a particular set of circumstances. To understand their appropriateness, it is necessary to have a thorough understanding of the associated theories and structural calculations

In such situations, Council customarily relies upon recognised engineering specialists engaged by the applicant (as provided for under the Building Act). The specialists engaged by the applicant provide 'producer statements' that the Council relies on as evidence that the works will/ do comply with the building code. In some cases, Council will require these producer statements to be peer reviewed by other experts. These experts may be engaged by the Council or be other independent

specialist engaged by the applicant. In such a project, Council specialists meet with the applicant's project team at the start of the project and agree what aspects of the construction they will accept producer statements for, which aspects of the work they will in addition require peer reviews by other recognised specialist for, and which parts of the work they will assess/inspect themselves.

The consent decision-making process utilised depends upon the risk and complexity presented by the construction elements concerned. For this purpose, Council maintains a register of producer statement authors. This register details specialists that it will accept for different types of work. To be accepted as a "producer statement author" or peer reviewer (typically a higher level of experience is required for peer reviewers), every author and peer reviewer is required to submit evidence of their qualifications and expertise. This information is then assessed by the Council as part of the consent application process.

Similarly, prior to the commencement of construction, Council will generally meet with the applicant and agree a monitoring programme. As part of this programme, Council will often seek to utilise the expertise of engineers familiar with the design or who have a speciality in a particular area. The engineers monitor the construction of elements of the work and record their observations on producer statements, which the Council will accept as evidence of their assessment of compliance, relying on engineering professional code of practice.

This approach is accepted by the Department of Building and Housing and well established in the construction industry.

In such projects, the project builder normally retains the right to design the 'temporary works' required to support the works during construction. Any permanent works required as part of this process require an amendment to be submitted for approval. The term temporary works covers temporary propping and 'falsework' required to hold up the building whilst the permanent works such as block retaining walls are set in place and achieve their full strength.

Normally, qualified people with specialised expertise e.g. CPEng will normally undertake this work as a service to the builder. The design engineer for his part will normally signal (by way of notes in the plans and specifications) where particular precautions are to be taken, particularly if omitting to undertake these may put the permanent works at risk.

This temporary work is not part of the building consent approval as the design is undertaken after the consent has been approved and a builder has been selected. Thus, the temporary work itself may not come under the jurisdiction of the Building Act.

4.5.2.2 The Consenting Process

The refurbishment of the Palace Hotel required both resource and building consent approvals. The resource consents approved included a number of specific requirements on the owners to preserve the 'heritage fabric' of the building. By heritage fabric, we mean those identified elements of the building that provide that connection with the past. The building consent conditions were focused on ensuring that the building elements constructed complied with the approved plans and the New Zealand Building Code.

As is often the case in these type of refurbishments, the owners (in conjunction with their design team) made a number of changes to their designs over time and this resulted in the requirement for additional consents and amendments to previously approved consents.

The key milestones in what was quite a complicated consenting process is detailed in Figure 12. below.



The detailed chronology of the consent process for the works is as follows:

6 September 2006, the original application for a resource consent [R/LUC/2006/6227] to redevelop the site was lodged. This consent did not progress.

In 2009, the property owners applied for a building consent B/2009/6267 through their agent Graham Crust Architects Ltd. The consent was for the excavation and partial demolition of an existing tavern. This consent was rejected, and a further application B/2009/6341 was lodged in 2009 for the same project. This consent was issued in January 2010.

June 2009, a further building consent B/2010/3162 was applied for and subsequently issued in September the same year. There were extensive delays with the fire design for this project. A further amendment to this consent B/2010/3162/A was lodged on 12 November 2009, for new addition façade design. It was still being reviewed by the Council at the time of the collapse.

30 November 2009, the Auckland City Council Heritage team recommended three engineers with extensive experience in the refurbishment of heritage buildings to the property owner.

20 January 2010, the Chow Group applied for a variation to that existing 2006 resource consent [R/VCC/2006/6227/1].

27 May 2010, a new resource consent application was lodged for re-development and alterations.

6 July 2010, a draft construction management plan was submitted for the project by Clearwater construction in accordance with condition #14 of R/LUC/2006/6227 (and R/VCC/2006/6227/1).

17 August 2010, a meeting was held between Adam Wild of Archifact and Robin Byron of the New Zealand Historic Places Trust. At that meeting, 'The extent of the basement excavations were queried and underpinning of the existing facade walls was suggested as this was what other engineers were designing for similar buildings in the area. The owners engineers rejected that underpinning was required.'p2 Marriott Consulting Engineers 02/02/2011

30 July 2010, a site inspection revealed that some works had commenced (demolition of outdoor decking area, removal of fire escapes and balcony from northern annex) without satisfying the precommencement requirements of applicable consent [R/VCC/2006/6227/1]. These requirements

included the submission and approval of plans detailing how the "heritage fabric" would be preserved together with a construction management plan.

As a result, an abatement notice was issued requiring all works to cease until the relevant documentation had been provided.

16 September 2010, a new consent [R/LUC/2010/2001] was approved. The abatement notice was subsequently uplifted a week later.

This new consent included a heritage condition that superseded that in the resource consent issued previously. It required the applicant to inform Council how the retention of the heritage fabric of the building would be retained during the course of construction. There was also a requirement on the applicants to provide aspects of this information prior to the commencement of construction. However, there were delays in the provision of this information to the heritage team and a meeting was scheduled for 18 November to provide it.

Whilst the information requested under this heritage condition would not have dealt with how structural loads were going to be addressed in the building through the construction process (and thus its absence was not a causative factor), the collapse does demonstrate the need to impose heritage requirements more holistically through the building consent process.

17 September 2010, a pre-construction meeting [a condition of the consent] was held between the Council's commercial inspection team leader, the owners and their development team. John and Vicki Chow attended (as the owner's representatives) accompanied by two representatives from their project managers Clearwater Construction. At that meeting, it was agreed that the Chow Group's engineers would undertake and provide oversight and report their observations of the construction works at key stages of the development of the works and Council would be required to be invited to audit every fifth inspection. This was in accordance with our standard operating procedure when dealing with complex specific design. Essentially, the design engineer and peer reviewer created and confirmed the efficacy of the design, thus they would be the best people to inspect it and ensure it had been built to specification.

Foundation, concrete block and framing related inspections were also undertaken on this project by the Council prior to the structural failure.

On 8 October, the construction team made a booking for the inspection of an internal gutter in the basement. The attending inspector took a photograph of the basement, refer Figure 13. The wall in the background of the photograph is the basement wall facing Federal Street. There is a marked absence of propping on this wall.



Figure 13

17 November 2010, Council carried out another requested inspection in the basement area, in the area where the failure is believed to have occurred. The inspection was booked for the inspection and approval of a new foundation block-work [several courses of bricks which may seen in the foreground on Figure 14] before it could be filled with concrete. The inspector arrived on site and was subsequently directed to the basement where the subcontractor responsible for the foundations in question, was working.

In the vicinity of the new basement block-work (not visible in Figure 14) was an existing internal wall. The foundations of this wall were found to have been excavated over a two-metre length, in such a manner as to remove support and leave the foundations resting on a number of clay pillars [the rest of the clay underneath having been removed to the level of the new excavated floor level].

The officer was sufficiently concerned by what he saw to request the attendance of the site engineer and amended plans for the works in that area. The engineer was not available and a site instruction was issued citing non-compliance and the inspection 'failed'. The officer instructed that no work was to be undertaken in the area of concern until the site engineer was available to inspect the works and report against the plans.



Figure 14

A further inspection, pre-booked for 18 November was cancelled that day and Council records show the reason for the cancellation as the construction project team 'not being ready.'

4.5.3 Evidence of Cause - Scene Examination

The findings of the three engineers are consistent in attributing the failure to the loss of lateral support from the foundations on the boundary wall on Victoria Street West and the subsequent sliding of this wall in towards the excavation.

¹ The forensic examination has confirmed that the brick wall on the Victoria Street West boundary at some 6-8 meters distant from the corner to 71-73 Victoria Street West has failed by sliding in towards the excavation. The excavation carried out to deepen the existing basement in front of the wall does not appear to have been carried out strictly in accordance with the drawing records [processed by Auckland City Environs on 9 September 2010 pertaining to building consent 2010/3162.' The consented plans indicated that the existing basement concrete floor in front of the brick basement wall was to remain in place-refer altered Spencer Holmes Ltd basement foundation plan no. EO9-954-30A. However this existing basement concrete floor was not evident at the bottom of inspection hole 3.....' **p3 Tonkin and Taylor 13/1/2011**

'The wall was installed approximately 1.5m away from a fragile 130 year old 15m high unreinforced brick wall. The existing brick basement wall was retaining approximately 2m of soil up to footpath level. It is most unusual that calculations and a methodology were omitted from the calculations. It also appears that they did not provide a shear key to the foundation of the wall to prevent sliding in the temporary condition.'p3 Marriott Consulting Engineers 02/02/2011

'As far as I can ascertain from witness statements, it appears that some time on Thursday 18 November 2010 there was an inward movement of the brick masonry walls at street level on at least part of the building perimeter, in my view as a result of inwards pressure of the external ground mass upon those walls. This inwards movement at ground level appears to have induced other movements further up the wall...' **p2 Fraser Thomas 21/2/2011.**

As described by Mr Radley, plans approved under building consent B/2010/3162 for the basement area detail that a portion of the existing basement slab approximately 1 metre wide be retained. No evidence of this was found in the area excavated.

This finding is consistent with the evidence of the building inspector who attended on 17 November noting the absence of under pinning/and the 'benching' of foundations in this area.

Walls and floors all contribute to a greater or lesser extent to the structural integrity of a building. When any one of these elements are removed during the course of renovation/redevelopment, consideration needs to be given to its effect on the overall integrity of the structure. This often requires the insertion of additional supporting elements in the form of props and walls to mitigate or cancel any loss of vertical or lateral support.

From reviewing evidence from the scene, interviewing project team members, Council staff and examining photographs taken of the basement area prior to the demolition, our engineers were unable to find any evidence to suggest how the loss of the lateral support contributed by the removal of the ground floor was being mitigated.

'We have not sighted an agreed demolition methodology from the contractor or his engineer but there was no evidence seen on site to suggest that the basement wall had been propped after the existing timber ground floor of the hotel had been removed. Our preliminary assessment of the stability of the existing basement wall concluded that excavation to a lower level in front of it would cause sliding and possible shear failure instability.'p3 Tonkin and Taylor 13/1/2011

'No calculations or construction methodology appear to have been provided by Spencer Holmes (owners engineers) for the new blockwork retaining wall along Victoria Street and Federal Street or against 71 Victoria. The new wall was being installed to enable the basement to be deepened by 1.05m.'p3 Marriott Consulting Engineers 02/02/2011

The need for such support was recognised by Spencer Homes, the design engineers for the project, when they submitted plans for the basement area renovations. Indeed, they specified [by means of a note alongside a construction detail on their drawings] that the 'existing brick wall remain and to be temporarily propped when existing timber floor (at ground floor level) is removed until new concrete floor is poured'.

'If the ground floor had been propped it may have prevented the lower section of the wall from moving inwards, leading to the cracking in the façade' **p3 Marriott** Consulting Engineers 02/02/2011

The failure may be explained through the use of a series of diagrams [Refer Appendix 1.]

4.5.4 Evidence of Cause - Conclusion

The Council's expert advisers reports detailing their findings are attached to this report. In summary, their conclusions as to the cause of the collapse are:

1. That the removal of the ground floor, over excavation of the basement and removal of a portion of existing basement floor [designated to be retained in the approved plans] removed significant lateral support from the base of the brick wall on the Victoria Street West boundary.

2. That the foundations of the 15 metre high un-reinforced brick wall on the boundary were retaining approximately two meters of soil up to the footpath level and that the factors above removed the support it needed to oppose the weight of this wall plus the weight of this retained soil and footpath.

3. That the 150 year old bricks and mortar comprising this building were very fragile; likely to have been significantly more so than assumed by Spencer Holmes in their design. Heritage buildings are brittle and lack the robustness (or the ability to sustain loss of support and/or deformation) that is an inherent feature of modern buildings. This makes recovery from 'over stress' situations difficult if not impossible to achieve.

4. That the boundary wall foundations slid in towards the basement. This resulted in a loss of vertical and horizontal support on this wall.

5. That the loss of vertical and horizontal support on the Victoria Street West boundary wall caused the rotation of the wall and tilting of the superstructure towards Victoria Street. It also

caused the shearing of bricks and separation of the mortar holding them together over a significant proportion of the building.

6. That the damage which occurred to the existing heritage building was wide-spread, severe and irrecoverable.

7. That the signals for temporary works requirements were included in both the geotechnical report by [Soil and Rock Consultants], (section 7), and in the works specifications by [Spencer Holmes], (section 2 [Demolition], and Section 3 [Excavation and backfilling]) and by the requirements of the main building plans [by Spencer Holmes] albeit not detailed enough.

8. That the construction team, who were responsible for maintaining the structural integrity of the building failed to undertake the necessary temporary works to maintain the integrity of the building.



The failure may be described through the use of the following diagrams.

FIGURE 15



FIGURE 16

Figure 15 Opposing Forces depicts the Palace Hotel as a box-like structure where the walls and floors of the structure all contribute to a greater or lesser extent to the structural integrity of the building. When any one of these elements is removed durina the course of renovation/redevelopment consideration needs to be given to its effect on the integrity overall of the structure. This often requires the insertion of additional supporting elements in the form of props and walls to mitigate or cancel any loss of vertical or lateral support.

Figure 16 Pre-Construction provides a cross-section of the boundary wall with Victoria Street West. The basement wall may be seen to be supporting approximately two meters of road reserve. This force may be seen to be opposed by the ground floor wall and the basement floor which includes a concrete floor topping. The bluestone slabs that form the foundation base of the un-reinforced brick wall may be seen at the base of the bricks.



FIGURE 17



Figure 17 Proposed Construction describes the proposed changes to the basement as part of this development. As may be seen, the basement floor was to be excavated approximately а further 1.1 meters. A section of basement floor and concrete topping were to be left at the base of the foundations to provide lateral support. A new ground floor was to be added and a new block wall to be established inside the boundary wall to the top of that new ground floor. The outside of the block was then to be infilled to provide further support to the foundations.

Figure 18 **Pre-Failure** describes the situation along at least some portions of the boundary wall prior to the collapse. As may be seen the around floor has been removed. The foundations have been further exposed and the concrete floor that was proposed to have been retained has been removed. The removal of the basement slab and the ground floor leaves a substantive portion of un-reinforced brick wall subject to pressure from the road reserve. The initial courses of the new block wall have been added but have yet to be backfilled as required in Figure 17.



FIGURE 19



FIGURE 20

Figure 19 Failure depicts the situation when the brick wall collapsed, The wall has no factor of safety against sliding in to the excavation. The resulting deformation of the wall increasing the inherent instability of that wall. The blue stone block moved inwards along with the brickwork above it. This movement has in turn caused a loss of vertical and lateral support to the wall on Victoria Street West. This led to the deformation seen in the rest of the building.

Figure 20 Condition of Brickwork presents a view from the basement wall after the failure revealing the effect the failure has had on brick work in the area. When shear forces subjected to many bricks have broken apart and the mortar has given way. This is indicative of low compressive strength of the brick work and the condition of the mortar.

'The hotel is considered to be earthquakes prone. Spencer Holmes assumed relatively high brick and mortar strengths in their design and this was verified by peer review. Testing of the actual bricks in the Federal Street annex revealed significantly weaker values than assumed and recommended testing take place in the main hotel building. This appears not to have been undertaken. We therefore believe that it is highly likely the brick walls were than significantly weaker the designers assumed.' p4 Marriott Consulting Engineers 02/02/2011



Figure 21 Post Failure Boundary Wall shows the basement wall bowed inwards over a 7-metre length along the Victoria Street West boundary.

FIGURE 21