

APPENDIX 3: HERITAGE REPORT

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CHRISTCHURCH CATHEDRAL PROPOSED REINSTATEMENT

Heritage Report

Prepared for the Cathedral Working Group

November 2016

Released under the Official Information Act 1982

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1.00 EXECUTIVE SUMMARY

Since the Christchurch Cathedral was badly damaged in the 2010 and 2011 earthquakes a number of attempts have been made to identify a sustainable and appropriate process for determining its future. These have been influenced by a number of factors, among them a lack of consensus as to what this approach should be. In 2015, the Government commissioned Miriam Dean QC to facilitate discussions between engineers and the Church Property Trustees. Her report the "Dean Report"¹ concluded that a structural solution which included a range of measures including repair, restoration, reconstruction and seismic strengthening was possible. The Government then established a special group, the "Cathedral Working Group", to identify suitable strengthening measures and to obtain full costs for the proposals.

Holmes Consulting Group (HCG), working in consultation with Dunning Thornton and Ruamoko Solutions, have prepared proposals which are currently the subject of a costing exercise, and this report addresses the impact on the identified heritage values of the Cathedral of these proposals.

Previous studies and documents have determined that the heritage significance of the Cathedral is high or exceptional. The Conservation Plan rates all heritage fabric and features having equal and exceptional value. However, the building has been badly damaged in the 2010 and 2011 earthquakes and has lain un-used and partly open to the weather since then, due to safety reasons, and as structural engineering and design options for its future treatment are considered.

Because of the poor condition of the Cathedral after the earthquakes, it will be necessary to accept that some losses of heritage fabric will have to occur and that this will affect the heritage value of the building. The crucial issue will be to ensure that these losses of heritage fabric are balanced in an outcome for the building that ensures it will have greater resilience, while retaining to the greatest possible extent its intrinsic heritage value.

The methodology for strengthening proposed by the engineers is based on a philosophy that minimises the impact on the heritage values of the building and retains as much historic fabric as possible. The most effective measure to achieve this has been base isolation of the foundations. This results in a reduced seismic load on the building compared to without base isolation. This will mean that fewer interventions into the fabric of the building will be required above ground to strengthen it - and consequently that the impact on the heritage values will be correspondingly reduced.

¹ Dean, Miriam, QC, Report on Facilitated Discussions with Engineers for Church Property Trustees and Great Christchurch Buildings Trust on Engineering Options for Repair, Restoration or Replacement of Christchurch Cathedral, November 2015.

Two main elements are to be demolished - these are the west porch, including the remaining badly damaged western façade, and the remains of the tower. A consequence of base isolation, however, is that the entire floor will have to be removed and replaced. Other measures include insertion of reinforced concrete cores within the composite stone masonry, replacement of lost elements and high level heavy masonry with steel frames with stone veneer claddings, grouting and coring of some of the masonry walls and some new exposed steel roof bracing. Where damage is minimal, repairs will be carried out in situ.

The measures described above are set out in decreasing order of their impact on the heritage fabric, from "demolition" down to "repair in situ". It is significant that the extent to which each technique will be applied will be in inverse proportion to their impact on the heritage fabric. In other words, the least intrusive methodology "repair in situ" will be most extensively applied, while the most intrusive - "demolition" - will be used the least.

The philosophy proposed by HCG is premised on the assumption that the building should be retained and that interventions should be kept to a minimum. There will have to be some losses of heritage fabric, but these are outweighed by other measures that ensure the long-term survival of the Cathedral.

Origin Consultants consider that this approach represents sound heritage practice in that it the majority of the building survives and the overall heritage significance of the Cathedral is maintained.

2.00 INTRODUCTION

Background

Christchurch Cathedral was badly damaged in the series of earthquakes which commenced in 2010, with the most severe damage occurring between February 2011 and June 2012. The building has been closed since then and a number of proposals have been investigated regarding the future of the building. However, there have been diverging views between the Church Property Trustees, (the building owner), and various other interested parties.

The Dean Report², was commissioned by the Government to facilitate discussion between these parties and this was published in 2015. It concluded that an engineering solution that included "....repair, restoration, reconstruction and seismic strengthening" was feasible, and in September 2016 the Office of the Prime Minister and Cabinet appointed the Cathedral Working Group to ascertain how this might be undertaken in practice and what the associated costs of the necessary work would be.

² Ibid

Holmes Consulting Group Ltd (HCG) has prepared stabilisation and reinstatement proposals in consultation with Dunning Thornton Consulting Ltd and Ruamoko Solutions for the Cathedral Working Group to consider.

Brief of the Cathedral Working Group

Origin Consultants has been approached by Resource Co-ordination Partnership Ltd (RCP) to prepare a Heritage Report setting out the impact of the proposal on the identified heritage values of the building of the stabilisation and future use plans which are currently being prepared by engineers and architects.

Information received and relied upon

RCP has provided the following documents describing stabilisation and strengthening of the Cathedral as prepared by the Holmes Consulting Group (HCG) as follows

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Proposed format

In order to assist the Working Group in their analysis of the HCG proposals and their impact on the overall heritage values of the Cathedral, this report sets out the heritage significance of the Cathedral as identified by a number of previous reports and discusses how the heritage fabric of the building contributes to this significance. The following section describes the approach taken in this report to the assessment of suitable repair and reinstatement measures for the Cathedral since this differs from that applied to non-disaster affected heritage buildings. The following two sections then describe the stabilisation and reinstatement measures proposed by HCG and include a commentary on the effect on the heritage significance of the building. The Discussion section reviews each of the main areas of work proposed by HCG and comments on the effect on the relevant heritage values. It also discusses the concept that this project must weigh up any lost heritage values of the work against the overall gain derived from retention of the Cathedral.

At the back of the report are a number of Appendices including detailed assessments of the HCG measures as they affect individual building elements and heritage fabric; and diagrams illustrating the assumed extent to which each different strengthening method is applied around the building.

3.00 HERITAGE SIGNIFICANCE

Historical background to the Cathedral

As stated above, the history of the Cathedral has been well documented by others and it is not the intention of this Assessment to repeat it in detail here. The Conservation Plan

prepared by Salmond Reed Architects in March 2006³ drew on those existing resources and has been the prime source for the historical background summarised below.

This historical background is important as it forms the basis for identification of each of the categories of heritage significance that are described below.

The Canterbury Association was formed in 1848 as a vehicle for the settling of the new colony and the foundation of the city of Christchurch. Its members comprised a number of selected Anglican families and the aim of the Association was to establish a new community of upright and like-minded people with shared social and religious beliefs.

Emigrants began to arrive from 1850 onwards and the location of the future city was selected. From the earliest surveys, plans included for a cathedral at the heart of the city, but it wasn't until 1864 that work commenced. The architect selected was George Gilbert Scott whose reputation for imposing Neo-Gothic style churches and cathedrals in England was well established. His first plans recommended a timber structure due to his (possibly prescient) concern for earthquake resistance, but this was overruled and he was instructed to design the building in stone.

Scott did not visit New Zealand and the supervision of the building was undertaken first by Robert Speechly and then by Benjamin Mountford. Mountford became one of Canterbury's most prestigious architects responsible for many of its most important buildings and was passionate about the Cathedral project throughout his career.

Foundations were laid in 1864, but since no further funds were available, no progress was made until 1873 when work began again on the walls, columns and roof. The first phase of the building included the nave, tower and spire, transepts and porches, but the apse was not complete until 1904 and the vestries in the mid-20th century.

From the start, the character and determination of the founding individuals and families directly influenced the way the new city developed and the Cathedral in particular. Their influence was demonstrated in their financial sponsorship and naming of many of the important features of the Cathedral building, including stained glass windows, columns and porches.

The building has remained as a highly significant feature in the city from its inception through to the present day. Not only does it have spiritual significance for the Christian faith, but it has been used for many Civic ceremonies and has become the symbol or icon of Christchurch and of the effect of the earthquakes.

Summary of cultural heritage significance

In 2011, Jackie Gillies + Associates prepared a Statement of Significance for the Cathedral for the Church Property Trustees and this has been used to as the basis for the summary of

³ A Conservation Plan for Christchurch Cathedral, Salmond Reed Architects, March 2006.

significance below. It was collated from three different sources of existing research and investigation namely:

- CCC Statement of Significance in the District Plan⁴
- Heritage New Zealand's description in its List⁵, and
- Statement of Significance of the Salmond Reed Conservation Plan, 2006⁶.

All three documents recognised the very high heritage significance of the Cathedral, not only in its local, Canterbury, context but also in a national if not international context.

The methodology for identifying heritage significance is common to all these documents and is based on the following key documents:

- ICOMOS NZ Charter⁷
- The Burra Charter of Australia⁸ and
- "The Conservation Plan" by James Semple Kerr".⁹

Heritage significance is usually described under a number of different headings and these include Historical, Social, Cultural, Architectural, Technological, Contextual and Archaeological. Significant Heritage fabric and spaces are also normally identified.

A summary of the heritage significance of the Cathedral as identified in the three documents above can be set out as follows and all three documents rate the overall heritage value as high or exceptional:

Historical + Social

- The Cathedral is associated with the founding of the city, not only as the focus of the new southern community of Anglican Christians, but it was promoted and sponsored by a number of its leading historical figures. Memorials and tablets remain as a physical manifestation and chronicle of their contributions. Christchurch Cathedral was the first cathedral to be built in New Zealand. The Cathedral remains as the symbol of the city for many of its residents as well as throughout New Zealand. Until the earthquakes it was one of the city's major tourist attractions and its image is used in promotion, logos and other publications.

⁴ Christchurch City Council, Operative and Proposed District Plans, Christchurch Cathedral, Statement of Significance.

⁵ HNZPT, List, Ref no 46.

⁶ ibid

⁷ http://www.icomos.org.nz/docs/NZ_Charter.pdf

⁸ <http://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf>

⁹ The Conservation Plan, J.S Kerr. Australia ICOMOS, 2013.

Cultural + Spiritual

- The Cathedral is the centre of Anglican Diocese in Canterbury and until the earthquakes was still used for regular worship, and for weddings, funerals, and other major cultural and spiritual events. It remains as the symbol of the spiritual ideals of the founders. It was designed to be the centrepiece of the new city and Christchurch remains as the only fully implemented planned city in New Zealand. It is a crucial part of the cultural precinct planned for the city's founders comprising the Canterbury Museum, the Arts Centre, the Provincial Chambers and the Cathedral.

Architectural + Aesthetic

- The Cathedral was designed by Sir Giles Gilbert Scott, a noted English ecclesiastical architect of the late 19th century and is the only building designed by him in New Zealand. It retains its authentic layout and appearance as designed with few modifications. It is also associated with William Mountford, who was responsible for much of the implementation of the design on site, and who became one of Christchurch's earliest and most prolific architects.

Technological + Craftsmanship

- The Cathedral is noted for the high quality of its materials and craftsmanship. This includes the decorative stone carving and masonry, the leadwork and ironwork of the roof details and rainwater goods and the traditional carpentry techniques of the heavy timber roof. The stained glass windows are also of high quality and the extensive use of decorative encaustic tile decoration on the walls and floors is uncommon and of superior quality.

Contextual

- The Cathedral has been since its inception, and remains today even in the post-earthquake hiatus, the focus of the city. Sadly many of the buildings surrounding it in Cathedral Square have been lost, but its relationship to the square and whatever new buildings replace the originals, remains important.

Archaeological

- As a site with pre-1900 human occupation, the site is likely to provide new evidence of the early use of the site and its archaeological values are therefore important. However, the opening up of parts of the building for the strengthening works will also provide much additional information regarding the Buildings Archaeology of the Cathedral.

Since the earthquakes, the heritage significance of the Cathedral has been augmented by a number of factors and these include:

Historical + Social Post Earthquake

- The rarity value of the Cathedral as an early colonial building has increased due to the widespread loss of other heritage buildings since the earthquakes and it remains as a symbol of the city despite the loss of the tower and the destruction of the west wall. The earthquakes are perhaps the most important episode in the history of the city and it is important that their effect can be read in the physical form of the Cathedral in the future.

Heritage fabric

There is a strong link between heritage significance and the heritage fabric. Heritage fabric is the embodiment and physical manifestation of the significance attributed to the Cathedral.

Assessment of acceptable degrees of modification to such heritage fabric form the crux of many heritage projects, and mechanisms have evolved which can assist the heritage professional in finding the approach which respects and retains the greatest degree of the building's heritage significance. These include a Schedule of Heritage Fabric, where each element is rated according to its contribution to the overall heritage significance is a useful tool found in many conservation plans and it allows a "hierarchy" of fabric to be identified. This can then help in the consideration of a schedule of priorities with respect to any future work.

The Salmond Reed Conservation Plan provides such a mechanism in the form of a Tabulation of Cultural Significance¹⁰. This includes the site or setting of the building, its main elevations, prime elements (such as roofs and walls) and spaces, through to individual elements of fabric such as cast iron gutters, the pulpit or the memorial plaques. It provides a breakdown of these different elements within the building and rates them according to their particular significance.

Nearly all of these elements are identified as having exceptional significance, and "all elements within the interior are regarded as intrinsic to the heritage and tradition of the cathedral."¹¹ Only the Pascoe additions at the east and the organ blower room below the chancel are rated as having a lower level of significance. As a result, in this report ALL heritage fabric and features (with the three exceptions noted above) are treated as having high or exceptional significance. Consequently, a different approach to how the building will be stabilised and strengthened is required.

Holmes Consulting has proposed alternative guiding principles for future stabilisation and strengthening and these are discussed below.

¹⁰ CP page 33

¹¹ CP page 38

4.0 THIS APPROACH

The documents describing the heritage significance of the Cathedral noted above were written before the Canterbury seismic events and did not contemplate the extent or type of damage that the building owners now face. A bald statement that all fabric and features have high or exceptional significance does not help when presented with the catastrophic extent of damage resulting from the earthquakes.

A more pragmatic approach is necessary which accepts the unavoidable loss of some heritage fabric if it is balanced against a nett gain in the retention of the heritage significance of the Cathedral as a whole. Without such an approach, the status of the cathedral would remain in limbo and its condition will continue to deteriorate. This report therefore attempts to clearly identify the losses that are involved in the HCG proposals, and also describes how these are offset by the positive effects on the overall balance of heritage value of the building through retention and strengthening of the building as a whole.

5.00 HCG PROPOSALS

Holmes Consulting Report

HCG, in consultation with Dunning Thornton and Ruamoko Solutions have been commissioned to provide engineering advice to the CWG to assist them in their response to the Office of the Prime Minister and Cabinet regarding the feasibility of the reinstatement of Christchurch Cathedral.

HCG Approach

The report is comprehensive and clearly based on a presumption of maximum protection and retention of heritage fabric. While this is a very positive approach, it also accepts (as noted above) that some compromises will be necessary to achieve this goal, and it sets out HCG's philosophy regarding these potential compromises.

HCG's report includes objectives and guiding principles for the work proposed. These are discussed in detail below, but in summary, they propose a hierarchy whereby the exterior takes precedence over the interior and this in turn takes precedence over added ornamentation such as finials, etc. They also allow that where an element has been completely lost or destroyed, such as the west wall or tower, it may be reconstructed in modern materials. The condition of the element or feature being reinstated or strengthened – no matter what its heritage value – must also affect the degree to which it is modified for engineering purposes.

Protection of the exterior appearance and finishes at the expense (potentially) of the interior may be seen to allow the retention of the original architectural form and aesthetic significance of the building as a whole. The exterior form and appearance of the building is an essential component of the contextual, cultural and symbolic values described above and contributes to a balance of the overall heritage values of the building. It also allows the retention of the authentic patina of weathered and aged materials and surfaces which is more evident in the exterior of the building.

However, close examination of HCG's proposals shows that the interior has not been "sacrificed" at the expense of the exterior. Losses will include much of the internal limestone ashlar linings in the Nave and side Aisles, but much of the remainder will not be affected by the strengthening works. Their approach to retain the maximum amount of heritage fabric has meant that the interior will also retain a great deal of its earlier significance. This will include the architectural volume and layout of the building, the powerful effect of the roof, and many of its original features.

Reconstruction of entirely destroyed features such as the tower or west wall in modern materials clad in traditional materials to the original design also allows retention of the architectural, cultural and symbolic values noted above, while allowing a pragmatic and appropriate engineering solution to its reconstruction.

HCG's approach protects the majority of the building's heritage significance components and is supported by Origin Consultants.

Base Isolation

In order to achieve their goal of maximising the retention of heritage values and heritage fabric, HCG has proposed the use of base isolation for the new foundations of the building. This technology greatly reduces the loads imparted by horizontal seismic action, which are the cause of considerable damage to an unreinforced masonry building in an earthquake. In consequence, the level of intervention required to strengthen individual heritage elements within the Cathedral can be greatly reduced.

This approach contributes considerably to reducing the impact of strengthening on the heritage fabric and the resilience of the identified heritage values in the future. Retention of the Roof in situ

Although this is not emphasised in the report, it is notable that the stabilisation and strengthening proposals set out by HCG do not include much - if any - remediation work to the roofs or roof structures. Most of the roof was strengthened in 1999 and this appears to have been generally very successful. The proposals assume the retention of the roof, possibly with minor repairs for weathering purposes and connections of new wall strengthening elements. This is a departure from previously published stabilisation schemes which required that the roof be deconstructed despite its good condition to allow the stabilisation of the lower walls.

The roof, including its original heavy timber frame, comprises a very large part of the total heritage fabric of the building. Its retention in situ contributes considerably to the balance of negative and positive effects on the overall heritage values of the building and off-sets some of the other proposals which, on their own, might be seen as unacceptably detrimental to heritage values. The heritage values protected by retaining the roof include architectural and cultural significance as described above, but in addition the technological value of the heavy timber carpentry is retained virtually unmodified. (It is accepted that the slates are not original fabric, but their retention contributes positively to the architectural values of the building).

Retention of the roof and repair in situ is a major positive factor in balancing adverse and positive effects on the overall heritage value of the Cathedral.

HCG Assumptions

HCG sets out a number of assumptions (section 2.2) regarding the degree of intervention likely to be required for many of the building elements. This table provides a broad brush description of the work proposed to each element.

The assumptions set out in Section 2.2 are based on the least possible impact on each element of heritage fabric and features and are seen as pragmatic and suitable.

Christchurch Arts Centre

HCG have had the benefit of very close involvement in the reinstatement of the Christchurch Arts Centre. They have been able to draw from this experience in their proposals for the cathedral both in repair and strengthening methodologies and construction arrangements. The success of the Arts Centre project from the viewpoint of heritage conservation / preservation is widely acknowledged, both within New Zealand and overseas. The application of this corporate knowledge, into the Cathedral project will therefore have similar benefits.

The methodologies applied at the Arts Centre demonstrate a successful balance between heritage values and retention of heritage fabric and the overall heritage values of the entire complex.

Holmes Consulting Group Stabilisation

HCG propose to carry out a programme of stabilisation prior to commencing permanent strengthening works. This is clearly necessary due to the dangerous condition of the building and the risk to workers without such preparation. The proposals are set out in three stages and include progressive stabilisation of the exterior from west to east, stabilisation of the interior and finally stabilisation of the transepts and apse. Full details of the proposed stabilisation works, are included in the HCG Report and will not be repeated here.

A detailed assessment of the impact of the proposed stabilisation methodology on the heritage fabric is included in the Appendices. This is set out in tabular form with a description of each element of proposed stabilisation, the heritage fabric affected, how it is affected and any mitigation for adverse effects on that heritage fabric.

The stabilisation proposals involve extensive propping and bracing of structure and features with minimal deconstruction and therefore minimal impact on heritage values.

The methodology proposed for stabilisation is very positive, especially when compared to previous methodologies which required the deconstruction of the Cathedral to sill height in order to make the building safe.

Holmes Consulting Group Reinstatement & Strengthening

HCG have opted to propose the use of Base Isolation of foundations as the primary method of seismic upgrade. As noted above, this has very considerable positive effects on the impact of the

strengthening works on the heritage fabric, since it means that the level of intervention on the rest of the building can be significantly reduced.

In broad terms there would appear to be five different types of reinstatement and strengthening techniques proposed by HCG. These are shown below from **least to most** impact on heritage fabric;

1. Repair insitu.
2. Core drilling and grouting,
3. Removal of inner wythe and rubble core of masonry wall and replacement with reinforced concrete,
4. Steel frames with stone veneer linings,
5. Demolition.

These techniques are used to a different extent throughout the building depending on the condition of the fabric and the seismic requirements of each element. A broad analysis of the extent that each of these techniques is proposed to be used around the building has been carried out and is shown on the diagrams in Appendix 2. However, it is clear that in general terms, the extent of use of the proposed techniques is in direct proportion to their impact on the heritage fabric. In other words, the least intrusive methodology is applied the most extensively and the most intrusive is used the least.

A detailed assessment of the impact of the proposed strengthening works on the affected heritage fabric is shown in Appendix 1. This is set out in tabular form with a description of each element of proposed strengthening, the heritage fabric affected, how it is affected and any mitigation for adverse effects on that heritage fabric.

Without going into detail regarding individual proposals for different elements of the building, this analysis demonstrates that the result will be an appropriate balance between adverse but necessary intervention and the positive effect on the resulting overall heritage significance of the building.

Non-structural repairs and effect on heritage fabric

This report only addresses the impact on heritage values and heritage fabric of the stabilisation and strengthening proposed by HCG. It does not assess any additional work that will be required to make the building weathertight or any other architectural or other upgrades.

However, some commentary should be included relating to the impact of HCG's proposals on non-structural heritage fabric where it is fixed to the structure. Effects on this fabric as a result of the earthquakes themselves and the impacts of weather and vermin on the fabric may further influence their proposed treatment and will be assessed only where they affect the stabilisation or strengthening proposals.

Non-structural fabric that will be affected by the proposals include the applied decoration fixed to the interior surfaces, and features which stand alone within the interior. Applied

decoration includes the encaustic tiled panels fixed to the lower north and south aisle walls, the carved stone or engraved brass memorial panels fixed to these walls, the carved timber panelling fixed to the south transept and the chancel and the timber choir stalls in the chancel. It also includes the stone altar table and the carved and separate features such as the pulpit and Bishop Harper's tomb.

Features fixed to walls which are to be strengthened will obviously have to be removed along with the interior lining and part of the rubble core prior to the work commencing. While it is accepted that the assumption made by HCG that much of the limestone ashlar linings to the interior of the Cathedral will not be able to be salvaged, these features are extremely important and cannot be replicated. A methodology for the removal of these features will need to be found once the danger of high level features falling on workers below has been resolved. Owing to their original method of fixing and their current condition, the encaustic tiled panels may not be recoverable. It is also accepted that the effect of pigeon faeces on the panelling in the south transept may render its recovery impractical. Further testing will be required to determine the extent of potential damage.

Warren & Mahoney proposals

Architects Warren & Mahoney have been in discussion with the Working Group regarding possible re-ordering of the Cathedral as well as treatment of the reconstructed tower. They have also been considering a replacement design for the west porch if it has to be removed. These have not yet been resolved and the impact on the heritage significance of the Cathedral will be addressed at a later date.

6.00 DISCUSSION

It is clear that Christchurch Cathedral has exceptional or high heritage significance, both locally and nationally and this has been well documented in the Salmond Reed Conservation Plan, as well as by other reputable heritage professionals. It is also undeniable that the building sustained severe damage in the 2011 and 2012 earthquakes and is now in a perilous state. The issue now is to find a process whereby the building can be reinstated to a safe and sustainable condition without unacceptably adverse effects on the heritage values.

In the normal way of things, the ICOMOS NZ Charter and a Conservation Plan would provide the guidance necessary for such work. However, the ICOMOS NZ Charter, which is the industry standard for work involving heritage buildings, focusses on conservation and repair, usually arising from wear and tear or minor damage and it does not provide guidance for the treatment of disaster damaged buildings. A Conservation Plan does not contemplate disaster remediation either but does usually include a rating system for the heritage fabric and features from which technical solutions can be proposed that target areas of lower heritage sensitivity. However, in the case of the Cathedral, all fabric and features have been identified as being of exceptional value and therefore other matters need to be applied to differentiate various areas and elements and provide guiding principles.

In the absence of these usual methodologies for devising sensitive solutions, HCG have proposed their own "Guiding Principles" to allow them to propose a unified and holistic approach to the works. These are based on a presumption of maximum retention of heritage values and heritage fabric. In summary, these include the external appearance having priority over the interior but that all work should involve the least possible loss of heritage fabric.

As noted above, the damage sustained by the Cathedral in the earthquakes is greater than that usually associated with repair and conservation. Similarly, it is clear that this damage cannot be repaired without far greater intervention than might be expected for repair and conservation.

A number of specific issues have been identified in HCG's proposals and these are discussed below:

Retention of the Roof and Repair In Situ

The roof of the Cathedral makes up the largest single feature of the building. This is not only in plan area, but as a three-dimensional feature it is even greater. It also contributes extensively to the heritage significance of the building since its architectural form is dominated by the roof, the spiritual significance of a high soaring roof symbolising a connection with God and the heavens, and the technological significance of one of New Zealand's largest timber roof structures based on medieval carpentry is also huge.

It seems apparent from external inspection and viewing from ground level in the interior immediately post-earthquake, that the roof is in good condition compared to much of the rest of the building and this should also affect its future treatment. It is understood that the slates are not original, and the flashings and cast iron rainwatergoods associated with the roof may be more severely affected by the earthquakes, but these are a minor element of the roof construction in toto.

HCG do not specifically mention the roof, other than in the addition of a few small roof bracing members, in their strengthening measures and the assumption has therefore been made that it will be retained and repaired in situ.

Retention of the roof and repair insitu has a considerable positive impact on retention of the overall heritage significance of the Cathedral.

Removal of the Floor

The floor of the Cathedral comprises nearly the same area as the roof, but as a two-dimensional feature its size is less. It also contributes less to the overall heritage significance of the Cathedral since it is only visible internally and is then only one feature among many in the interior of the Cathedral. That is not to demean its value on its own, as the tiles and the design of the floor are exceptional.

However, unlike the roof, the floor has sustained considerable damage in the earthquakes, mainly from falling masonry and the efforts of initial search and rescue teams. Many of the tiles have been cracked or broken and many have deep scratches on their surface. The effect of ingress of weather and pigeon faeces over the time the building has been closed will have exacerbated this damage further.

The loss of the floor in total will be a consequence of the decision to use base isolation as the primary means of seismic upgrade. New foundations will have to be constructed right around the building and across it in a grid and the removal of the original floor is therefore unavoidable.

However, methodologies may be found that allow small panels of the tiled floor including its concrete base to be removed intact and later re-laid in the new floor.

Despite the loss of one large component of the building's heritage fabric, it is considered that it is an acceptable measure since its contribution to the overall heritage significance of the building is not high and the use of base isolation will reduce the impact on the rest of the building to a considerable degree.

Replacement of rubble core with reinforced concrete

HCG propose the use of this strengthening technique to all the walls which have suffered large amounts of movement and displacement. This is most apparent in the side walls of the aisles and buttresses, the transept gable walls and in the chancel.

This technique has been applied extensively and successfully in the Christchurch Arts Centre and its effect on heritage values is low.

The technique allows the architectural form of the exterior walls to be retained, often in situ, and this is closely linked to the architectural, aesthetic, cultural and contextual values of the Cathedral. However, the technique also requires the loss of the internal inner stone linings and some of the rubble core and this affects the authentic technological values of the original masonry construction and the interior architectural and aesthetic values.

It may be possible to avoid widespread loss of some of the carved decorative stone elements of the internal linings, such as string courses and window facings, with suitable methodologies once the building is stabilised.

The interior limestone linings are not actually continuous within the interior, with some areas of the interior walls remaining as exposed rubble core or covered in panels of tiles or memorial tablets. The explanation for this is understood to be that the Cathedral was not "finished" and that its completion is an ongoing process. Replacement of the limestone linings is therefore seen as a measure with low impact on the overall heritage values of the Cathedral.

The West Facade

The west wall of the Cathedral suffered very badly in the series of earthquakes and much of it has now collapsed. The "rose window" at its centre has particular importance to many in the community and has also been destroyed. Only the lower portion of the wall survives, where it has been protected by the western porch adjacent to it.

HCG propose to remove the remaining portions of the wall and reconstruct it as a new seismically designed steel frame which would be clad internally and externally in stone to resemble its original appearance.

The western façade is perhaps the most important of the Cathedral's elevations. It is the primary architectural elevation and it is the most photographed elevation of the building. Its image is still used in the promotion of the city, even since the earthquakes. It faces the square and is where the majority of visitors or worshippers enter the building. Its contribution to the architectural, aesthetic, spiritual and cultural values of the Cathedral are considerable.

Since it has been almost completely lost, its renewal in modern materials is appropriate. The additional structural properties of the frame will contribute to the overall seismic strength of the Cathedral and this in turn contributes to protection of the building's heritage values. Since it will be clad in new or recycled materials, its technological value will be lost and its architectural values reduced (due to the loss of its weathered appearance and patina of age).

The carved limestone surround of the rose window will be replaced in moulded precast concrete for structural reasons. Details are not available regarding whether this will be a replica of the lost window or if it will be a contemporary version of the original. This latter option would accord with good heritage practice and is the preferred option of Origin Consultants since replication without full and detailed records of the lost item can only result in an approximation of the original. Further, it would provide an opportunity to create a memorial for the lives lost in the earthquakes. This would follow the example of the other commemoration of other momentous and tragic events in the history of the city such as the two World Wars.

If the rose window is recreated to its original design in concrete, impacts on the heritage values will depend on the level of care and attention to detail of the pre cast concrete. In this scenario, whether it is carried out as a near replica of the previous stone surround, or a new contemporary version of this is not the issue. If the quality of the casting and its design reflects that of the original it will allow the façade to retain its architectural significance.

If the window is redesigned in a contemporary style it will again be the quality of that design that results in either positive or adverse effects on the heritage values of the western façade.

The Tower

The spire and part of the square tower base were lost in the earthquakes and the north wall was demolished to provide access for search and rescue personnel to the base of the tower. These actions affected its structural integrity and in 2014 the remains of the tower were deconstructed to sill height for safety reasons.

HCG have proposed that the tower be detached from the main Cathedral building to allow the 500mm rattle space around the Cathedral to continue. They do not propose base isolation for the tower.

Treatment of the tower and spire are not dealt with in any detail in the HCG report since they consider that it will be built in modern materials using modern techniques.

However, there are a number of options for its future form, and these may have different heritage impacts.

The option hinted at by HCG in the report is that the tower will be constructed in its new location in reinforced concrete with a steel spire, and that it will be clad in stone to match the original as closely as possible. Since the tower will become a separate building from the Cathedral and no longer simply a part of it, it will be difficult to reconstruct the exterior in a convincing way, replicating the original details. Further the function of the ground floor space may be such that openings are required on many of the ground floor elevations and this would create a considerable departure from the original design.

An alternative option is to accept that the original is lost and design a new tower and spire that complements the Cathedral, sits comfortably beside it (no longer joined to it), and provides an apt memorial to the earthquakes and the effect on the city and its communities.

The impact on heritage values of each of these options vary a little, but since neither of them can be attached to the Cathedral and truly replicate the original tower they will both have an impact on a number of these values. Approximate replications are not favoured in heritage practice and a new structure which honestly expresses its source is preferred. The architectural significance will be affected since in either case the design of the tower and its relationship to the Cathedral itself will have to change. It will be the quality of the design that will create either a negative or a positive impact on this value rather than the replicated or contemporary design. The technological significance will be lost completely since the tower was destroyed, although detailed records have been kept for archaeological purposes.

Upper Clerestorey Walls

There has been some discussion between the engineers regarding the treatment of the walls of the upper clerestorey above the nave. HCG propose that they should be treated as per the lower stone masonry walls with a new reinforced concrete inner core. As with the walls already discussed above that will be subject to this treatment, the heritage values will only be affected to a low degree.

However, since there has been a suggestion that grouting and centre coring may be possible, it is clear that this method would have considerably less impact on the fabric and this alternative method is encouraged for the sake of the overall heritage values of the reinstated Cathedral.

Transept Crossings

The walls above the transept crossing arches have been damaged, but they also place loads at a high level in the building which can be difficult to contain. The proposal to replace this masonry with a steel frame, clad on both sides by new limestone ashlar facings resolves this issue.

This feature does not contribute to a significant extent to the heritage values, and while loss of the 19th century masonry decreases the technological values, the impact on the overall heritage significance is negligible.

Non Structural Heritage Features

HCG's report only addresses structural matters. However, there are a number of heritage features that will be affected by their proposals. These include stone and brass memorials, tiled panels, and carved timber joinery and panelling. These are fixed to the walls that are intended to be partially

reconstructed with a new reinforced concrete core. **It will not be difficult to reattach these features to the walls after strengthening and thereby retain their heritage value in situ** but their safe removal may cause difficulties, both from the point of view of the site workers and for the features themselves – to reduce potential damage as they are removed.

Other features include the pulpit, Bishop Harper's tomb and possibly the font (although this may be too badly damaged to be reinstated). These are freestanding and will have to be safely salvaged prior to the removal of the original floor. **Their heritage values will not be affected by this temporary removal nor by relocating them in a new position if desired.**

Identified Loss of Heritage Values v Overall Positive Retention

The approach taken by HCG is based on ensuring the survival of the building intact as far as possible and minimising any reduction in its heritage values. There will inevitably be loss of some heritage fabric. The overarching goal to minimise that loss has meant that this can potentially be outweighed by the preservation of other elements intact. As a result the effect on the heritage significance of the Cathedral as a whole will be less than if a more intrusive stabilisation and strengthening process was adopted.

The HCG report focusses on the works that they see as necessary for the immediate repair and long term survival of the Cathedral, and it naturally places less emphasis on what does not need to be done for that purpose. By reviewing the areas of the building affected in the context of the whole Cathedral it has been possible to gain a more accurate impression of the impact on the building of the works.

As noted above, the roof makes up a very large proportion of the building fabric, and is to be retained in situ with only minor repairs. This means that the effect of other more intrusive measures such as demolition or the loss of the floor can be off set against the retention of heritage values from retaining the roof unmodified.

All the measures described by HCG, with the exception of demolition, still manage to retain a proportion of the heritage values ascribed to the affected elements despite the works involved. An assessment of the total balance of loss and retention can therefore come down in favour of a positive retention of heritage values from the works.

7.00 CONCLUSION

Decisions relating to the future of Christchurch Cathedral have been in limbo since the earthquakes in 2010 and 2011. The direction provided by the Dean Report and the subsequent workshopping between specialist engineers has provided the opportunity to propose measures which will satisfy the crucial safety and seismic issues and also retain the heritage values of the building. In order to implement the intentions of the Dean Report, it has been necessary to accept that compromises will be necessary and that some of the heritage fabric will be lost. However, the philosophy adopted by HCG at the outset that all works should have the least possible effect on heritage values and that the

building should be stabilised and strengthened in situ has meant that these compromises have been kept to a minimum.

The proposal to provide base isolation for the foundations has probably had the greatest impact on reducing the extent of intrusive works required to bring the building up to a suitable standard and therefore a corresponding reduction of negative impacts on heritage values.

Recognition that the roof is in an acceptable state and can be retained intact is another major factor in allowing an assessment that the nett sum of positive versus negative effects.

Stabilisation of the building will be carried out with little or no effect on the fabric and despite its important role can be done with a light touch, leaving the building intact for later strengthening.

In conclusion, the proposals of Holmes Consulting Group in consultation with Dunning Thornton and Ruamoko Solutions will allow the Cathedral to be reinstated with minimal loss of overall heritage values.

As heritage professionals, Origin Consultants believe the HCG proposals represent a sympathetic and sound approach to the future of the Cathedral and welcomes the work carried out by them and their associates to achieve this.

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APPENDIX 1

HERITAGE IMPACT ASSESSMENT TABLES

PRELIMINARY HERITAGE IMPACT ASSESSMENT OF PRELIMINARY SCOPE OF STABILISATION WORKS

| HCG Ref | HCG proposals | Heritage Affected | Fabric | How affected | Mitigation |
|----------------|--|--|--------|---|--|
| PHASE 1 | | | | | |
| 1.1 | Remove existing steel frame, concrete foundations & shipping containers on west elevation. | None | | | |
| 1.2 | Remove remnant west wall to porch roof level. | Halswell stone random walling external wythe, rubble core, internal ashlar lining. | | Removed. | Deconstruct carefully, labelling and setting aside undamaged stone for re-use. |
| | | Remnants of limestone rose window surround. | | Removed. | Retain fragments as model for replication. |
| | | Remnants of rose window stained glass and frames. | | Removed. | Collect remnants of stained glass where fragments are greater than 75 x 75mm for reinstatement |
| | | Niches with mosaic tile scenes on interior. | | Removed. | Cut out niches individually and intact and set aside for re-use. |
| 1.3 | Install new permanent steel frame into new opening at west end. | Existing and remaining stone masonry. | | New drilled and grouted bolted connections through the wall. Some reinforced concrete infill to wall end. | Maximise re-use of weathered stone and replicate previous stone detailing. |

| HCG Ref | HCG proposals | Heritage Affected | Fabric | How affected | Mitigation |
|---------|--|---|--------|---|--|
| 1.4 | Connect new west frame to nave roof. | Timber rafters of main roof truss. | | Drilled for new dowel connections to west frame. | |
| | Deconstruct damaged clerestory walls to sill level in first bay only. | Halswell stone random walling external wythe, rubble core, internal ashlar lining | | Damaged walling removed. | Deconstruct masonry carefully, labelling and setting aside undamaged stone for re-use. |
| | | Remnants of limestone clerestorey window surrounds. | | Damaged stone features removed. | Deconstruct masonry carefully, labelling and setting aside undamaged stone for re-use. |
| 1.5 | | | | | |
| 1.6 | Construct new clerestorey braced frame behind line of existing west porch. | None, (temporary only) | | | |
| 1.7 | Connect new clerestorey frames to existing masonry walls. | Portions of existing modern slate roofing at top of aisle roof. Existing clerestorey masonry wall structure. | | Some roof slates removed to make connection down to 1999 strengthening steel beam internally. | Remove undamaged slates and lead flashings carefully and set aside for re-use. |
| | | Existing clerestorey masonry wall structure. | | Holes for new connections drilled through masonry. | |
| 1.8 | Deconstruct west porch. | EXTERIOR Entire porch structure including: lead roof, carved masonry, random stone walling, | | Removed | Deconstruct masonry carefully, labelling and setting aside undamaged stone for re-use. |

| HCG Ref | HCG proposals | Heritage Affected | Fabric | How affected | Mitigation |
|---------|---------------|--|---------|--------------|--|
| | | Decorative stone window and door surrounds, Remnants of stained glass windows and iron frames, Timber door and frame and hardware, basalt stone plinth. | | | Careful deconstruction is preferred if safe working environment can be achieved. |
| | | | | | |
| | | INTERIOR (Porch side) | Removed | | Careful deconstruction is preferred if safe working environment can be achieved. |
| | | Timber panelled ceiling lining | | | Undamaged materials to be set aside for re-use. |
| | | Ashlar linings. Decorative stone door and window surrounds. | | | Damaged materials set aside for use as models for recreation if required. |
| | | Inlaid stones form English Cathedrals. | | | |
| | | Founding memorial. | | | |
| | | Bench mark. | | | |
| | | Remnants of stained glass. | | | |
| | | Internal timber entrance doors and frames including hardware. | | | |
| | | INTERIOR (Nave side) | | | Careful deconstruction is preferred if safe working environment can be achieved. |
| | | Decorative carved stone door surrounds | | | Undamaged |
| | | Decorative stone dado. | | | |

| HCG Ref | HCG proposals | Heritage Affected | Fabric | How affected | Mitigation |
|---------|--|--|--------|--------------|--|
| | | Encaustic tiles. Decorative stone plinth. | | | materials to be set aside for re-use. Damaged materials set aside for use as models for recreation if required. |
| | Complete installation of new west wall bracing frame. | | | | |
| 1.9 | Remove loose masonry around north and south transept gables. | Loose and damaged stones in existing wall | | Removed | Remove carefully, labelling and setting aside undamaged stone for re-use. |
| | Lower precast concrete foundation blocks for transept gable stabilisation frames. | None, temporary. | | | |
| 1.10 | Install steel transept stabilisation frames to north and south transept gable walls. | None, temporary. | | | |
| 1.11 | Remove loose masonry around north porch. | Loose and damaged stones in existing wall | | Removed | Remove carefully, labelling and setting aside undamaged stone for re-use. |
| | Lower precast concrete foundation blocks for porch stabilisation frames. | None, temporary. | | | |
| 1.12 | Install steel porch stabilisation frame. | None. | | | |
| 1.13 | Remove or pin loose masonry at high level | Loose masonry at high level such as gable | | Removed | Remove carefully, labelling and setting |

| HCG Ref | HCG proposals | Heritage Affected | Fabric | How affected | Mitigation |
|----------------|---|--|--------|--|---|
| | such as gable capping stones, loose slates, ornamentation etc. | capping stones, loose slates, ornamentation etc. | | | aside undamaged stone for re-use. Retain fragments of broken carved stones for use in replication. |
| PHASE 2 | | | | | |
| 2.1 | Connect west frame to existing masonry piers | Remaining stone masonry walls. | | New connections drilled and grouted. | |
| 2.2 | Reconstruct lost portion of north aisle roof using temporary steel rafters, braces and steel sheet roofing. | | | | Reconstruct to match existing south aisle wall. |
| | Repair top of wall including new concrete capping beam. | Existing masonry. | | | |
| 2.3 | Install new steel roof race to south aisle roof. | None. | | | |
| 2.4 | Shore clerestorey arches and columns. | None. | | | |
| 2.5 | Insert timber propping to aisle roof rafters. | None. | | | |
| | Stabilise aisle piers with ratchet tie downs. | Carved stone window surrounds, internal ashlar and pier masonry. | | May be dislodged or marked by tie-downs. | Install soft padding behind tie-downs. |
| 2.6 | Deconstruct damaged portion of north porch roof. Cover with temporary steel | Damaged roof timbers and slates. | | Removed. | |

| HCG Ref | HCG proposals | Heritage Affected | Fabric | How affected | Mitigation |
|----------------|--|--|--------|--|--|
| | sheet roofing. | | | | |
| | Remove tower rubble from attic floor. | Remaining timber floorboards. | | May be scratched or marked by heavy removal. | Remove rubble by hand or by careful use of excavator bucket. |
| 2.7 | Shore, cover and brace all window openings. | Carved stone window surrounds, internal ashlar and pier masonry. | | Fixings in stonework. | Locate fixings in discreet places where not visible later. |
| PHASE 3 | | | | | |
| 3.1 | Shore transept piers and arches with new braced towers and timber propping. | Transept piers and arches. | | | |
| 3.2 | Secure external transept bracing frame foundation through to interior using ties to double PFC walers. | Base of existing transept wall. | | Holes drilled through thickness. | Locate holes in mortar joints if possible. |
| 3.3 | Strengthen badly damaged piers to south transept gable using strops and tie-downs. | Possible marking of strops and tie downs on delicate limestone window surrounds. | | Limestone window surrounds. | Use soft packing beneath strops. |
| 3.4 | Install temporary roof level ties between north and south transept gable frames. | Stone masonry at high level. | | Masonry drilled through. | |
| 3.5 | Prop and shore remaining arches in apse and chancel. | Possible marking of strops and tie downs on delicate limestone window surrounds. | | Limestone arches and window surrounds. | Use soft packing beneath strops. |
| 3.6 | Strengthen badly damaged walls to north and south apse walls using strops and tie-downs. | Possible marking of strops and tie downs on delicate limestone window surrounds. | | Limestone arches and window surrounds. | Use soft packing beneath strops. |

| HCG Ref | HCG proposals | Heritage Affected | Fabric | How affected | Mitigation |
|---------|---|--|--------|-----------------------|--|
| | Core through existing walls for wire rope. | Existing stone masonry. | | | |
| 3.7 | Shore, cover and brace all window openings. | Carved stone window surrounds, internal ashlar and pier masonry. | | Fixings in stonework. | Locate fixings in discreet places where not visible later. |

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PRELIMINARY HERITAGE IMPACT ASSESSMENT OF PRELIMINARY SCOPE OF STRENGTHENING WORKS

| HCG Reference | HCG proposals | Heritage Fabric Affected | Non-structural heritage fabric affected | How affected | Mitigation |
|---------------|---|---|--|--------------------------------------|--|
| 6.4.1 | Grout and pin stone rubble walls to be retained insitu. | Existing stone masonry. | | New drilled and grouted rubble core. | |
| 6.4.2 | Underpin shallow foundations. | None. | | | |
| 6.4.3 | Replace steel bracing in aisle roofs to augment 1999 strengthening. | None. | | | |
| 6.4.4 | Remove inner lining of ashlar and part rubble core of walls and pour new reinforced concrete infill wall. | Inner wythe of limestone ashlar and rubble core. North and south aisle walls to sill level, transept gables, part of apse. | | Removed. | Investigate methodologies for the safe removal of carved decorative elements such as string courses for later reinstatement. |
| 6.4.5 | | | Stone memorial panels fixed to lower aisle walls. | Removed. | Carefully remove stone or brass panels and store for refixing. |
| 6.4.6 | | | Encaustic tile panels at lower aisle walls including decorative stone surrounds. | Removed. | Investigate techniques for removing tiles from substrate if possible. Alternatively record in place and then remove. |
| 6.4.7 | | | Carved timber | Removed. | Carefully remove panels from wall. |

| HCG Reference | HCG proposals | Heritage Fabric Affected | Non-structural heritage fabric affected | How affected | Mitigation |
|---------------|---|--|---|---|--|
| | | | panelling attached to south transept walls (Memorial Chapel), and to chancel. | | Protect against ... pigeon guano Remove pigeon guano and set aside for repair and refixing. |
| 6.4.8 | | | Carved timber choir stalls. | Removed. | Carefully dismantle and remove for later repair and refixing. |
| 6.4.10 | Replace north and south aisle buttresses in reinforced concrete and replace exterior stone as veneer. | Halswell stone faced buttresses with rubble core and limestone ashlar inner wythe. | | Masonry deconstructed to ground level, exterior stone labelled and stored for refixing onto concrete core. Rubble core and internal ashlar removed. | |
| 6.4.11 | Construct new reinforced concrete foundation beams cut into and sandwiching existing stone foundations. | Existing stone foundations. | | Pockets cut through for finger beams through to base isolation. | |
| | Construct new reinforced concrete foundation beams beneath existing | Existing | | | |

| HCG Reference | HCG proposals | Heritage Fabric Affected | Non-structural heritage fabric affected | How affected | Mitigation |
|---------------|---|--|---|--|--|
| | floor and nave columns. | | | | |
| 6.4.12 | Upper clerestorey walls. | Halswell stone exterior wythe with rubble core and limestone ashlar inner wythe. | Carved decorative string courses etc. | Rubble core grouted, cut back, new concrete wall and inner wythe replaced. | |
| 6.4.813 | Repair stone nave columns. (Possibly deconstruct and reconstruct to allow construction of new foundations). | | Brass memorial plaque. | Removed | Carefully remove and set aside for refixing. |
| 6.4.14 | Insert additional ties between new and existing elements. | Existing stone masonry. | Core drilled and grouted. | | |
| 6.4.15 | Pin and secure vulnerable exterior and interior ornamentation. | | Parapet cappings, finials, window mullions, | New fixings. | |
| 6.4.16 | Install base isolation throughout building. | Existing floors | Encaustic tiles, and other floor surfaces. | Removed. | Much of the existing floor has been damaged by falling masonry, heavy plant immediate post-earthquake, or neglect and may not be retrievable anyway. |
| 6.4.17 | Core and reinforce "minaret" towers. | Existing stone masonry and roof slates. | | Core drilled and grouted. | |

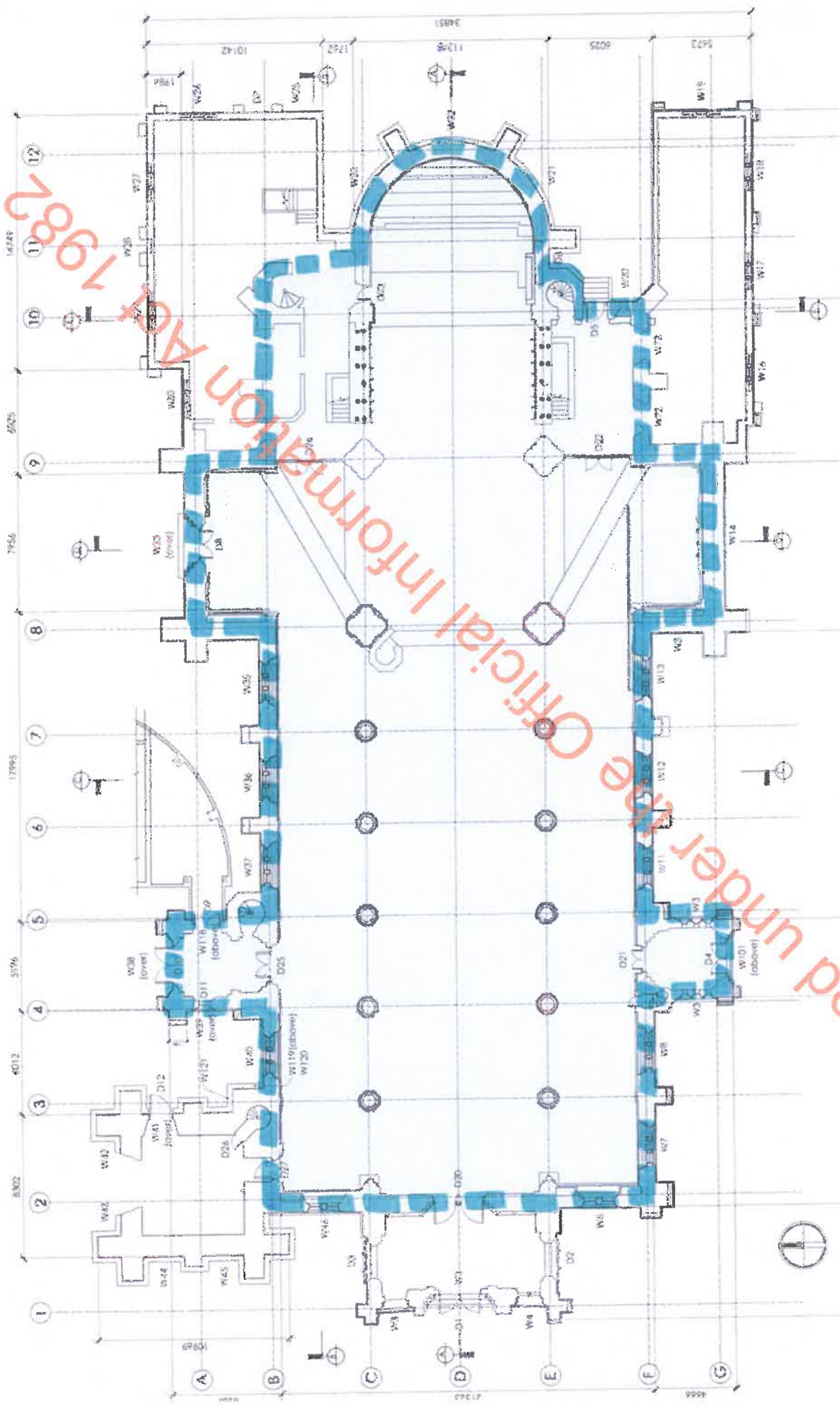
| HCG Reference | HCG proposals | Heritage Fabric Affected | Non-structural heritage fabric affected | How affected | Mitigation |
|---------------|---|---|---|--|--|
| 6.4.18 | Construct reinforced concrete skin wall to clerestorey walls. | Existing stone masonry including limestone ashlar and decorative stone carving. | | Removed. | Investigate other less intrusive techniques once internal access possible. |
| 6.4.19 | Install new pre cast concrete rose window frame. | | Original carved stone rose window surround. | Replaced in new structurally efficient material. | Design concrete rose window in sensitive manner. |
| 6.4.20 | Construct new 200mm concrete floor throughout. | | Existing encaustic and mosaic tiled floor. | Removed. | Investigate methodologies to lift panels of the tiled floor with their concrete backing for reinstatement. Design new floor finishes in new materials which reflect existing design but also reflect the enormity of the earthquakes in the city's history. |
| | | | Carved stone pulpit. | Removed. | Repair and replace in original location or new location according to new layout. |
| | | | Effigy of Bishop Harper. | Removed. | Repair and replace in original location or new location according to new layout. |
| | | | Stone altar table. | Removed. | Repair and replace in original location or new |

| HCG Reference | HCG proposals | Heritage Fabric Affected | Non-structural heritage fabric affected | How affected | Mitigation |
|---------------|---------------|--------------------------|---|--------------|-----------------------------------|
| | | | | | location according to new layout. |

APPENDIX 2

Extent of use of each strengthening methodology sketches.

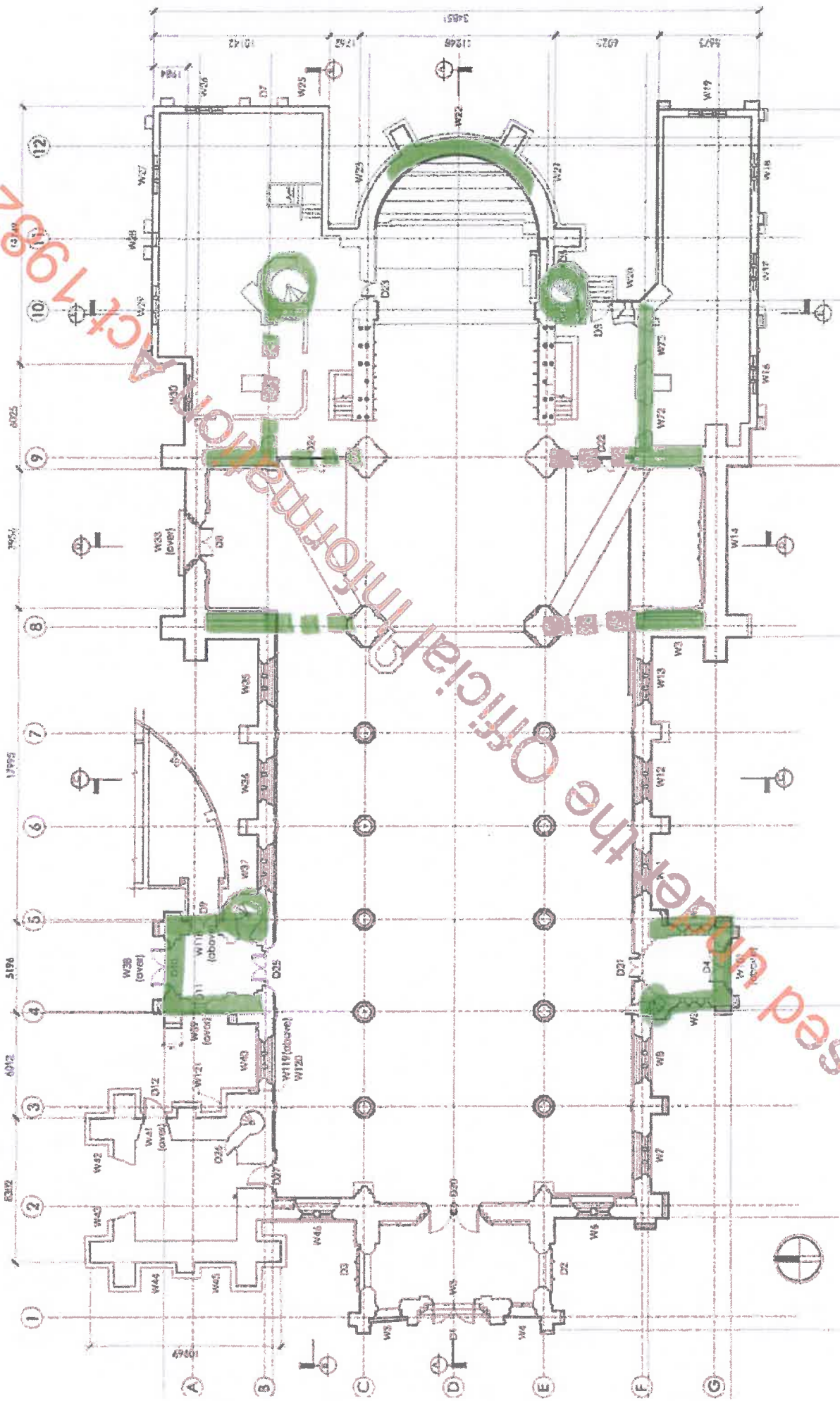
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KEY

- Repair in-situ
- Repair entire roof

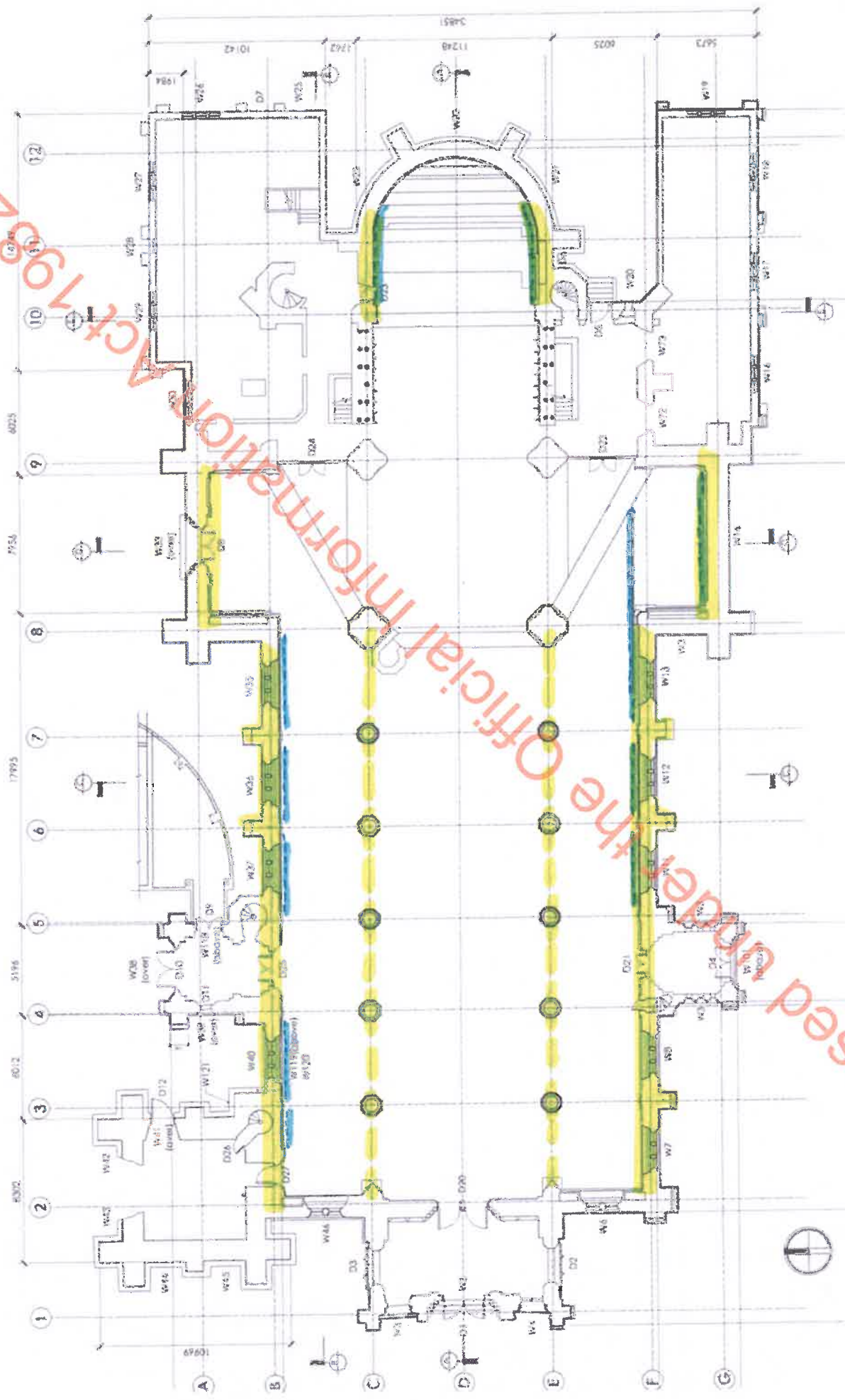
1. Repair in-situ



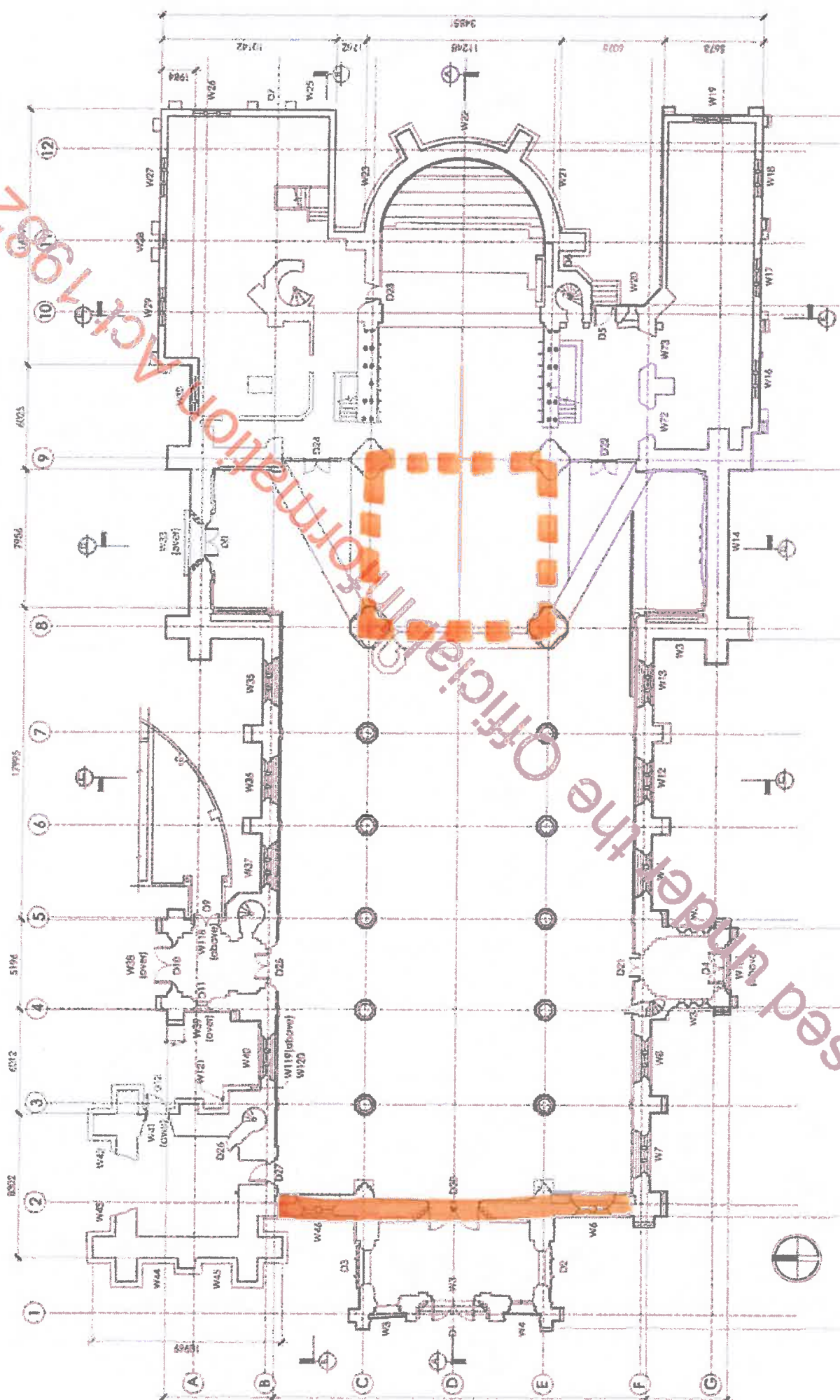
2. Core and drill

KEY
Core and drill

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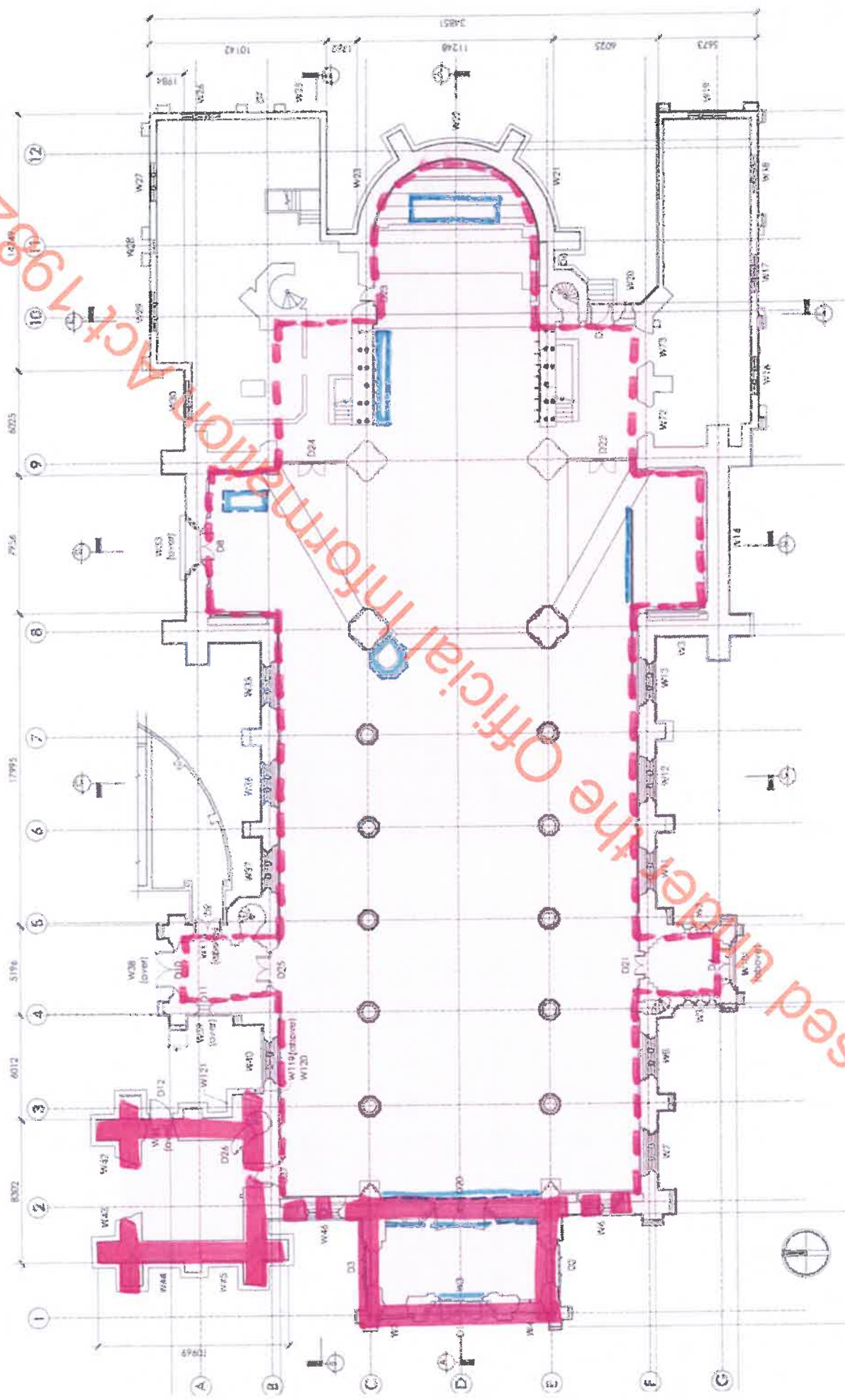
3. Replace core with reinforced concrete
(note non-structural fabric attached to existing walls)



4. New structural steel frames

KEY
 New structural steel frame

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5. Demolition