From: [redacted] "LHNH Launceston Heritage Not High Rise"
[redacted]
Sent: Tue, 2 Nov 2021 17:05:13 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: Representation to Application ID DA0486/2021
Attachments: REPRESENTATION DA0486 2021 LHNH.pdf

You don't often get email from [redacted]. Learn why this is important

Please find attached
Representation in regard to:
Application ID DA0486/2021 at 89-93 Cimitiere St, Launceston
--

[redacted]

Mr Michael Stretton
Chief Executive Officer
PO Box 396, LAUNCESTON TAS 7250
By email: contactus@launceston.tas.gov.au

LHNH LAUNCESTON HERITAGE NOT HIGHRISE

Launceston Heritage Not Highrise
[redacted]

1 November 2021

Representation:

Application ID DA0486/2021 at 89-93 Cimitiere St, Launceston

Business and Professional services, General Retail and Hire, Food Services - Construction of a mixed use development involving partial demolition of existing buildings at 89-93 Cimitiere Street, Launceston (CT 90992/1, CT 248431/1 & CT 112123/1) including the construction of a pedestrian walkway across 34 Cameron Street, Launceston (CT 226231/1).

Building Height:

@ 31.01 mts P1 (15.4.1) as stated is not sufficient to justify more than two and a half times the acceptable solution of 15.4.1 height of 12 mts.

> *"Of relevance for the subject site is the absence of either 'local area objectives' or 'desired future character statements.* (Pg 30 DA)

There are six levels of commercial office space plus two floors of the St Luke's own use on Lvls 6 & 7. There is room to move – down.

The **Verge Hotel** was made to decrease the original height of their first DA to the current height of 23.2mts. This action was imposed in response to the Paul Davies report and we see no reason not to impose this again.

Likely Reflectivity:

The artist impressions appear to give prominence to the structural wood components however the reflective glass with *"black film"* finish on all external walls will mask this. The 3D photomontages show ***"likely reflectivity"*** (Appendix D). Views out of the building will be maximised but views to the building will show a big black, and looming reflecting box.

Heritage:

The building has no state or local heritage listing: Therefore, at some future stage in the development process, the unlisted elements of the existing building that are incorporated into this current DA could be removed. **There should be secure conditions placed on any approval in relation to this and urgent heritage listing undertaken.**

In summary:

- Stop the creep of height and do not pass this DA at the height submitted.
- Undertake further examination of the reflective finish of the façade.
- As a matter of urgency, heritage listing must be enacted.
- Please advise what are the *'local area objectives' or 'desired future character statements'* of this so called precinct.

Jim Collier [redacted] and Victoria Wilkinson [redacted]
On behalf of LHNH Email: [redacted]

From: "June Dave" [redacted]
Sent: Tue, 2 Nov 2021 16:57:38 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: Representation - Ref: DA0486/2021

[You don't often get email from [redacted] Learn why this is important at http://aka.ms/LearnAboutSenderIdentification.]

Dear Mr Stretton
This is my representation AGAINST the proposed DA ID DA0486/2021, 89-93 Cimitiere Street, Launceston.

Here we go again, another high rise, spoiling the low rise streetscape of the Heritage buildings in Launceston. The reasons that I understand that these high rise developments are getting through are with the help of the LCC providing the Area codes to suit the developers and working with the developers to get them passed, despite the existing planning scheme height limits.

This photo below was taken alongside the Tamar Road Bridge and Lindsay Street (a view the UTAS will soon been enjoying). I believe this area is classed as Industrial, so where does The current DA proposed by St Lukes Health come under Industrial? Indeed where does The Verge Hotel and The (council passed) Fragrance Hotel come under Industrial?

Should the developers build something in keeping (without the Highrise of no more than 15mts preferably, as in the planning scheme, or no more than the Verge hotel of 24mts (they had to drop off one level due to height restrictions!) with The existing Heritage Industrial buildings? which people admire and appreciate that they have been kept and still in use.

Look into this photo below, you can see the Verge Hotel and beyond the green wall, the Grand Chancellor is visible (on the bridge it is even more visible), as a result of the Fragrance Hotel going up at 43mts, the Verge and Grand Chancellor Hotels will be hidden and overshadowed.


CHEAPCARS
ESK BREWERY 1950.

Now this recent article in the Examiner below, did you see it or read it?
Are you concerned that the opinions of the Major in stating that "proliferation" is actually part of a broader trend throughout the city?
Are you also concerned with the Councils lack of respect to The President of the Heritage Society of Tasmania, Mr Lionel Morrell? his opinions just don't count when it comes to Highrise developments in Launceston (possibly Hobart too)....I'm sure he only passed the changes to the Clarion Hotel only as in keeping with the heritage guidelines, he would NOT have approved the rest of the Fragrance Hotel structure I'm sure.
The Boland Street Hotel is another one, back in 2017 LCC passed plans for that as acceptable height with the re-use of the heritage listed cottages convict bricks in its frontage.....now LCC have passed it at over height and not a brick in the design.

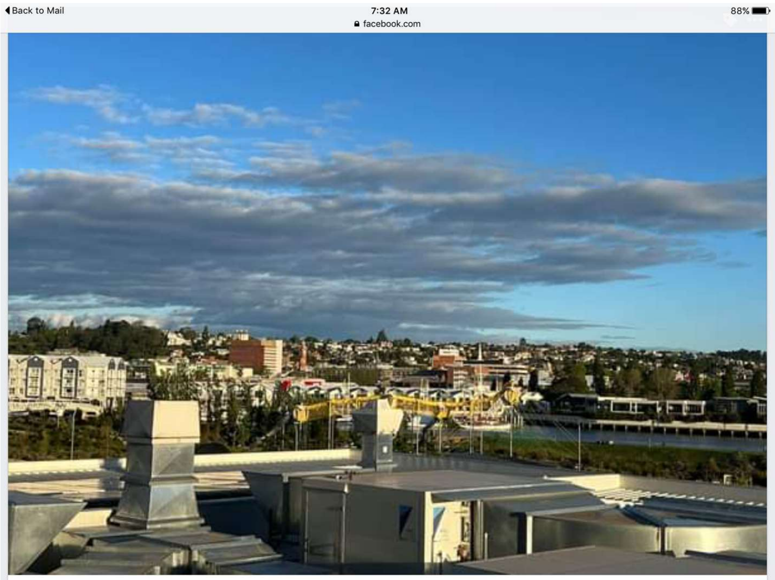
This page has been removed due to copyright restrictions. This page was a newspaper article published in the Examiner on Friday October 22, 2021, Titled "Bigger may be new norm".

[redacted]

Apart from the ugly Gorge Hotel in this group of high rise developments. four are all in the same vicinity, including The Verge Hotel. UTAS will have city views blocked out from every angle. The Harvest Market will be overshadowed, by three of them, visitors to the market can see all of them, LCC can hardly say they are all in keeping with the streetscape, in design and in height.

This last photo below was taken just a couple of days ago by a friend of mine while staying at The Silos Hotel.
What stands out to you? Would it be the Telstra building with the clock tower next to it and the Myer building?
Is LCC starting another trend of ugliness of high rise throughout the city of Launceston? These two building are past mistakes with Heritage buildings being demolished to build them, the current developers are using these heights as the reason that they too can raise the heights above council planning heights.

Just who in the Council are concerned that these current high rise buildings are changing the face of Launceston forever, the Telstra and Myer building are past mistakes of previous council planners and should not be a guide to the non concerned developers of today. Certainly the town planners are not concerned and definitely the mayor and most councillors, the very representatives of the residents of Launceston.



In conclusion I would like to add that YOU should be concerned regarding the attitude of your staff and lack of respect to the people who put in representations at the time of the Fragrance Hotel going before the Tribunal, which they passed with some guidelines.
After the tribunal LCC passed, what they said, as minor changes to the plans so they could get started with their build... Did you know LCC wrote to all of the representatives stating "LCC have passed these minor changes and if we, representer's, didn't like it we could take it to the tribunal and not to contact the Council about it!
Words to that affect is nothing but a clear snub to Launceston's concerned residents and the likes of Lionel Morrell. The councillors (except a couple) deserve to be voted out next year and quite likely will, just a pity the planners can't be, but you as Manager should put a stop to these high rise developments now, before they are a terrible blot of the face of Launceston City, once the first one is there the rest and more will follow.

Although I have written this email to you on a personal level Mr Stretton, covering the various high rise proposed by LCC in the hope that you can make your planners and councillors stick to the council rules and schemes, show more respect to its residents, it is high time someone listened to the people and take on board advice from professionals.

I strongly oppose the St Lukes Health development.

Regards
June Burnet
[redacted]
2-11-21

From: "Victoria Wilkinson" [redacted]
Sent: Tue, 2 Nov 2021 12:51:39 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: Representation to Application ID DA0486/2021
Attachments: REPRESENTATION DA0486 2021 VW.pdf

Please find attached
Representation in regard to:
Application ID DA0486/2021 at 89-93 Cimitiere St, Launceston
Regards - Victoria Wilkinson

[redacted]

Mr Michael Stretton
Chief Executive Officer
PO Box 396, LAUNCESTON TAS 7250
By email: contactus@launceston.tas.gov.au

Victoria Wilkinson
[redacted]

1 November 2021

Representation in regard to:

Application ID DA0486/2021 at 89-93 Cimitiere St, Launceston

Business and Professional services, General Retail and Hire, Food Services - Construction of a mixed use development involving partial demolition of existing buildings at 89-93 Cimitiere Street, Launceston (CT 90992/1, CT 248431/1 & CT 112123/1) including the construction of a pedestrian walkway across 34 Cameron Street, Launceston (CT 226231/1).

Building Height: 31.01 mts is simply too high.

Without going into LIPS 2015 (or the yet to be enacted SPP/LPS) my comment here is that 31.01mts is simply too high. And compliance with 15.4.1/P1 as stated is just the usual battle cry and basically claims that in **absence of design guidelines**, these can be provided by the developer *("when arranged in a sensitive and appropriate manner"* really?):

> *"Of relevance for the subject site is the absence of either 'local area objectives' or 'desired future character statements.*
>
> *… Evidence provided by three different planning experts advocated different approaches to defining the character of an area. Common to all was an attempt to describe the mix of use and development that helped to define the 'character' of an area. … the character of an area cannot be narrowly defined; it is essentially the sum of its parts …"* (Pg 30 DA)

The height of this building can and should be reduced – the claim of attenuation does not hold up in regard to the surrounding area. There are six levels of commercial office space (apart from the St Lukes own offices on Lvls 6 & 7). I disagree with the statements made in the proposal (quoted below) and also draw attention to the incorrect use of yet to be built developments as support.

> *"The larger scale generally of the proposed development is attenuated to a pedestrian scale through the retention of the existing street-level buildings."* (Pg 10 Appendix D)
>
> *"When seen from a distance the height of the proposal sits comfortably into the predominant heights set by existing and proposed buildings along Cimitiere Street as shown on the street elevation as per Figure 5 "* (Pg 18/3.2.2 DA)

The **Verge Hotel** was made to decrease the original height of their first DA to the current height of 23.2mts (plant room) and 21.7mt (to roof) and so should this one.

Materials:

GLAZING. This building has a lot of glazing – curtain wall on all sides. The artist impressions seem to give prominence to the wood components. The reflective glass with *"black film"* finish will predominate and mask the timber except for the outdoor 'room' on Lvl 6 where it will be exposed. The 3D photomontages show ***"likely reflectivity"*** views (Appendix D) and appear to show the internal wood structures. Appears to show? However, with the reflectivity of black film glass, this will be minimal. Views out of the building will be maximised but views to the building will simply show a big black, reflecting box.

Photomontages:

> *"…the cost of preparing rendered images is expensive. As such we have provided an additional 4 perspectives (refer photomontages 2-5) now included with the proposal plans which have been prepared showing realistic finishes to the building.* (Pg 4 RFI)

Yes they are expensive but this is a significant proposal.
Photomontages 2 – 5 show the looming nature of all the black glazing.

WOOD: Source of the wood. DA states (Appendix D Pg 22) *"**intended** to be sourced within Tasmania".* Intended but not guaranteed – any other source will diminish embodied carbon claims made in the DA. The Verge used bricks from Longford TAS. The expressed timber on levels 6 – 7 is to be a different species and "*therefore be visually different"* (Pg 35 DA) Is there a reason for this?

Heritage:

The building has no state or local heritage listing: Therefore, at some future stage in the development process, the unlisted elements of the existing building that are incorporated into this current DA could be removed. (Or stored for symbolic use as with the heritage listed Boland St site, which of course never happened). **There should be secure conditions placed on any approval in relation to this and urgent heritage listing undertaken.**

There is a statement as to the importance of looking down views from surrounding areas (Pg 35 DA). The proposal includes full coverage with solar panels. These should be constructed to minimise glare.

Residential amenity: Noise Level 15.3.4:

> *" Across Cimitiere Street (A in Figure 1) are a selection of commercial uses, generally occupying the ground floor of two-storey buildings. It is unknown if the upper levels of these buildings have residential occupants. As such, **the location of the nearest sensitive use is unknown**, and thus it is conservatively assumed it may be location A."* (Pg 1 Appendix F)

Perhaps this could be determined, not to mention where does residential fit into the *'local area objectives' or 'desired future character statements'?*

In summary:

- Stop the creep of height and do not pass this DA at the height submitted.
- Undertake further examination of the reflective finish of the façade.
- As a matter of urgency, heritage listing must be enacted.
- And perhaps a proper public exhibition about what are the *'local area objectives' or 'desired future character statements'.* of this so called precinct.

Yours truly, Victoria Wilkinson [redacted]

"Launceston is not seen as a city of tall or large buildings but rather a unique collection of buildings of generally very consistent scale and form that sets Launceston apart from other cities in Australia."

Scale and general homogeneity of forms is one of Launceston's greatest assets that sets it apart from other cities and adds to its desirability as a place to live and work."

LAUNCESTON HEIGHT STUDY FINAL DRAFT FOR COUNCIL REVIEW FOR LAUNCESTON CITY COUNCIL
PAUL DAVIES PTY LTD ARCHITECTS HERITAGE CONSULTANTS JULY 2018

From: "Julie Mack"[redacted]
Sent: Tue, 2 Nov 2021 12:58:09 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: DA0486/2021. Cimitiere Street Launceston
Attachments: Cimitiere Street.pdf
Importance: Normal

[You don't often get email from [redacted]. Learn why this is important at http://aka.ms/LearnAboutSenderIdentification.]

Please see attachment.

John Green
Ritchie & Parker Alfred Green & Co | Barristers & Solicitors
[redacted]

[redacted]

1 November 2021

Mr Michael Stretton
Launceston City Council
Town Hall
St John Street
LAUNCESTON TAS 7250

By email to contactus@launceston.tas.gov.au

Dear Mr Stretton,

Re: DA0486/2021. Construction of a mixed use development involving partial demolition of existing buildings at 89-93 Cimitiere Street, Launceston (CT 90992/1, CT 248431/1 & CT 112123/1) including the construction of a pedestrian walkway across 34 Cameron Street, Launceston (CT 226231/1).

This proposed building is too tall and being taller than the nearby Verge Hotel will further compromise the settings of important heritage buildings including Holy Trinity Church and adjacent Sunday School Hall, the old Baptist Tabernacle and the Crown Mill Building in Cameron Street.

I am concerned that with the precedent of ever-increasing heights for developments in this area, that other sites such as the balance of Council's Cimitiere/Cameron Streets Carpark, the former Deans Bakery site at 28 Cameron Street, the adjacent RACT site, and possibly even the Holy Trinity Carpark site itself, will push development envelopes beyond reason, and convert the area into a series of uncoordinated tall boxes with little architectural merit or individuality.

It is my understanding that the proposed site was considered by Council in context with the desirability of taller buildings being constructed within the central Launceston area, and a lower height of just 12-14M established by the Planning Scheme.

Accordingly, I submit that this proposal not be approved, and instead be limited in height in accordance with Council's earlier considerations, and under no circumstances would there be justification to go higher than the Verge Hotel development.

Yours faithfully,

[redacted]

J.M.Green

From: [redacted]
Sent: Tue, 2 Nov 2021 13:53:14 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>;"Eve Gibbons" [redacted]
Subject: Representation DA0486/2021
Attachments: TRA Inc Representation DA0486 89-93 Cimitiere St Launceston.pdf

Please receive the attached Representation from TRA Inc.

Tasmanian Ratepayers' Association Inc.
[redacted]

31 October 2021

Mr. Michael Stretton
General Manager
City of Launceston Council
Town Hall
St John Street
LAUNCESTON TAS 7250

By email to: Michael.stretton@launceston.tas.gov.au
contactus@launceston.tas.gov.au

Dear Sir,

Ref: DA0486/2021 89-93 Cimitiere Street Launceston

In making this representation we refer to the advertisement in the Examiner Newspaper, dated 16 October 2021 which invites representations to be lodged by 5.00pm on Monday 1 November 2021 (hence 2 November 2021 due to public holiday).

At the outset, we draw attention to the prudent and feasible development opportunity we will go on to outline in this representation.

Tall building developments are an unnecessary argument to have in Launceston, and it is timely to remind CoL Councillors of the background to the failed Development Proposal for a 43m high building on land for a Gorge Hotel (Ref. RMPAT 58/19P) :

> *79. For the reasons set out above in respect to the failure of the proposed development to satisfy the criteria in P3 (b), (c) and (d)* ***the building height is not compatible with the streetscape and the character of the surrounding area.*** *The second ground of appeal is made out.*

It is our opinion, City of Launceston Council should NOT approve this application to enable a tall building to be constructed on this site to a height of 31.01 M.

RMPAT also considered other evidence during Hearing 58/91P, regarding **visual impacts, assessment of character of the area and, whether such a proposed building 43M high could be excused or justified as being a landmark or even an iconic building**, recording that:

"The Appellant contends that the relevant surrounding area must be considered in the context of the visual impact of the development beyond the site, such that the relevant surrounding area for analysis of character is that from which the development will be

visible and likely to impact upon character. That is, potentially, an extremely large area. The landscape and visual impact assessment included the plan below showing an area in red from which the development would potentially be visible, disregarding the mitigating effects of vegetation, buildings and other structures: 15 Figure 3.1 – proof of evidence of Durwan Dharmaraj, 23 August 2019.
Clearly, the zone of theoretical visibility is too large to be an applicable surrounding area for the purposes of Clause 15.4.1. In his response proof, Mr Brownlie provided photographs of the Launceston cityscape, looking towards the development site, across the CBD and also from a point south west of the development site, looking towards the CBD. Once again, the area shown in the photographs is simply too large to realistically be considered as the surrounding area of the development, when considering the distinctive qualities and identity of the area surrounding the development site such as to enable an assessment of character."

"Landmark or iconic building.
The Developer and the Council contend that the proposal would be an iconic or a landmark building. It is apparent that there is a difference between the two. A landmark building, as pointed out in the Developer's submissions, is an object or feature in a landscape or town that is easily seen and recognised from a distance, especially one that enables the viewer to establish their location. Mr More referred to the proposal as a landmark in his report to the Council regarding the development application. Ms Duckett considered that height alone made the building a landmark building. Clearly, the tower would, by virtue of its height, be a landmark that would locate the existing tourism precinct within which it would be situated.
Whether the proposal is an iconic design is another matter. The design response prepared by the architects of the proposal is included in the development application. It says that the development has been designed to be an iconic building that will provide a connection between the Launceston CBD and the surrounding natural beauty of greater Launceston. It does not explain why the proposal will constitute an iconic building. Generally, an iconic building will be one which is symbolic of the concept, culture, heritage, religion and so forth of a place. Its location may, or may not, be an important contributing element. The height of the proposal and its design would undoubtedly cause the tower to stand out from its surroundings and differentiate it from other Launceston buildings. However, the evidence did not establish how it might be so markedly unique, peculiar or recognisable as to present an identity symbolic of Launceston or as an expression of its location in that city or of some cultural, religious or heritage significance."

"There is nothing in the Scheme that recognises or regulates the nature or value of a landmark building or an iconic building or provides either with any particular status exempting them from compliance with the express performance criteria relevant to the assessment of a development. A landmark or iconic building would still need to conform with the objective in Clause 15.4.1 and, if it did not meet the acceptable solution in A1, be compatible with the streetscape and character of the surrounding area pursuant to the performance criteria in P1. Even if the criteria in P1 are not the only matters that the Tribunal can have regard to in considering the objective of the Clause, it must still have regard to the criteria. Absent any provision in the Scheme that permits departure from the development standards, the Tribunal is not able to

read down or ignore the express development standards in the Scheme even though the building may be a landmark, and even if it were an iconic building."

We repeat the decision of the Tribunal :

> ***79. For the reasons set out above in respect to the failure of the proposed development to satisfy the criteria in P3 (b), (c) and (d) the building height is not compatible with the streetscape and the character of the surrounding area. The second ground of appeal is made out.***

We refer you to the *Land Use Planning and Approvals Act 1993:*

48. Enforcement of observance of planning schemes

Where a planning scheme is in force, the planning authority must, within the ambit of its power, observe, and enforce the observance of, that planning Scheme in respect of all use or development under-taken within the area to which the planning scheme relates, whether by authority or by any other person.

Planning is concerned with the public good, not private interests. Planning schemes are developed to reflect community aspirations for the future of their municipal area. Website: Premier of Tasmania, RH. Peter Gutwein

<u>Prudent and Feasible Alternative</u>

The form of this development proposal appears to be a response to a requirement by the client/user for a building that will all their present 4 separate locations in Launceston to be combined on one site. No information has been provided concerning these various sites and apart from the St Luke's State Headquarters located in the prestigious 'INGLES' Building in Quadrant Mall in the CBD, we assume the other premises are small suburban 'shopfront-type' premises developed for ease of customer access.

NOT WITHSTANDING, we note from the applicant's proposal, much of this proposed building is speculative office space, as a commercial investment, and not for the noble and essential occupation by St Luke's itself.

Accordingly, we question why the excess levels, other than the top two levels, are being constructed at all, given that this is the reason for the excessive height being generated.

We observe that immediately next door to the development site is the vehicle premises for RACT. That site is a parking yard area and small workshop, a somewhat under-developed piece of land given its key location in the city.

Should this proponent be able to add the RACT land to its development site, (and the ground level use for RACT could easily be retained) then the total height of the proposed development, even with the multiple levels of speculative office space, could be HALVED.

This reduction is height would likely place the proposed development within the present Planning Scheme's height limitations, and also produce a building less-likely to succumb to liquefaction impacts should a seismic event occur.

Accordingly, we implore Council to encourage the proponent and its principals, to reconsider their proposal.

Why does a modern 12-storey building suddenly collapse – pancake ?

Photo courtesy AFP, Joe Raedle

On June 24, 2021, at about 1.30am EDT, Champlain Towers South, a 12-storey beachfront condominium in the Miami Florida USA, partially collapsed. [ABC reports that as at 1 June, 18 people are confirmed dead and the number of residents still unaccounted for stands at 147 people].

It will be some time before experts can access the site and investigate why this building suddenly collapsed and **pancaked.**
"There's no reason for this building to go down like that," *Surfside Mayor Charles Burkett told reporters* ***"Unless someone literally pulls the supports from underneath, or they get washed out, or there's a sinkhole or something like that because it just went down."***

Surfside lies on a stretch of coast where severe tropical storms form, so Florida has some of the strictest building codes in the USA. Because of the marine exposure, additionally, local authorities require buildings more than 40 years old to undergo mandatory structural testing, and that process was underway. But there are concerns that these inspections do not take sufficient account of subterranean damage caused by ***rising sea levels*** and the ***state of the bedrock.*** Reports say that the building was built on ***reclaimed wetlands*** which were native to the area prior to development.

Authorities say that it could be months, maybe years before they have the answers.

Could this happen in Launceston, where the subject site is on Zone e of the Microzonation Map of Launceston.

The subject land is on a tidal flood plain and is subject to certain seismic activity risks. Not only does the seismic risk endanger the safety of any infrastructure that may exist or is proposed to be constructed there, but it also endangers the stability and durability of the Flood Levee system which allegedly is intended to make-safe from inundation, the land area in question.

The proponent trumpets a construction method using an expressed timber frame, clad with glass curtain walling. There is no indication whether this construction method is capable of withstanding the special structural stresses that are likely to be experienced with earthquake activity.

Seismic microzonation in Australia

Jensen, V, Seismic microzonation in Australia, Journal of Asian Earth Sciences, 18, (1) pp. 3-15. ISSN 1367-9120 (2000) [Refereed Article]

DOI: doi:10.1016/S1367-9120(99)00048-6

Abstract

Since the 1980s seismic microzonation studies have been undertaken in Australia to assess the likely effects of earthquakes on urban centres built on unconsolidated sediments. Presently the Nakamura method is used for processing data. So far parts of Perth, Adelaide, Cairns, Gladstone, Rockhampton, Newcastle, Sydney and Launceston have been zoned. The Launceston, Tasmania, study was the pilot study for many of these as it refined the methodology used and the data obtained were incorporated into a GIS database. Building heights and site factor zoning maps were produced for the Launceston City Council. One of the major activities, of the new initiative by the Australian Geological Survey Organisation (AGSO), popularly known as the 'Cities Project', is coordinating seismic microzonation throughout Australia. Microzonation data have been included in AGSO's geohazards GIS database. This is helping local councils zone land for seismic hazards. State Emergency Services use the information to plan for emergencies resulting from the effects of earthquakes. These practical applications of seismic microzonation data will help mitigate the destructive effects of any future large earthquakes occurring near major urban centres. In the Launceston case it was found that there is a variable risk dependant on epicentral distance and the nature of relatively unconsolidated sediments in various parts of the city. Disastrous amplification could occur at some sites.

Following scientific study, measuring and assessment, the Launceston microtremor analysis does not hold to the conventional assumption of a 1-dimensional homogeneous geology. In scientific hypothecation of Launceston's geology, due to the presence of the Tamar Rift Valley, amplification of seismic waves is thought to occur due to patterns of earthquake damage that occurred in the past during historic earthquakes. This results in a suspicion that 2-dimensional effects occur on this site.

Earthquake Engineering in Australia, Canberra 24-26 November 2006
169-Claprood-Asten.pdf

Use of microtremors for site hazard studies in the 2D Tamar rift valley, Launceston, Tasmania

Maxime Claprood and Michael W. Asten
Monash University

Abstract

Analysis of microtremor for risk zonation is conventionally interpreted in terms of sub-horizontal layered geology. This assumption not being valid in some cases, there is a need to take into account the impact of 2D/3D geology for analysis of more complicated models. Bard and Bouchon (1980a, 1980b, 1985) intensively studied SH, SV and P waves motions in sediment-filled valleys. Identification of 2D and 3D effects has been analyzed by Field (1996), Steimen et al (2003), and Roten et al (2006) using spectral amplification and phase behavior. Modeling and interpretation of 2D microtremor data is the next challenge, and several methods have been developed to do so. A finite difference code was developed by Moczo and Kristek (2002) within the European SESAME project. Tessmer et al (1992) and Faccioli et al (1997) present the basis of a pseudo spectral approach combined to domain decomposition techniques for modeling of propagating waves. The research group led by Komatitsch and Tromp developed a spectral element code for 2D and 3D seismic wave propagation (Tromp3D), using a combination of finite-elements method with spectral analysis. Assessment of the different methods available for detecting, modeling and interpreting 2D and 3D effects is the main objective of this project, using both H/V and SPAC data. Modeling methods will be compared with microtremor data acquired over a 2D rift valley (the Tamar Valley in Launceston, Tasmania) where there is a history of earthquake damage associated with site effects.

Introduction

Figure 1 shows the location of Launceston in Tasmania, south of the Australian mainland. Even if Launceston is not located in a very seismically active zone, damage has occurred in the past from earthquakes. Epicenters of earthquakes are located in two seismic zones:

• West Tasman Sea Zone,
• Western Tasmanian Zone.

Earthquake damage in Launceston is thought to be caused by site amplification response due to 2D geology effects. Figure 2 presents the results of the microzonation project at Launceston (Michael-Leiba, 1995). Profiles are obtained from a gravity survey (Leaman, 1994). Bedrock is Jurassic dolerite, which presents low seismic risk when outcropping. The survey outlines the presence of at least 2 deep NNW-SSE trending valleys filled with Tertiary and Quaternary sediments:

• along Tamar Valley axis, maximum sediment thickness of 250m,
• along North Esk Valley (floodplain), maximum sediment thickness of 130m.

Microtremor survey has previously been done in Launceston, using the H/V spectrum ratio (Nakamura, 1989) to estimate the natural site period of site amplification at 56 sites, and to create zoning maps of Launceston. Periods calculated present a large range of values from 0.1 to 1.5 sec. These variations in the calculated periods over the 56 sites do not appear to fit known geological depth; hence they may be explained by 2D effects generated by the presence of deep and narrow valleys. More data will be obtained with SPAC processing of array data as well as H/V data, with the aim being to identify and model 2D effects in the Tamar rift valley.

Figure 1. [see link 169-Claprood-Asten.pdf]
Location of Launceston, Tasmania. Epicenters of earthquakes with Richter magnitudes of 4.0 or more around Tasmania from 1884-1994 (from Michael-Leiba, 1995)

Figure 2. [see link 169-Claprood-Asten.pdf]
Microzonation of Launceston (Michael-Leiba, 1995). Sites where microtremor data have been obtained with H/V spectrum ratio. Geological profiles obtained from a gravity survey (Leaman, 1994)

Review of the problem

Interpretation of single-station H/V microtremor data has traditionally used the hypothesis of a layered geology, where waves of fundamental modes are assumed to dominate the signal. From Nakamura's technique, natural period of a layered site is calculated as:

$$T = 4H/V,$$

where H is the layer thickness and V is the shear wave velocity in the layer. Developments have been made analyzing variations of H/V spectral ratios and reference site method (RSM) along a profile over a valley to detect and analyze 2D effects.

The SPAC method measures the covariance at different frequencies between the signals observed at different stations. Phase velocities are determined by averaging signal coherency between the different points of observation in an array of receivers. Depending on the components of the signal analyzed, Rayleigh and Love waves can be analyzed to determine a 1D shear velocity depth profile.

Bard and Bouchon (1980a, 1980b and 1985) studied the variation in spectral amplitude of SH, SV and P waves along a profile over 2D geology. Trying to extend the H/V spectrum ratio technique to more complex geology, Field (1996) found that the method did not fit the sediment to bedrock ratio over a 2D geology. He recognized that H/V spectral ratio could be used to detect 2D effects. He observed shifting in the peak frequency along a profile over a valley. Data obtained with SPAC method in Launceston will be of interest to see if the use of H/V ratio and SPAC data simultaneously is of interest to better detect and analyze 2D effects in microtremor data.

Working hypotheses

Measurement of Vs depth profile using array methods will provide quantitative shear velocities to use in models.

H/V spectral ratios are an efficient tool to detect and analyze 2D effect in microtremor data.

Array methods (SPAC) applied over a basin edge will give perturbed microtremor phase velocities; these types of perturbations can be studied using 2D or 3D models.

Information deduced from SPAC data will help improve the detection and interpretation of 2D effects in microtremor data.

Methodology

The first step is to obtain H/V spectral ratio and SPAC microtremor measurements on a profile crossing the Tamar Valley in Launceston. H/V spectral ratio data should then be analyzed using 2D effect developed by Bard and Bouchon (1985) and Roten et al (2006). Modeling should then be used to represent Launceston area, using both 1D and 2D geology models. Comparison between SPAC data modeled from 1D and 2D geology would better assess the type of data recorded at Launceston. Recognition of 2D effects from SPAC data is the final step in the project, using both modeled and field data. Few programs can be used to model complex geology. Two approaches will be assessed in this study; the spectral element method, and the joint mode-summation and finite difference method.

Spectral Element Method (SEM)

• Work with Tromp3D program using SEM method (Komatitsch and Tromp, 1999)
• Weak formulation: integral formulation of seismic equations of motion. The weak formulation naturally satisfies the stress-free surface boundary condition.
• Hexahedra elements (quadrangles in 2D)
• Lagrange high-order polynomial representation of elements
• Gauss-Lobatto-Legendre approximation used for integration of equations of motion
• Mass matrix diagonal by construction in SEM: reduces cost of calculations. Mode-summation and finite-difference modeling
• 3D fourth-order staggered grid finite-difference for modeling seismic motion and seismic wave propagation (Moczo et al, 2002)
• Mode-summation method is used to model wave propagation from source position to local 2D/3D irregularity. Path from source to irregularity is assumed to be flat, homogeneous layers.
• Finite-difference method is used in the laterally heterogeneous part of the model (Tamar rift valley). Spurious effects might be created due to the need to impose artificial boundaries to the model to save on CPU time and memory.

Conclusion

Analysis of microtremor data conventionally assumes a 1D homogeneous geology. This hypothesis does not hold in Launceston, Tasmania, due to the presence of the

Tamar rift valley. Amplification of seismic waves is thought to occur at Launceston due to patterns of earthquake damage in historic quakes. 2D site effects are suspected.

The expected pattern in H/V spectrum ratio can be used to identify these 2D effects in the Launceston area. SPAC measurements will be used to complete the study. Microtremor data acquired over Launceston will be used to assess modelling over 2D and 3D effects, using the SEM method and the joint mode-summation and finite-difference method.

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Michael L. Turnbull, publishing in ***Journal of Earth System Science***, May 2009, supports the methodology of site responsiveness to earthquakes with a adaptation of the ***Nakamura horizontal to vertical spectral ratio method***, and gives credit to such work as was done by Michael-Leiba M and Jensen V 1999 **Seismic Microzonation of Launceston, Tasmania.**

Turnbull says ***"The resulting microzonation maps indicate the relative seismic shaking vulnerability for built structures of different height categories within adjacent zones, with a resolution of approximately 1 km."***

Combining HVSR microtremor observations with the SPAC method for site resonance study of the Tamar Valley in Launceston (Tasmania, Australia)

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Summary

The presence of the deep and narrow Tamar Valley in the City of Launceston (Tasmania, Australia), in-filled with soft sediments above hard dolerite bedrock, induces a complex pattern of resonance across the city. Horizontal to vertical spectrum ratio (HVSR) microtremor observations are combined with 1-D shear wave velocity (SWV) profiles evaluated from spatially averaged coherency spectra (SPAC) observations of the vertical component of the microtremor wavefield to complete a site resonance study in a valley environment such as the Tamar Valley. Using the methodology developed in a previous paper, 1-D SWV profiles are interpreted from observed coherency spectra (axial-COH) above the deepest point of the Tamar Valley, using pairs of sensors spatially separated parallel to the valley axis. The 1-D SWV profiles interpreted at five sites suggest the depth to bedrock interface varies from approximately z= 25 m north of the city, to z= 250 m above the deepest point of the valley. Numerical simulations of the propagation of surface waves in a 2-D model representation of the Tamar Valley compare well with HVSR observations recorded on two profiles transverse to the valley axis. HVSR observations can identify the in-plane shear (SV) frequency of resonance above the deepest part of the valley on two separate profiles transverse to the valley axis. By computing the ellipticity curves from the preferred SWV profiles interpreted by the SPAC method, the antiplane shear (SH) modes of resonance expected to develop in the Tamar Valley are identified; modes which HVSR observations alone fail to locate with precision. HVSR observations suggest a complex mix of 1-D and 2-D patterns of resonance develops across the valley. The results from this paper suggest that HVSR microtremor observations can be combined with SPAC microtremor method to characterize the geology and the pattern of resonance in a 2-D narrow structure such as the Tamar Valley.

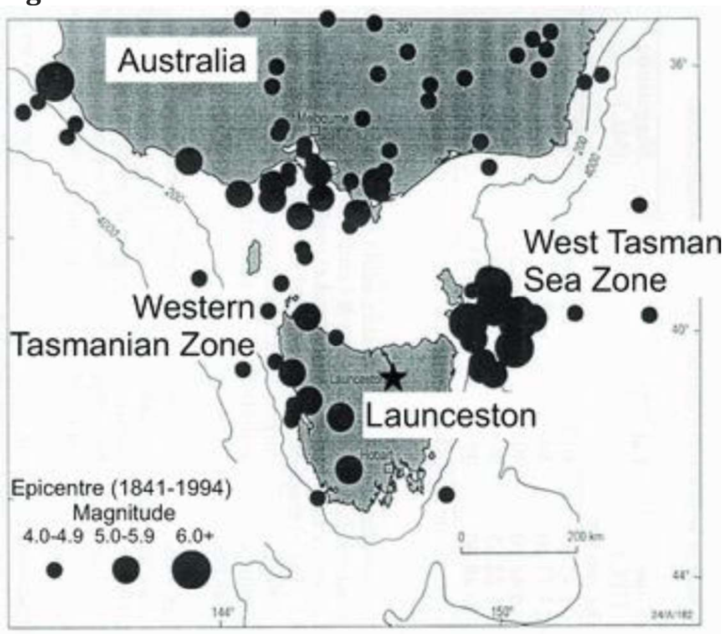
Numerical solutions, Surface waves and free oscillations, Site effects, Wave propagation, Australia
Issue Section:
Seismology

1 Introduction

The presence of low velocity sediments slows down the propagation of seismic waves generated by earthquake. It also induces amplification of the surface motion at a frequency of resonance proportional to the velocity and thickness of soft sediments above hard bedrock. Abrupt lateral variations of geology further amplify the surface motion and shift the frequency of resonance, generating a different pattern of resonance than expected above a layered earth. These local geology effects have significant importance when evaluating seismic hazard and seismic risk at specific sites (Horike 1985).

The situation of the City of Launceston (Tasmania, Australia) is an interesting example where such local geology effects are observed. While Launceston is not located in highly seismically active region (Fig. 1), damage has occurred to some buildings in the city from past earthquakes, which epicentres were located at more than 200 km from the city centre. Several hypotheses may explain the damages, including high vulnerability of the structure and complex pattern of resonance generated by abrupt changes in the near surface geology across the City of Launceston. While we do not discard the hypothesis of structure vulnerability, our study investigates the site resonance pattern expected to develop in the Tamar Valley.

Figure 1



Location of Launceston in Tasmania, Australia. Epicentres of earthquakes with Richter magnitude of 4.0+ around Tasmania from 1884–1994 (modified from Michael-Leiba 1995).

The recording of ambient ground vibrations, or microtremors, has proven to provide a good estimation of the frequency of resonance and shear wave velocity (SWV) structure to complete such hazard zonation studies (Horike 1985; Field 1996; Kudo *et al.* 2002). For the purpose of this study, we use the term microtremor for ambient vibrations of any sources, from low frequency natural phenomena to high frequency human activities.

Single station microtremor methods, such as the horizontal to vertical spectrum ratio (HVSR) and the standard spectral ratio (SSR), are commonly used to estimate the frequency of resonance of layered earth geology, and to generate earthquake hazard or expected ground motion zonation maps (Ibs-von Seht & Wohlenberg 1999; Parolai *et* *al.* 2002; Fäh *et al.* 2003; Mirzaoglu & Dýkmen 2003; Tanimoto & Alvizuri 2006). The efficiency and low cost of HVSR field survey make that method a popular choice for resonance and microzonation studies (Lachet & Bard 1994). The interpretation of HVSR observations gives an accurate estimate of the fundamental frequency of resonance of soft sediments over hard bedrock (Field & Jacob 1995).

Different patterns of resonance develop above complex geologies such as 2-D and 3-D valleys in-filled with soft sediments. Several studies were completed to analyse the generation and propagation of the different components of surface waves induced in valleys of various dimensions (Bard & Bouchon 1980a,b, 1985; Kawase & Aki 1989; Frischknecht & Wagner 2004).

Many authors have demonstrated the potential of single station microtremor methods to detect a 2-D pattern of resonance, and to identify the frequencies of resonance expected to develop in a valley environment. Steimen *et al.* (2003) used the SSR method to analyse the resonance effects from the St Jakob-Tüllingen and Vetroz valleys in Switzerland. Results from the Vetroz Valley were studied in further detail by Roten *et al.* (2006) to better distinguish between laterally propagating surface waves induced by a 1-D pattern of resonance and vertically propagating standing waves generated by a 2-D pattern of resonance. Uebayashi (2003) used HVSR observations to constrain the modelling of 3-D basin structures; comparing modelled HVSR, observed HVSR and theoretical Rayleigh wave ellipticity curves to analyse the complex geology across the Osaka Basin (Japan). Hinzen *et al.* (2004) used HVSR observations to map the changes in sediments thickness across the normal fault Lower Rhine Embayment (Germany). Cara *et al.* (2008) noted significant variations in HVSR measurements from 90 sites above alluvial sediments in riverbeds in the city of Palermo (Italy). Recently, Lenti *et al.* (2009) analysed 2-D site amplification in the Nera River alluvial valley (Italy), using SSR and HVSR observations from microtremor and earthquake weak ground motion. Barnaba *et al.* (2010) used HVSR observations to estimate sediment thickness (assuming 1-D geology) in irregular shape valley in the Friuli region (Italy), comparing with gravity interpretation and seismic refraction velocity profiles.

We record HVSR observations in Launceston to analyse the frequencies of resonance in and around the Tamar Valley in Launceston. The choice of the HVSR method rather than SSR was justified on the basis that HVSR observations do not require the use of a reference station on hard bedrock, whereas the distant location for a reference station relative to the other stations can violate the hypothesis of spatial stationarity of the microtremor wavefield.

Single station microtremor observations do not provide good estimates of the SWV structure of a soil (Asten *et al.* 2002; Chávez-García *et al.* 2007), an important parameter to evaluate for site hazard study. Several authors demonstrated that the reliability of site resonance studies is greatly improved by combining array based and single station microtremor observations to evaluate the SWV structure and the pattern of resonance. For example, Satoh *et al.* (2001) used HVSR observations at 48 sites to constrain SWV profiles evaluated by array based FK method at four sites in the Taichung Basin (Taiwan). Scherbaum *et al.* (2003) used the FK method to evaluate dispersion curves to constrain the velocity to depth dependence, and HVSR observations to constrain the layer thickness in the Lower Rhine Embayment (Germany). Parolai *et al.* (2005) proposed a joint inversion of HVSR and velocity dispersion curves, using fundamental and higher modes of propagation to determine the SWV structure by a genetic algorithm at a test site in the Cologne area (Germany). Similarly, using microtremor observations at four sites in the cities of Kushiro, Odawara, and Tokyo (Japan), Arai & Tokimatsu (2005) demonstrated that a joint iterative non-linear inversion of HVSR spectra and array derived velocity dispersion curves gives better results at evaluating SWV profiles than using velocity dispersion curves alone. Di Giulio *et al.* (2006) combined HVSR and FK observations in the Colfiorito Basin (Italy) to derive SWV profiles. Chávez-García *et al.* (2007) conducted a microzonation study of the city of Colima (Mexico) by combining HVSR observations at 315 sites with array based ReMi and spatially averaged coherency spectra (SPAC) microtremor methods at eight sites for improved resolution. Roten & Fäh (2007) concluded that the combined inversion of velocity dispersion curves obtained from the FK method, with 2-D frequencies of resonance evaluated from SSR observations, was a reliable method to evaluate SWV profile to bedrock interface in the Rhône Valley.

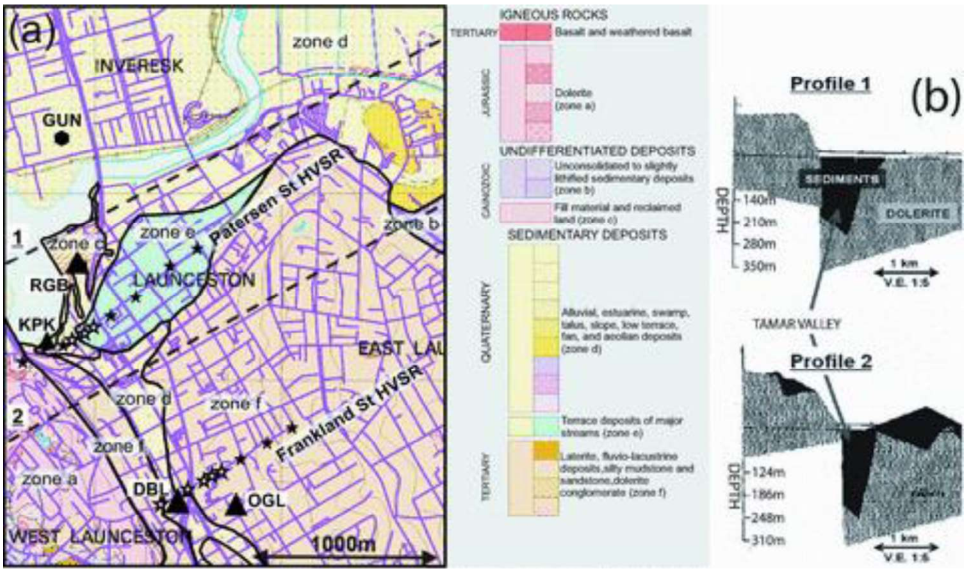
Several authors have analysed the use of array based microtremor methods in complex geology. For example, Cornou *et al.* (2003a,b) used the MUSIC algorithm with HVSR observations to identify the wavefield associated with site amplification in the Grenoble Valley (France), using an extensive array of 29 three-component seismometers with a total array aperture of 1 km. Hartzell *et al.* (2003) used the FK and MUSIC methods to detect edge generated surface waves with a dense array of 52 sensors in the Santa Clara Valley (USA), using site response spectra from earthquake generated motion to evaluate the SWV profile. Roten *et al.* (2006, 2008) used the FK method to identify the modes of resonance expected to develop in the Rhône Valley (Switzerland). Seismic noise tomography was used by Picozzi *et al.* (2009) to image shallow structural heterogeneities with an array of 21 geophones at the Nauen test site in Germany.

In this study, we present the results of a site resonance study conducted in and at the edge of the Tamar Valley in Launceston, combining the results obtained from HVSR and SPAC observations at separate sites. Until recently, the use of SPAC method was restricted to regions where the geology could be approximated by a layered earth geology. A methodology was developed in Claprood *et al.* (2011), paper subsequently referred to as CAK1, to permit the use of temporally averaged coherency spectra observations to evaluate SWV profile above the deepest point of a valley. Building on the results obtained in CAK1 at two sites DBL and RGB, we complete the site resonance study in Launceston by analysing SPAC observations at three additional sites (GUN, OGL, and KPK) to evaluate 1-D SWV profiles in and outside the valley. HVSR observations at all five sites are analysed to constrain SPAC observations and to evaluate the frequencies of resonance at separate sites in Launceston. Additional HVSR observations are recorded on two profiles transverse to the valley axis to identify the different modes of resonance which develop in the Tamar Valley.

2 Geophysical Settings

While other causes such as structure vulnerability are not excluded, we investigate the possibility that site amplification response due to local geology effects could induce the earthquake damages observed in Launceston. Information on the geology of Launceston is available from unpublished maps from Mineral Resources Tasmania, borehole logs held by the Launceston City Council, and a gravity survey completed by Leaman (1994). The geological map of Launceston presented in Fig. 2 outlines the rapid changes in surface geology in the Central Business District of Launceston, with the geological interpretation of two gravity profiles recorded across the valley.

Figure 2



(a) Map of surface geology of Launceston (modified from Mineral Resources Tasmania), divided into six zones by thick black lines. Triangles and hexagons are location of SPAC microtremor observations at sites GUN, RGB, KPK, DBL and OGL. Black stars: stations for HVSR profiles. White stars: projected stations for HVSR profiles. Dashed lines: location of two gravity profiles from Leaman (1994) which geological interpretation is presented on panel (b).

The area covered by this survey is topographically flat. The bedrock comprises dense, fractured and weathered Jurassic dolerite; which provides reduced seismic risk and excellent foundation conditions (Leaman 1994). It is covered by poorly consolidated materials, i.e. clays, sands, conglomerates, silts and fills which can be compressible, water saturated, plastic, and of low density. Quaternary alluvial sediments (silts, gravels, fills) were deposited in valleys floor and other marshy areas near sea level. These sediments have poor cohesion, negligible strength, and may be thixotropic. The ancient valley systems beneath Launceston are Tertiary rift valleys, filled with low density Tertiary sands and clays. A gravity interpretation (Leaman 1994) identified two palaeo-valley systems, i.e. the Trevallyn-Tamar lineament referred as the Tamar Valley in this paper, and the North Esk Palaeovalley, both trending in a NNW-SSE direction. The Tamar Valley is the focus of our research for it is more continuous and better defined than the North Esk Valley. Interpretation of the gravity survey indicates that the Tamar Valley has a width of 700 to 1000 m and an approximate maximum depth of 250 m.

Borehole logs, located at proximity to site DBL and in the northern part of Launceston (Inveresk, Fig. 2), are drilled to a maximum depth of 20 m, hitting hard dolerite bedrock in Inveresk only. The boreholes drilled at site DBL were terminated, for unknown reason, at depth less than 10 m in silty sand, interpreted to be the interface between Quaternary and Tertiary sediments. The interpretation of borehole logs gives little information about the geology inside the Tamar Valley. While the interpretation of the gravity survey from Leaman (1994) provides some knowledge about the extent of the soft sediments filling the Tamar Valley, it adds little information about the shear wave velocity inside the valley.

3 Geophysics Surveys

Prior to the first microtremor field survey completed in October 2006, some geophysical surveys have been completed to characterize the geology and to identify the frequency of resonance at several sites in Launceston. We briefly present the main conclusions interpreted from a gravity survey (Leaman 1994) and a microzonation project (Michael-Leiba 1995), which results suggested the need of acquiring additional microtremor observations in Launceston.

3.1 Gravity survey

The geological interpretation of two gravity profiles recorded across the city is presented in Fig. 2(b). The survey provided some evaluation of the geometry of the valley systems, and outlined the importance to complete a microzonation study in the city of Launceston to evaluate the frequency of resonance at separate sites in the city. We use this interpretation to constrain some SWV profiles recorded in Launceston, and to constrain the geometry of the Tamar Valley during the numerical simulations.

3.2 Microzonation project

The microzonation study was completed by Michael-Leiba (1995), by recording HVSR observations to estimate the natural period of resonance at 56 sites in Launceston. The observations were used to create two zoning maps of the city, depicting site soil factors and building height groups which may be affected by resonance.

The periods of resonance evaluated during this microzonation project present a large range of values (0.1–1.5 s), variations which do not always appear to fit the interpreted bedrock interface from gravity data (Leaman 1994). The hypothesis of multiple layering of sediments, non-uniformity of the layer with respect to shear-wave velocity, or departure from simplified layered earth geology were advanced by Michael-Leiba (1995) to explain these disagreements. We further investigate the hypothesis that 2-D effects generated by the presence of soft sediments in the Tamar Valley could explain some of these contradictory observations.

4 Site Resonance Study

We recorded array based SPAC and single station HVSR microtremor observations in and around the Tamar Valley to increase our knowledge of the pattern of resonance which develops in Launceston.

Two HVSR profiles transverse to the valley axis are used to identify the frequencies of resonance which are induced in the Tamar Valley. The SPAC method is used to evaluate the SWV structure above the deepest point of the valley, which is used to compute the Rayleigh wave ellipticity curve. The peak of the ellipticity curve is an estimation of the expected frequency of resonance *fh* when assuming a layered earth geology. Using a model developed by Bard & Bouchon (1985), we compute the frequencies of all expected modes of resonance in the Tamar Valley using the SWV information from SPAC interpretation and the frequencies of resonance observed from the HVSR profiles. Both sets of observations (SPAC and HVSR) are needed to complete the site resonance study of the Tamar Valley because: (1) HVSR observations can not resolve for all modes of resonance, and (2) the modes of resonance computed from the SWV determined by the SPAC method need validation from HVSR profiles at different points across the valley. Numerical simulations of the propagation of surface waves in a 2-D model representation of the Tamar Valley are completed to confirm the interpretation of microtremor observations recorded in Launceston, and to better define the geometry, geology, and modes of resonance of the valley.

4.1 SPAC method

The SPAC method was introduced by Aki (1957) under the name spatial autocorrelation method. Assuming the spatial and temporal stationarity of microtremors, coherency spectra are evaluated between all pairs of sensors in an array. The spatially averaged coherency spectrum $C(f)$ is computed for multiple inter-station separations as:

1

where J_0 is the Bessel function of first kind and zero order, k is the spatial wavenumber at frequency f, r is the interstation separation, and $V(f)$ is the S-wave velocity dispersion function of a layered earth model, which SWV profile is evaluated (Aki 1957; Okada 2003; Asten 2006a). While Aki (1957), Fäh *et al.* (2007), and Köhler *et al.* (2007) demonstrated the potential of using vertical and horizontal components of the microtremor wavefield (method referred as the 3cSPAC), the vertical component alone is used in this project for its simpler processing. Observed coherency spectra are directly fit to theoretical coherency spectrum (COH) by least-square optimization (Herrmann 2002) to evaluate the SWV to depth profile, as proposed by Asten *et al.* (2004). The domain of validity of the frequency interval to interpret SPAC observations with an array of sensors is still debated in the literature (Henstridge 1979; Okada 2006; Asten 2006a,b; Ekström *et al.* 2009). We select the interval of valid frequencies on a case-by-case scenario from the analysis of the microtremor wavefield. The valid frequency range is identified on each selected sites on the coherency spectra.

When the hypothesis of a layered earth is not valid, suggesting the presence of 2-D effects from the valley, we use the methodology developed in CAK1 to identify the patterns of resonance and evaluate 1-D SWV profiles from microtremor observations recorded in a valley environment. The coherency spectra observed with pairs of sensors with separation parallel to the valley (axial-COH) of the vertical component alone is fit to the theoretical coherency spectrum to evaluate the depth to bedrock interface above the deepest point of the valley. The use of single pair of sensors to evaluate the coherency spectrum, replacing the spatial averaging by temporal averaging and increasing the length of the microtremor time series, has been validated by different studies (Aki 1957; Capon 1973; Morikawa *et al.* 2004; Chávez-García *et al.* 2005; Claprood & Asten 2010).

4.2 HVSR method

The HVSR, introduced by Nogoshi & Igarashi (1971) and popularized by Nakamura (1989), provides a good estimate of the natural frequency of resonance of soft sediments over hard bedrock (*fh*). In a layered earth geology, the HVSR peak is empirically found to be a reliable estimation of the Rayleigh wave ellipticity R_0 (Lachet & Bard 1994; Tokimatsu 1997; Scherbaum *et al.* 2003), where the shape of the elliptical motion is determined by the shear wave frequency of resonance in particular, and more generally by the elastic parameters of the earth. In a typical interpretation sequence, Rayleigh wave ellipticity curves are computed from the SWV profiles evaluated by the SPAC method. At the shear wave frequency of resonance of an assumed layered earth, the Rayleigh wave's elliptical motion tends to degenerate into a dominantly horizontal motion (Asten *et al.* 2002), showing a peak on the ellipticity curve.

An intricate pattern of resonance develops across a valley in-filled with low velocity sediments. Surface waves bounce back and forth from the edges of the valley, creating interference and inducing a pattern of resonance different than that expected over a layered geology. A 2-D pattern of resonance develops in deep and narrow valleys. A critical shape ratio was expressed by Bard & Bouchon (1985) to better define the conditions of formation of 1-D and 2-D patterns of resonance with respect to the dimensions of the valley. The shape ratio of a valley is defined as the ratio between the maximum thickness of sediments H to the half-width w of the basin (the length over which the local sediments thickness is greater than half the maximum thickness H).

Different modes of resonance develop in a valley, shifting the frequency of resonance to higher frequencies when compared to its equivalent layered geology. Bard & Bouchon (1985) recognized the SH mode of resonance excited by the axial component of horizontal motion (parallel to the valley axis), and the SV and P modes of resonance excited by the transverse component of horizontal motion (perpendicular to the valley axis) and the vertical component of motion. The theoretical SH and SV modes of resonance are expected at frequencies:
where *fh* is the frequency of resonance of an equivalent layered earth, *m* and *n* are the number of nodes in the vertical and horizontal standing modes, respectively. By decomposing the horizontal microtremor time series into its axial and transverse components of motion relative to the valley axis, we seek to detect these theoretical frequencies of resonance on HVSR observations recorded in the Tamar Valley in Launceston. At a qualitative level, a difference in observed HVSR frequency maxima for axial and transverse components of motion can be an indicator of 2-D effects in the geology. Where the different frequency maxima are resolvable, we are able to make quantitative conclusions on the nature of a 2-D valley.

5 Microtremor Observations

Microtremor observations were recorded in October 2006 and 2007 in the city centre of Launceston. We used seven vertical component Mark L28—4.5 Hz cut-off frequency sensors to record SPAC observations; and one three-component Mark L4C—1 Hz cut-off frequency geophone to record HVSR observations at the centre of each array during the 2006 field survey. Two 5 min time series were recorded at each site. To gain sensitivity at depth, we used four three-component Guralp CMG-3ESP—30 and 60 s period geophones to record SPAC and HVSR observations in 2007. Observations were recorded with time series of 20 to 30 min, sufficient to ensure reliability in the observed coherency spectra computed with a limited number of sensors (Chávez-García & Rogríguez 2007; Chávez-García *et al.* 2007; Claprood & Asten 2010) and to significantly reduce the statistical variability of microtremor observations (Picozzi *et al.* 2005).

The time series are divided into 80-s time segments, with 50 per cent overlap, weighted with a Hanning bell, and fast-Fourier transformed in the frequency domain to obtain the raw spectra *Si*(*f*) of microtremor energy at every sensor *i*. HVSR or SPAC processing were then computed on every time segment, from which the temporal average over all time segments was evaluated.

The SPAC results for sites DBL and RGB have been used in CAK1 to develop the methodology permitting the use of the SPAC method in valley environment. We now include three additional sites (KPK, GUN, OGL), integrating HVSR data with the SPAC data for identifying perturbations attributable to the 2-D geology. The location of the sites GUN, RGB, KPK, DBL and OGL is presented in Fig. 2(a). Two HVSR profiles are also recorded transverse the Tamar Valley along Paterson and Frankland Streets to analyse the frequencies of resonance across the valley.

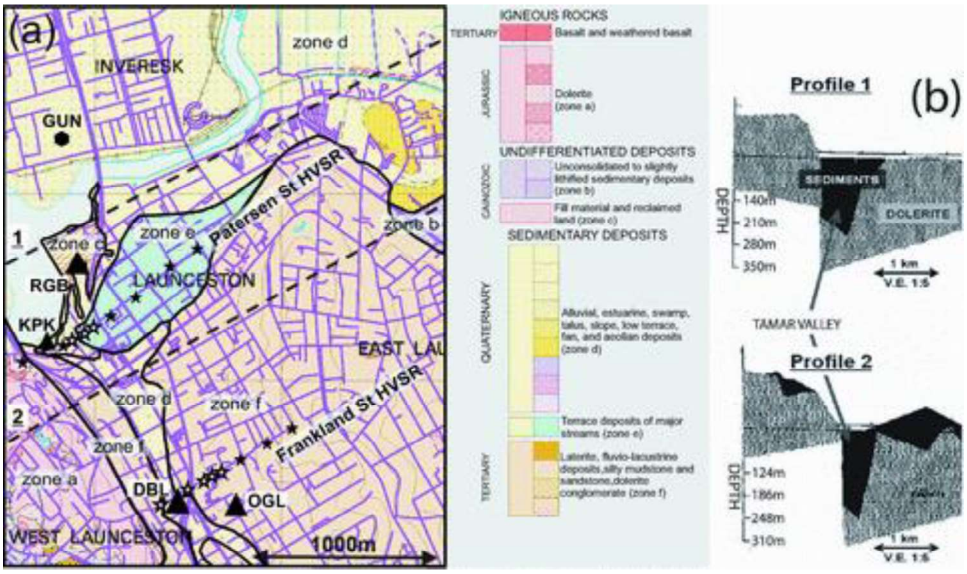
5.1 SPAC observations

The complex coherency spectrum *Cij* (*f*) between each pair of sensors (*i*, *j*) is computed using the equation:

4

where * denotes complex conjugate. Complex coherency spectra are averaged over all time segments to yield the temporally averaged coherency spectrum at each pair of sensors. The abbreviation COH is used for coherency spectrum throughout this paper. SPAC are computed by averaging over azimuth for all interstation separations possible from the array geometry. We used centred hexagonal arrays of n= 6 sensors during the 2006 field survey and centred triangular arrays of n= 3 sensors during the 2007 field survey. The geometry of both arrays is presented in Fig. 3.

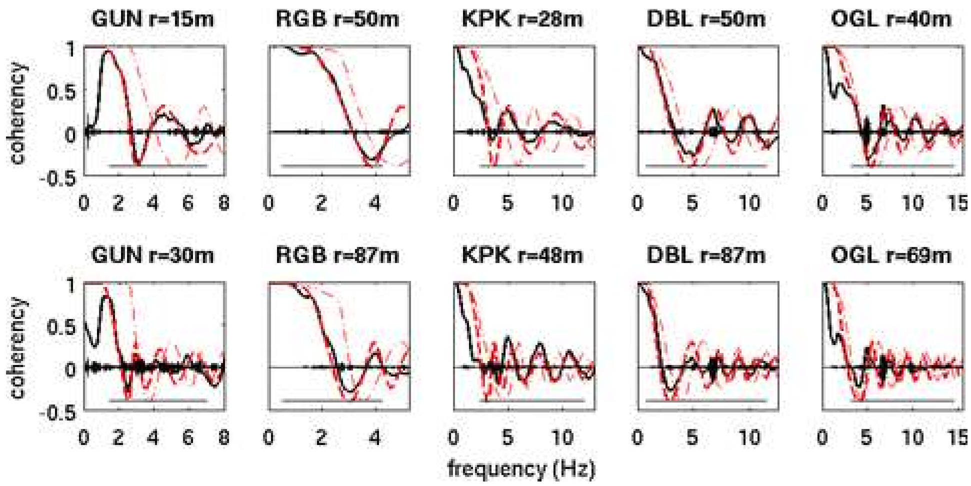
Figure 3



Common SPAC array geometries. (a) Centred hexagonal array of six stations with four interstation separations r_1, r_2, r_3 and r_4. (b) Centred triangular array of three stations with two interstation separations r_1, r_2.

The coherency spectra observed at all five sites in Launceston are presented in Fig. 4 for all pairs of sensors of selected interstation separations, along with the spatially averaged coherency spectra recorded at five sites in Launceston and the theoretical coherency spectrum computed from the preferred SWV profile at each site.

Figure 4



Best-fit coherency models at five sites for selected interstation separations. Hexagonal arrays used at sites GUN and KPK, sum of two triangle arrays with pair of sensors XA oriented axial and transverse to valley axis used at sites RGB, DBL and OGL. Thick black curve is real component of observed spatially averaged coherency spectrum (COH). Bars are roughened imaginary component of observed COH. Thick dashed red curve is the theoretical COH for the fundamental mode Rayleigh wave, for the preferred SWV layered earth model. Dash–dotted red curve is the theoretical COH for the 1st higher mode Rayleigh wave. Straight line at bottom of each graph shows the frequency interval over which the theoretical COH is fitted to the observed COH.

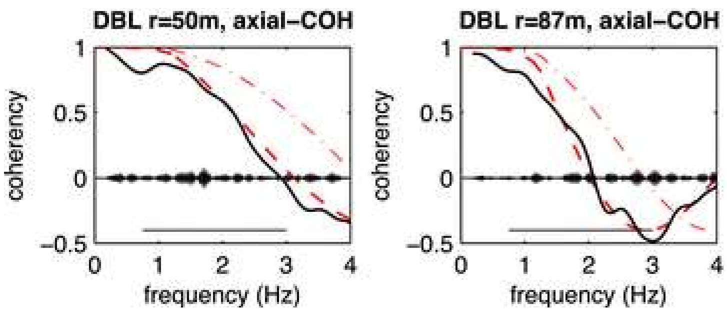
Coherency spectra were recorded with two centred hexagonal arrays of 15 and 30 m radius at site GUN. The SWV profile was evaluated by fitting the theoretical coherency spectra to the observed SPAC for frequencies $1.5 \leq f \leq 7.0$ Hz. The observed SPAC agree well with the theoretical coherency spectra, and the SWV profile evaluated compares well with the borehole logs obtained from the Launceston City Council.

The site RGB is located above the eastern flank of the Tamar Valley. Previous analysis of SPAC observations at site RGB in CAK1 suggested a directionality of the microtremor wavefield (Claprood & Asten 2010), which was not induced by 2-D resonance from the Tamar Valley (CAK1).

The site KPK is assumed to be located above the deepest point of the valley (Leaman 1994). Observed coherency spectra at site KPK are analysed over an extended frequency interval ($2.5 \leq f \leq 12.0$ Hz) with a 28 m radius centred hexagonal array in 2006 and two 28 m radius centred triangular arrays in 2007. The bedrock interface is not detected with SPAC observations alone due to the small array size; HVSR and gravity interpretation were used as constraints to fix the depth to bedrock interface at site KPK.

The site DBL is assumed to be located above the deepest point of the Tamar Valley at approximately 1 km southeast of site KPK. A 20 m radius centred hexagonal array was used in 2006 to resolve the shallow layers (Claprood & Asten 2008a). This site was revisited in 2007 with two 50 m radius centred triangular arrays for improved resolution at depth. As outlined in CAK1, different behaviours were detected on the coherency spectra observed at low frequencies with the 50 m radius array with respect to azimuth. Following the methodology developed in CAK1 concerning the use of the SPAC method in a valley environment, only the axial-COH was used to evaluate the depth to bedrock interface at site DBL. The coherency spectra observed on other pairs of sensors are affected by the 2-D resonance pattern, and could not be used to interpret a 1-D SWV profile at site DBL. Fig. 5 presents the fit between the theoretical coherency spectra and observed axial-COH at site DBL for interstation separations r_1= 50 m and r_2= 87 m on the frequency interval 0.75 ≤f≤ 3.0 Hz.

Figure 5

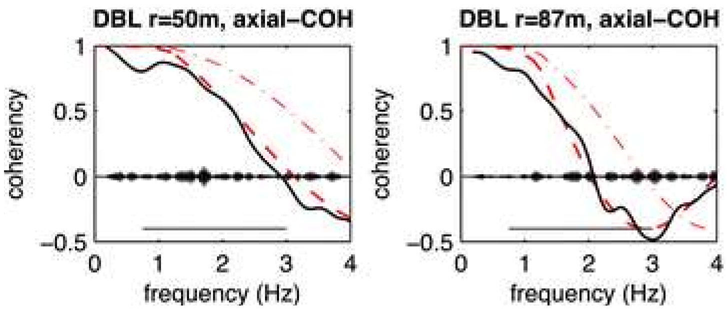


Best-fit coherency model at site DBL between theoretical coherency spectrum (thick dashed red curve for fundamental mode, dash–dotted red curve for 1st higher mode) and observed axial-COH (thick black curve) for interstation separations r_1= 50 m and r_2= 87 m on frequency interval 0.75 ≤f≤ 3.0 Hz.

Observed coherency spectra at site OGL, located on the eastern flank of the Tamar Valley, show poor resolution at low frequency, and were used in combination with HVSR observations to resolve the bedrock interface at this site. The depth to bedrock of the SWV profile was adjusted so the peak of the ellipticity curve, computed from SPAC observations, would match the frequency of resonance observed on HVSR data.

Conversely to Di Giulio *et al.* (2012) who explored the whole model space by ranking the best classes of models for the inversion of surface-wave dispersion inversion, we only present the preferred SWV profiles (thick lines) and the 20 per cent lower and upper bounds in sediments thickness (dashed lines) evaluated at all five sites (Fig. 6). We believe our approach is sufficient to analyse and differentiate the impact of the complex geology such as the Tamar Valley on SPAC and HVSR observations. Fig. 6 outlines the variability in the shear wave velocity structures interpreted at different locations within the city of Launceston. The bedrock interface is interpreted to be at $z \simeq$ 25 m at site GUN, and deeper than 200 m at sites KPK and DBL (Fig. 6). This explains the large range of periods of resonance recorded by Michael-Leiba (1995) over the city. The interpreted 1-D SWV profiles are used to compute the expected frequencies of resonance at these five separate sites in Launceston.

Figure 6



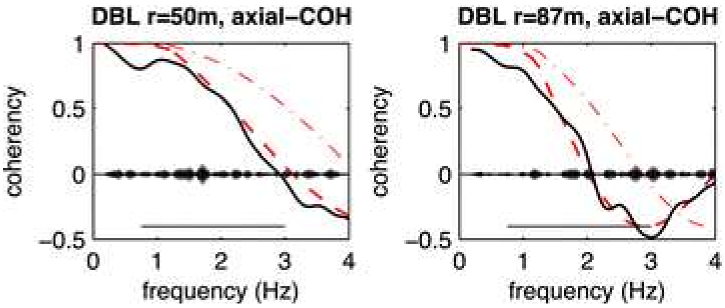
Thick lines: preferred SWV profiles evaluated at at sites GUN, RGB, KPK, DBL and OGL from SPAC observations. Dashed lines: lower and upper bounds on sediment thickness of preferred SWV profiles by adjusting layers thickness by ±20 per cent.

5.2 HVSR observations

Horizontal to vertical spectrum ratios are computed to estimate the frequency of resonance at separate sites in Launceston. The sensors are oriented to record the horizontal components parallel and perpendicular to the valley axis to identify the and frequencies of resonance which develop in a valley (Bard & Bouchon 1985; Steimen *et al.* 2003; Roten *et al.* 2006). We use the term axial-HVSR for HVSR computed with the axial horizontal component to the valley axis, and to the term transverse-HVSR for HVSR computed with the transverse horizontal component. For the example of a valley striking north-south, we compute HVSR as:
where is the north-south (axial in Launceston) component of horizontal power spectrum, is the east-west (transverse in Launceston) component of horizontal power spectrum, and is the vertical microtremor power spectrum.

We present HVSR observations recorded at the centre sensor of all SPAC arrays in Fig. 7. HVSR observations are compared to the Rayleigh wave ellipticity computed from the 1-D SWV profiles evaluated at all sites (Fig. 6).

Figure 7

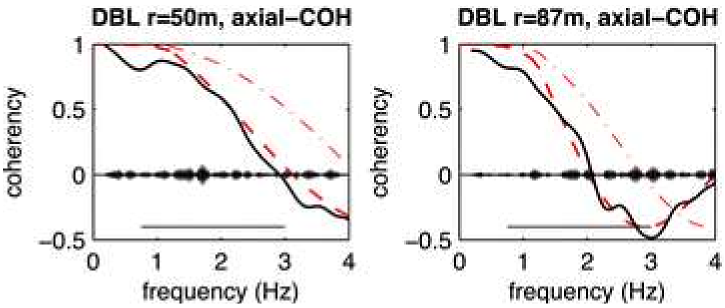


HVSR observations at all five sites. Thick black solid line is conventional HVSR; blue line is axial-HVSR; green line is transverse-HVSR; thick red and yellow lines are Rayleigh wave ellipticity curve of fundamental mode R_0 and first higher mode R_1 from the preferred SWV profile at each site; thin red and yellow lines are R_0 and R_1 from the lower and upper bounds of SWV profiles.

Different behaviours are observed on the HVSR curves depending on the site analysed. Conventional, axial and transverse-HVSR all agree well with the Rayleigh wave ellipticity curves computed at sites GUN, RGB and OGL. A sharp peak is recognized on HVSR observations at *fh*= 1.18 Hz at site GUN, and at *fh*= 1.31 Hz at site RGB. It is interesting to note the frequency of resonance is lower at site GUN than at site RGB, despite a much shallower bedrock interface (SWV profiles, Fig. 6). Sediments of very low velocity at site GUN are thought to be the main cause of such a low frequency of resonance. The frequency of resonance is estimated at *fh*= 0.87 Hz from HVSR observations at site OGL.

Despite the fact that the sites RGB and OGL are assumed to be located within the Tamar Valley, they do not show 2-D frequencies of resonance. We propose the hypothesis that the east flank of the valley is dipping at such low angle that the geology can be approximated by a layered earth for microtremor studies at these sites. This hypothesis of a layered earth does not hold true above the deepest point of the valley, where a separation of the modes of resonance is observed at sites KPK and DBL. At both sites, the peaks are located at different frequencies on axial-HVSR and transverse-HVSR; at higher frequency than the expected frequency of resonance *fh* computed from the ellipticity curve from SPAC observations by considering a layered earth. Fig. 8 better expresses that difference by zooming on the HVSR curves at sites KPK and DBL around their frequencies of resonance.

Figure 8



HVSR observations at sites KPK and DBL around the frequencies of resonance. Same legend as Fig. 7.

The difference in behaviour observed on the axial and transverse-HVSR is typical of the separation of modes of resonance expected in deep and narrow valleys. The frequencies of resonance on the axial-HVSR and Hz on the transverse-HVSR at site KPK; and Hz and Hz on the axial-HVSR, and Hz on the transverse-HVSR at site DBL were identified in Claprood & Asten (2008b).

We observe that the uncertainty in the 1-D SWV profiles can not explain the discrepancy observed between the ellipticity curves and HVSR observations at sites KPK and DBL. A significant change in the sediment thickness can not explain the separation in the frequency of resonance regarding to the orientation of the horizontal components. Similar analysis is also true concerning the higher modes of propagation, which affect both horizontal components by the same amount. This is not observed on HVSR curves, where the horizontal components are shifted differently depending on their orientation.

6 Tamar Valley Characterization

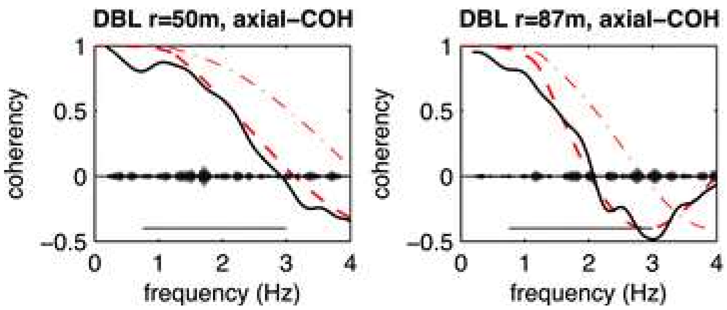
Building on the SPAC and HVSR results obtained at five separate sites, we complete the site characterization study of the Tamar Valley by recording two HVSR profiles transverse to the valley axis. The first profile runs along Paterson Street, at proximity to the sites KPK and RGB, while the second profile runs along Frankland Street at proximity to the sites DBL and OGL (Fig. 2a).

Axial- and transverse-HVSR profiles are constructed by presenting the observed HVSR curves side by side with respect to the distance from the western edge of the valley. A grey tone contour map is generated from the traditional HVSR observations. Each HVSR curve is normalized so its peak is fixed to a value of 1. This normalization was completed to present a smoother map of HVSR observations, and to better observe the variations in the pattern of resonance across the Tamar Valley. It is commonly accepted that, while HVSR observations are reliable to evaluate the frequency of resonance, their amplitude does not give an accurate estimation of the actual site amplification (Lachet & Bard 1994; Dravinski *et al.* 1996), which justifies the normalization process.

6.1 Paterson Street HVSR profile

The Paterson Street profile is formed from HVSR observations recorded at different sensors at site KPK and additional stations along Paterson Street. The axial-HVSR and transverse-HVSR profiles on Paterson Street are presented in Figs 9 and 10.

Figure 9



Observed axial-HVSR profile recorded across the Tamar Valley along Paterson Street. The contour map shows amplitude of HVSR (white is maximum) as a function of position and frequency. Expected frequencies of resonance *fh* from Rayleigh wave ellipticity at site KPK, and , , and computed from Bard and Bouchon's model (eq. 2) are shown as vertical dashed lines. Circles on the right are the location of HVSR observations along the profile. Left: model representation of the Tamar Valley along Paterson Street used in the numerical simulations.

Observed transverse-HVSR profile recorded across the Tamar Valley along Paterson Street. Expected frequencies of resonance *fh* from Rayleigh wave ellipticity at site KPK, and computed from Bard and Bouchon's model (eq. 3) are presented. Left: model representation of the Tamar Valley along Paterson Street used in the numerical simulations.

Combining all geophysical information (gravity interpretation, SPAC and HVSR), we evaluate the geometry of the valley along Paterson Street profile. The maximum depth to the bedrock interface is fixed at H= 230 m from gravity interpretation (Leaman 1994). The width at half-depth is evaluated at w= 500 m to match most observed HVSR peaks to the expected frequencies of resonance of modes SH and SV. These expected frequencies of resonance are computed by the Bard and Bouchon's model using the ellipticity curve from SPAC observations. A shape ratio of SR= 0.46 is computed for the Tamar Valley along Paterson Street. The expected frequencies of resonance of modes SH and SV are annotated on Figs 9 and 10.

The peak on the axial-HVSR profile on Paterson Street is located at f= 0.90 Hz. This is significantly higher than the expected frequency of resonance for an equivalent layered earth (fh= 0.74 Hz), and is located between the expected Hz and Hz frequencies of resonance. A double peak feature is observed at f= 1.27 Hz on axial-HVSR and on the transverse-HVSR profile (Fig. 10). We suggest this peak corresponds to a 1-D frequency of resonance above the flank of the valley. A 1-D frequency of resonance was identified at fh= 1.31 Hz from HVSR observations at site RGB which is located at similar distance to the edge of the valley, supporting this hypothesis. Such complex spectral resonance in a valley environment, including a mix of 1-D and 2-D patterns of resonance, has been recognized by Lenti *et al.* (2009). The peak located at f= 1.16 Hz above the deepest point of the valley at x= 250–300 m on the transverse-HVSR profile on Paterson Street (Fig. 10) agrees well with the expected Hz computed from Bard and Bouchon's model.

6.2 Frankland Street HVSR profile

HVSR observations recorded at selected sensors from the SPAC arrays at sites DBL and OGL and additional stations are used to construct this HVSR profile across the Tamar Valley, located approximately 1 km southeast of the Paterson Street profile. The HVSR stations from the site OGL are projected parallel to the valley axis to correctly evaluate the distance from each station perpendicular to the edge of the valley. The profile contains a total of ten stations, unequally spaced. Figs 11 and 12 present the Frankland Street axial-HVSR and transverse-HVSR profiles. An expected 1-D frequency of resonance of fh= 0.61 Hz is evaluated on the ellipticity curve computed from SPAC observations at site DBL. The peaks identified on HVSR profiles in Figs 11 and 12 are clearly located at higher frequencies.

Observed axial-HVSR profile recorded across the Tamar Valley along Frankland Street. Left: model representation of the Tamar Valley used in numerical simulations.

Combining the SWV profiles obtained by the SPAC method and observed frequencies of resonance observed on HVSR data is necessary to evaluate the geometry of the valley along this profile. The maximum sediments thickness is evaluated at *H*= 250 m from axial-COH interpretation at site DBL while the numerical simulations of the valley presented in the Section 6.3 allows to determine the width at half-depth (*w*= 421 m) by fitting the expected and observed frequencies of resonance from HVSR profiles.

We observe a peak at *f*= 0.90 Hz on the axial-HVSR profile above the deepest point of the valley in Fig. 11. This frequency approximately equals that of the computed Hz. SH modes of resonance of higher order could not be detected on the axial-HVSR profile.

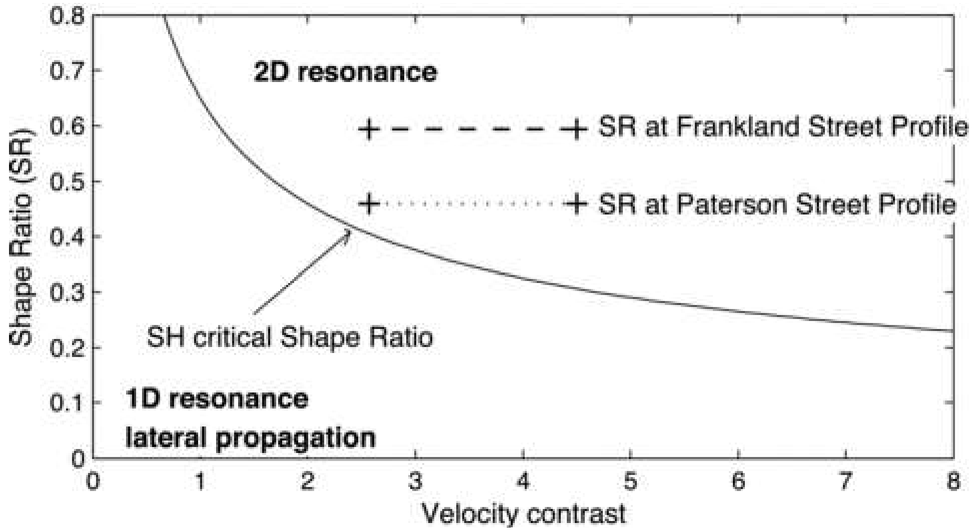
On the transverse-HVSR profile (Fig. 12), a clear peak is identified at frequency *f*= 1.18 Hz above the deepest point of the valley, which corresponds to the expected frequency of resonance Hz. This peak, along with the peak observed on axial-HVSR at *f*= 0.90 Hz (Fig. 11), suggests the presence of a 2-D pattern of resonance above the deepest part of the Tamar Valley.

A peak is also identified at location *x*= 450 m above the gently dipping flank of the valley, which location corresponds to the site OGL. A 1-D frequency of resonance was previously identified at *fh*= 0.87 Hz on HVSR observations and the ellipticity curve computed from the preferred SWV profile at site OGL. This suggests the resonance behaviour above this side of the valley reacts as a layered earth geology; in a similar pattern than was previously observed on the HVSR profile along Paterson Street.

We note a significant change in the pattern and frequencies of resonance on the axial- and transverse-HVSR profiles at $x \simeq 500$ m. HVSR data show a peak at constant frequency $f \simeq 3.5$ Hz on both profiles for $x > 550$ m. This suggests the geology east of the Tamar Valley can be approximated by a layered earth.

Fig. 13 presents the shape ratio of the valley computed along Paterson and Frankland Street profiles. The shape ratios computed on both profiles are plotted against the critical shape ratio of the SH mode of resonance in Fig. 13. It shows that a 2-D pattern of resonance is expected to develop in the Tamar Valley along both profiles when considering the SH mode of resonance, which confirms the results obtained with HVSR observations. The velocity contrast was computed for a dolerite bedrock shear wave velocity estimated at 1800 m s^{-1}, and Tertiary sediments shear wave velocity of 400 to 700 m s^{-1}, evaluated on the 1-D SWV profiles at sites KPK and DBL.

Figure 13



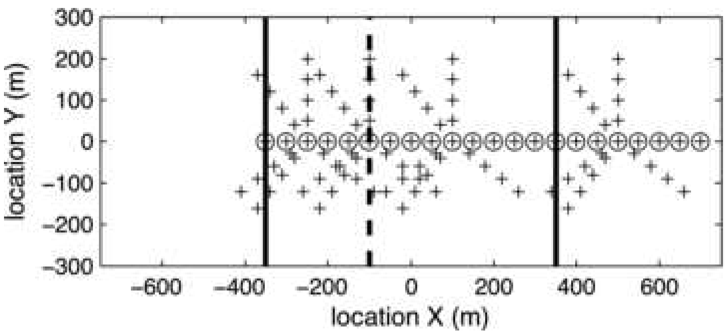
Shape ratio (SR) computed for the Tamar Valley in function of velocity contrast along Frankland Street Profile (dashed line with crosses, *H*= 250 m, *w*= 421 m, for *SR*= 0.59), and along Paterson Street Profile (dotted line with crosses, *H*= 230 m, *w*= 500 m, for *SR*= 0.46). Velocity contrast is computed between bedrock velocity (1800 m s^{-1}) and minimum (400 m s^{-1}) and maximum (700 m s^{-1}) Tertiary sediments velocity from the SWV profiles evaluated at site DBL and KPK. Solid curve is the critical shape ratio of SH mode of resonance in function of velocity contrast (from Bard & Bouchon 1985).

6.3 Numerical simulations

We simulate the propagation of surface waves in complex geology to constrain the geometry and geology of the Tamar Valley. We use the program package NOISE developed within the European 5FP project 'Site Effects Assessment using Ambient Excitations (SESAME)' to complete the numerical simulations (Moczo & Kristek 2002). NOISE is designed to compute the propagation of seismic noise (microtremors) in 3-D heterogeneous geological structures with a planar free surface, from surface and near-surface random sources (Moczo & Kristek 2002). The package is divided in two main programs: Ransource for the random space-time generation of microtremor point sources and Fdsim for the computation of seismic wavefields in 3-D heterogeneous geological structures based on the finite-difference method (Moczo *et al.* 2002; Kristek *et al.* 2002, 2006; Moczo *et al.* 2007).

The 2-D model representation of the Tamar Valley is described in CAK1, to which the reader is referred to for additional information concerning the initial parameters used in the numerical simulations. We only model the Frankland Street profile because SPAC observations recorded above the deepest point of the valley along the Paterson Street profile (site KPK) do not offer adequate resolution of the depth to bedrock interface, an important constraint in the numerical simulations. Simulated three-component microtremor time series are recorded at a series of receivers positioned at 50 m spacing to construct a HVSR profile across the model representation of the valley (circles in Fig. 14). Additional simulated receivers were also positioned to record simulated SPAC data used in CAK1 (crosses in Fig. 14).

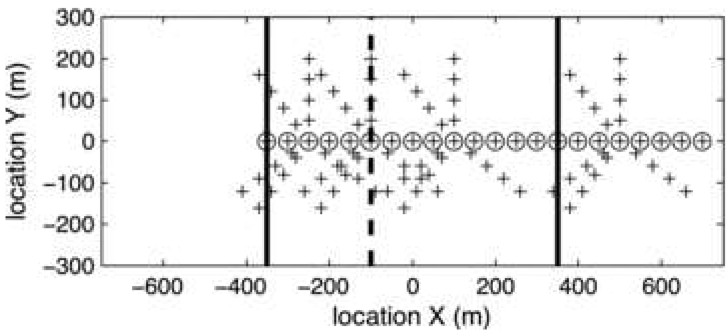
Figure 14



Location of all simulated receivers across the Tamar Valley. Crosses: receivers forming SPAC arrays. Circles: receivers for HVSR profile across the valley. Thick vertical solid lines are the edges of the valley. Thick vertical dashed line is the axis of the valley, at its deepest point.

The parameters of the model representation of the Tamar Valley are determined to fit HVSR and SPAC microtremor observations recorded along the Frankland Street profile. The SWV profile used in the simulations above the deepest point of the valley is an approximation of the SWV profile evaluated by the axial-COH method at site DBL (Fig. 15b). The geometry of the right flank of the valley is constrained by simulating HVSR measurements over a layered earth model, varying the depth to bedrock interface to fit SPAC and HVSR observations at site OGL, and HVSR observations at different stations on the Frankland Street profile. The SWV profile interpreted at site OGL, and its approximation used in the numerical simulations are presented in Fig. 15(c). The assumption of a layered earth on this flank of the valley is postulated by the behaviour of HVSR observations presented in Section 6.2.

Figure 15



(a) Bedrock interface of model representation of the Tamar Valley (vertical exaggeration of 2). Circles are locations of HVSR receivers. Dash–dotted line is bedrock interface interpreted from gravity survey by Leaman (1994) (Fig. 2b, Profile #2). Dashed lines are the location of SWV profiles presented in (b) for site DBL, and (c) for site OGL. Solid lines on SWV profiles are preferred SWV profiles from SPAC observations; dashed lines are SWV approximation used for the numerical simulations of the Tamar Valley.

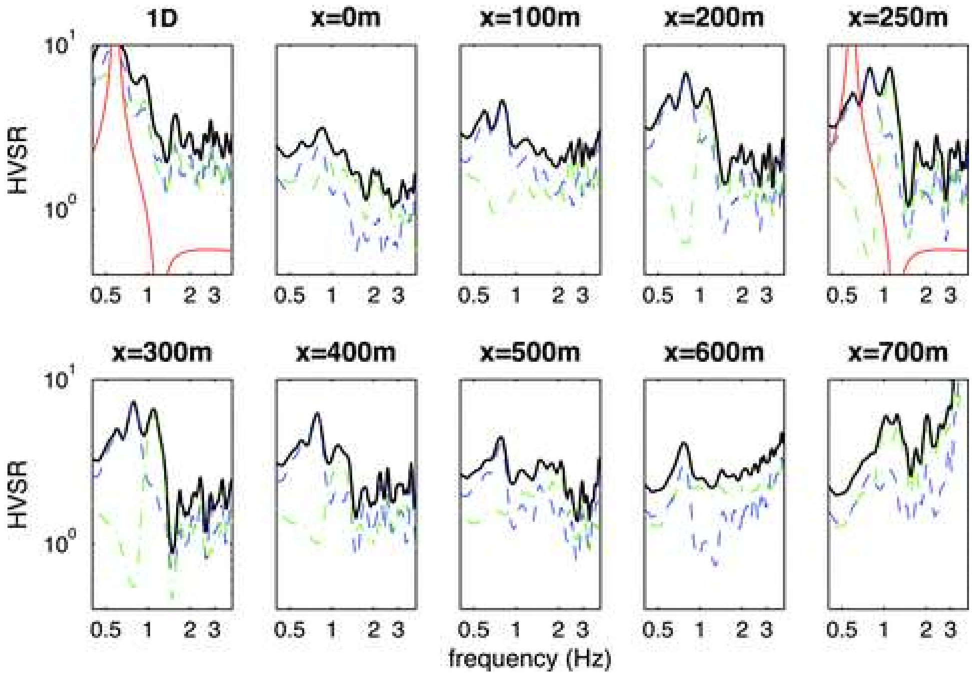
The 2-D model representation of the valley (Fig. 15a) is simulated by an exponential analytical expression inspired from Paolucci (1999), which parameters are described in CAK1. A layered earth with depth to bedrock *z*= 25 m is interpreted right of the valley from the HVSR profiles presented in Figs 11 and 12. The propagation of surface waves in a layered earth geology using the SWV profile above the deepest point of the Tamar Valley model (Fig. 15b) is also simulated to better understand the differences between HVSR observations in a layered earth and in a 2-D valley.

6.4 Simulated HVSR

Simulated HVSR curves are computed at all points across the valley. These are used to validate the frequencies of resonance which develop within the valley, and the variations of HVSR observations along the Frankland Street profile.

HVSR simulated at ten receivers are presented in Fig. 16. The top left panel presents the HVSR curves simulated for the equivalent layered earth, with the Rayleigh wave ellipticity curve computed from the SWV profile of Fig. 15(b). HVSR simulated at different locations across the valley are presented in the other panels with respect to the distance x to the left edge of the valley. The deepest point of the valley is located at x= 250 m.

Figure 16



Simulated HVSR above layered earth model (top left) of SWV profile from Fig. 15(b); and at distance x from the left edge of the 2-D model representation of the Tamar Valley. Thick solid black line is conventional HVSR; dashed blue line is axial-HVSR; dash–dotted green line is transverse-HVSR. Solid red line is the Rayleigh wave ellipticity computed assuming a layered earth model of SWV profile from Fig. 15(b). Rayleigh wave ellipticity is presented for location where the depth to bedrock interface is simulated at H= 250 m.

We observe some variability in the HSVR curves simulated above a layered earth and those simulated at different locations across the 2-D model representation of the Tamar Valley. HVSR peaks from all components (HVSR, axial-HVSR and transverse-HVSR) agree well with the peak on the ellipticity curve above a layered earth (Fig. 16, top left). We observe a separation of the peaks on simulated axial-HVSR and transverse-HVSR, indication of a 2-D pattern of resonance at distance 200 ≤x≤ 400 m from the edge of the valley. The peaks on simulated HVSR above the deepest point of the valley (Fig. 16, top right) are shifted to higher frequencies when compared to the peak on the ellipticity curve computed for an equivalent layered earth. A change in the pattern of resonance, similar to what was observed on the HVSR profiles recorded in Launceston, is observed between *x*= 400 m and *x*= 500 m, where the peak is unclear on simulated HVSR curves.

Simulated axial-HVSR and transverse-HVSR profiles are presented in Figs 17 and 18 to better identify the pattern of resonance which develops in the 2-D model representation of the Tamar Valley. The expected 1-D frequency of resonance for the equivalent layered earth (SWV profile from Fig. 15b) is computed at *fh*= 0.59 Hz. No peak is detected at this frequency on the simulated axial- or transverse-HVSR profiles. Using Bard and Bouchon's model with a shape ratio '*SR* = 0.59 (*H*= 250 m, *w*= 421 m), we seek to identify 2-D frequencies of resonance on the simulated HVSR profiles.

Simulated axial-HVSR profile across a 2-D model representation of the Tamar Valley (left). Expected frequencies of resonance *fh* from Rayleigh wave ellipticity from SWV profile presented in Fig. 15(b), and , and computed from Bard and Bouchon's model are presented. Circles on the right are the location of HVSR observations along the profile.

Simulated transverse-HVSR profile across a 2-D model representation of the Tamar Valley (left). Expected frequencies of resonance *fh* from Rayleigh wave ellipticity from SWV profile in Fig. 15(b), and computed from Bard and Bouchon's model are presented. Circles on the right are location of HVSR observations along the profile.

A broad peak is observed on the axial-HVSR profile at frequency *f*= 0.81 Hz, between the expected frequencies of resonance and Hz. Similar difficulties in precisely separating the multiple SH modes of resonance were recognized on the Paterson and Frankland Streets HVSR profiles. While simulated HVSR data fails to provide accurate detection of the different SH modes of resonance, it is effective in the recognition of a 2-D pattern of resonance; the peak on the axial-HVSR is located at frequency significantly higher than that of the equivalent layered earth.

The fundamental SV mode of resonance is accurately identified on the simulated transverse-HVSR profile (Fig. 18). The peak is observed at *f*= 1.11 Hz, approximately equal to the computed SV frequency of resonance Hz (eq. 3). This confirms the capability of the transverse-HVSR to identify the SV mode of resonance across a deep and narrow valley such as the Tamar Valley.

The peak on the transverse-HVSR is not well defined at locations *x*≥ 450 m, for which location the peak seems to follow more closely the shape of the valley. The results of the numerical simulations agree well with SPAC and HVSR observations recorded across the Tamar Valley in Launceston, and confirm the results of Lenti *et al.* (2009) concerning the possibility of developing a mixture of 1-D and 2-D patterns of resonance in a valley environment such as the Tamar Valley.

6.5 Frequencies of resonance

The site resonance study of Launceston is summarized in Table 1. The table lists the expected (from Bard and Bouchon's model), observed, and simulated frequencies of resonance at all five sites. The expected 1-D frequencies of resonance *fh* are interpreted from the peaks in the Rayleigh wave ellipticity curves computed from the preferred SWV profiles evaluated by the SPAC method. The expected SH and SV frequencies of resonance are computed from the eqs (2) and (3) of Bard and Bouchon's model, using the shape ratios evaluated on Paterson Street and Frankland Street profiles. The frequencies of resonance identified on HVSR observations at all five sites in Launceston are indicated in brackets. The frequencies of resonance computed and identified from the numerical simulations of the Tamar Valley model are presented in the right column of the table.

Table 1

Mode	GUN	RGB	KPK	DBL	OGL	Tamar
f_h	1.16 (1.18)	1.24 (1.31)	0.74 (–)	0.61 (–)	0.95 (0.87)	0.59 (–)
SH_{00}	–	–	0.83 (–)	0.71 (–)	–	0.68 (–)
SH_{01}	–	–	1.01 (0.90)	0.94 (0.90)	–	0.91 (0.81)
SH_{02}	–	–	1.27 (1.25?)	1.24 (1.20?)	–	1.20 (–)
SV_{fund}	–	–	1.24 (1.16)	1.21 (1.18)	–	1.17 (1.11)

Expected 1-D frequencies of resonance f_h computed on the Rayleigh wave ellipticity curves from the preferred SWV profiles, and SH and SV frequencies of resonance computed at separate sites in Launceston. Frequencies of resonance identified on HVSR observations at five sites in Launceston, and above the deepest part of model representation of the Tamar Valley are presented in brackets (frequency in Hz). The question mark '?' indicates these values are identified with low confidence on HVSR observations.

The site resonance study completed in Launceston verifies the existence of a complex pattern of resonance across the city of Launceston. A 1-D pattern of resonance is recognised at sites GUN, RGB and OGL where the peaks identified on HVSR observations agree well with the peaks on Rayleigh wave ellipticity curves. This result was expected at site GUN, which was assumed to be located above a layered earth, however it is a surprising result at sites RGB and OGL which are located within the limits of the Tamar Valley. As initially expressed by Bard & Bouchon (1985) and later observed by Lenti *et al.* (2009), certain valleys simultaneously develop 1-D and 2-D patterns of resonance. We suggest this is the case in the Tamar Valley, where a 2-D pattern of resonance is clearly recognized at sites KPK and DBL, located above the deepest point of the valley.

We observe from Table 1 that HVSR observations are adequate to identify the expected frequency of resonance in a layered earth, and the expected frequency of resonance in valley environment. Good fits are obtained between expected and observed at sites KPK and DBL above the deepest point of the valley. While HVSR observations can detect the shift in frequency induced by the SH mode of resonance, they fail to identify the expected SH frequencies with adequate precision. The frequencies of resonance of the SH mode can be estimated by using the peak of the ellipticity curve determined from SPAC observations, and computing the shifts to higher frequencies from Bard and Bouchon's model. Combining the results from SPAC and HVSR methods permits to get the complete picture of the site resonance study across the Tamar Valley.

7 Conclusions

We conducted a site resonance study at five separate sites in and around the deep and narrow Tamar Valley in the City of Launceston (Tasmania, Australia). We combine the use of the array based SPAC microtremor method to evaluate SWV profiles with single station HVSR microtremor observations to evaluate the frequency of all modes of resonance.

The SPAC method is conventionally applied to reliably evaluate the SWV profile at site GUN, located above an assumed layered earth. The frequency of resonance is identified at *fh*= 1.18 Hz from HVSR observations; frequency which agrees well with the expected frequency of resonance above a layered earth from the Rayleigh wave ellipticity curve computed at site GUN.

The interpretation of SPAC observations at sites RGB and OGL provides credible SWV profiles at both sites. While the gravity survey from Leaman (1994) suggests these sites are located in an area having 2-D geology, the similar behaviour of the observed coherency spectra when comparing different orientations suggests the geology can be approximated by a layered earth at both sites. This is confirmed by HVSR observations which peaks, identified at the same frequency on the axial and transverse components, agree well with the peaks on the Rayleigh wave ellipticity curves computed from the SWV profiles interpreted by SPAC method. HVSR measurements simulated in a 2-D model representation of the Tamar Valley confirm the presence of a 1-D pattern of resonance above the flank of the valley. The frequency of resonance identified on HVSR observations is estimated at *fh*= 1.31 Hz at site RGB, and at *fh*= 0.87 Hz at site OGL.

A 2-D pattern of resonance is detected above the deepest part of the Tamar Valley on two HVSR profiles recorded transverse to the valley axis along Paterson and Frankland Streets, as judged from the separation of SH and SV modes of resonance at sites KPK and DBL. The fundamental SV frequency of resonance is identified on the transverse-HVSR component at *f*= 1.16 Hz along Paterson Street profile and at *f*= 1.18 Hz along Frankland Street profile. While a shift to higher frequencies is clearly recognized on both axial-HVSR profiles, HVSR observations fail to identify with precision the SH frequencies of resonance expected to develop in the Tamar Valley.

SPAC observations recorded above the deepest point of the valley are used to constrain the SWV structure and geometry of the Tamar Valley, and to evaluate the different SH modes of resonance expected to develop in the valley. As originally proposed in CAK1, coherency spectra recorded with pairs of sensors oriented parallel to the valley axis (axial-COH) are used to evaluate the SWV profile above the deepest point of the valley at site DBL.

From Bard and Bouchon's model, we can evaluate the expected SH and SV frequencies of resonance in the Tamar Valley by computing the Rayleigh wave ellipticity curve from the SWV profile evaluated by axial-COH above the deepest point of the valley. The frequencies of resonance expected to develop across the Tamar Valley along Frankland Street are Hz, Hz, Hz and Hz.

We suggest the frequencies of resonance are shifted to slightly higher frequencies along the Paterson Street profile, but lack of resolution of the bedrock interface with SPAC observations limits the conclusions. Observations with larger SPAC arrays would be necessary to gain resolution at depth. Deployment of such arrays was made difficult by the layout of the streets of Launceston. The best estimates of the expected frequencies of resonance along Paterson Street profile are Hz, Hz, Hz and Hz.

The results demonstrate a successful application of combined SPAC and HVSR observations recorded at separate sites to conduct a site resonance study in a 2-D valley environment, where the use of both methods allows identification of the complex pattern of resonance (modes and frequencies of resonance) which develops in this narrow deep valley.

Acknowledgments

Maxime Claprood is supported by a Monash Graduate Scholarship, an International Postgraduate Research Scholarship, and a Québec's Funds for Nature and Technology Scholarship. Seismometers used in this project were loaned to Monash University by the Australian National Seismic Imaging Resource (ANSIR). We are grateful to the City Council of Launceston, for their assistance during field survey. Geological maps of Launceston were provided by Mineral Resources Tasmania. We would like to recognize the help of Miss Janett Steiner for her assistance during the field survey. Thanks are due to the editor Prof. Jean Virieux and Matteo Picozzi whose constructive suggestions helped improving the quality of the manuscript and our research in general.

NOTE : The test site denote KPK Figures 2 &3 is the are of the subject land Amendment 66.

Environmental hazards and constraints have not been properly identified nor addressed by the proponent. The proposed development site is situated on a narrow seismic plate between to seismic fault lines (one running parallel beside the abutments of Paterson Bridge, immediately on the east side of Ritchie's Mill along. Bourke Street via Glen Dhu St and beyond the former Coates Paton's building, and the other passing midway between Park and Margaret Streets and extending beyond the junction of Melbourne and Leslie Street in South Launceston. These particular fault lines are two of quite a number of faults crossing the Launceston area and accurately displayed on the Geological Survey of Launceston (part of the survey of Tasmania) conducted by Department of Mines, Tasmania Ref. 8315 S1 1 & 111 Zone 7 Sheet No.39). This seismic plate has dropped approximately 3OOm from the adjoining Trevallyn plate, and then the next eastern plate has dropped approximately a further 300m. We interpret this as showing the development siie being founded on a differing geological base of at least 300m compared.to adjacent foundation and with well-documented evidence of building damage having occurred in recent times (geologically speaking) along the course of Margaret Street. A copy of this reference is readily available and can be found in Council's own files.

ln 1965, as part of due diligence by engineers designing the Paterson Bridge, a Geophysical Survey of the bridge site was undertaken by the National Bureau of

Mineral Resources, Geology and Geophysics for the Commonwealth's Department of National Development (Ref Record No. 1965/153), pinpointing the location of the western-side fault line crossing the South Esk River at a point about 35m downstream of the old Kings Bridge. The decision was made to particularly position the new bridge abutments on just one side of the fault line, so as to attempt as much as possible to minimise the risk of a structural collapse.

In 1990 and with historical awareness from earlier studies and seismic events, the then LCC City Engineer commissioned Dr Owen lngles to carry out a seismic risk assessment for the Launceston Municipality, his report being submitted in March 1991. lngles considered four risk factors from potential earthquakes: fault displacement; landslide/landslip; sediment liquefaction; and fill settlement. The more recent 2006 GHD study notes the presence of fill and the potential for ongoing settlements" when undertaking an assessment of the stability of Launceston's flood levee system.

In December 1995, Dr Marion Leiba, Geologist, Geophysicist, Seismologist and much more, authored a report on behalf of Australian Geological Survey Organisation io Launceston City Council titled **Survey and Seismic Microzonation, Launceston Tasmania**. ln this report, she pointed out that Launceston had been damaged by 5 earthquakes in the West Tasman Sea (18B4, 1885, 1992, 1929 and 1946). The damage was thought to be caused by amplified earthquake shaking because of sediments and possibly other aspects of geology and topography in certain parts of Launceston. Consequently, zoning maps were prepared using microtremor measurements at 53 sites, a soils map by Steve Forsyth of Mineral Resources Tasmania, a gravity interpretation by David- Leaman, and unpublished drillhole data.

These maps showed areas of Launceston where amplified earthquake shaking may occur because of the presence of underlying sediments. Also resonance effects may increase the destructiveness of the earthquake. She explains in relation to the period of vibration of the ground, if matching that of a building above it, to be like a person pushing a swing higher and higher by matching the push to the moving swing. This resonance effect increases the likelihood of a building being damaged by an earthquake. She advises that one can lessen the chance of Earthquake Damage by avoiding erecting a building with a certain resonant period on a site within the same period.

Three groups of buildings were considered for the map: low rise (1-3 storeys), medium rise (4-9 storeys) and high rise (10+ storeys). Certain soil characteristics can give a more sophisticated method for computing the "period" of the building (when the natural 'period' of the ground matches the period of the building, probable maximum damage to the building occurs.

Seven zones on the **building heights earthquake zoning map** are:
ZONE 0. No resonance, but for other geological reasons, a response would be unknown.
ZONE 1-3 Possible resonance for 1-3 storeys (low rise buildings).
ZONE 1-5 Possible resonance for .1-5 storey buildings (a narrow NNW -SSE trending zone along the eastern side of the Tamar axis valley.

ZONE 1-9 Possible resonance for 1-9 storeys (low and medium rise buildings (Small zones on Windmill Hill and near Coronation Park).
ZONE ALL Possible resonance all buildings. (Tertiary sediment areas and in particular NE part of the North Esk axis and floodplain.....
ZONE 4+ Possible resonance for 4 or more storeys (high rise) buildings - mainly deep sediment fill in the Tamar and North Esk axis valleys and the Norwood area. Also on shallow floodplain sediments, including most of the old railyards......what a wonderful choice as the site for a new University....
ZONE 10+ Possible resonance for 10 or more stories (high rise) buildings - from gravity and soils map, to the east of the old rail yards.

The ongoing studies and assessments of various works and reports by Dr Ingles warned against building structures in Launceston higher than **4 storeys**.

It is our submission that the assessment of the environmental hazards and constraints for the proposed development site has not been adequately investigated nor has the associated risk of the Paterson St earth levee being breached by the combination of rising sea and silt levels (most recent advice to LCC is that even the newly reconstructed levees are now only 1:100 yr not 'l: 200 y. as proclaimed at the end of the reconstuction project in 2017) and the potential for a seismic event destabilising the levee as well as the proposed building, sufficient to potentially cause great public risk, notwithstanding potentially damaging the proposed structure itself.

The objectives of the LUPA Act includes for sustainable development whereby in Part 1 ***sustainable development*** is defined as managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well-being and for their health and safety while-
2(c) avoiding, remedying or mitigating any adverse effects of activities on the environment.
And in Part 2
(f) to promote the health and wellbeing of all Tasmanians and visitors to Tasmania by ensuring a pleasant, efficient and safe environment for working, living and recreation, and
(i) to provide a planning framework which fully considers land capability.

It is our general submission that CoL will fail its ratepayers, citizens and visitors to Tasmania should it allow this unstable, flood prone and undesirable land to be further developed with buildings constructed to a height of 43m, when prudent and feasible alternatives are available, elsewhere within the Central Launceston area, and land that does not suffer from an inability to be evacuated in the event of flooding, inundation by sea level rises or climate change or such dangers and risks being compounded by seismic activity.

MANAGEMENT OF RISK

"Hazard consideration at the strategic planning level is critical to determining whether the benefits of allowing consideration of development in certain areas subject, or likely to be subject, to a natural hazard outweigh the costs to the

community and individuals required to mitigate that hazard in the short, medium and long term. Other strategic planning issues need to be considered alongside the natural hazard issue to enable an informed judgement that is based on holistic planning and balancing social, economic and environmental benefits and costs. The strategic consideration of natural hazards could result in decisions about settlement planning, zoning, and the articulation of hazard layers through land use strategies. It can also provide an indication of the need to establish buffers, or areas of hazard expansion, over longer time frames than are expressed in planning schemes, which are generally focussed on a five to ten-year time frame. As the controls at this stage represent a 'first cut' of limitation on use and development, they can be seen as a trigger for more detailed assessment of the hazard risk, which can be more directly translated into use and development controls."

GUIDE TO CONSIDERING NATURAL HAZARD RISKS IN LAND USE PLANNING AND BUILDING CONTROL – Aug 2013 TRIM Ref 12/11/11634
Department Premier and Cabinet, Tasmania

Guide_to_consideri
ng_natural_hazards.

The management of risk-

- probable flood events
- land stability/seismic risk

importantly must take a precautionary approach. Accordingly, the limitation on building heights for any constructions located within the land area of this LPS Scheme amendment Ref SF7233 Amendment 66 Planning Scheme, must take these risks into account, and accordingly the limitation on building height must not exceed 12-14M.

This present Development Application is not supported by Tasmanian Ratepayers Association Inc.

The banner of RETREAT from building and retaining developments of flood plains that will be further impacted by climate change and rising sea levels and furthermore with seismic risks, could not be more solemn. The spectre of liability should this development be allowed to occur will be forever a dark cloud over the heads of Councillors and other Statutory Approval Authorities.

Accordingly, we implore that this Development Application, be refused, and instead the development site be expanded to include the adjoining RACT site so that a significantly lower and less controversial and lower-risk building can be constructed without risk of structural collapse due to a seismic event.

Yours faithfully,

Lionel Morrell

President
For and on behalf of
TASMANIAN RATEPAYERS ASSOCIATION INC.

From: "Bill Reynolds"[redacted]
Sent: Tue, 2 Nov 2021 14:40:08 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: DA0486 2021, Cimitiere St, Launceston.
Attachments: HPS Rep DA0486 2021 Cimitiere St Launceston 1 November 2021.pdf
Importance: Normal

You don't often get email from [redacted] Learn why this is important

HERITAGE PROTECTION SOCIETY (TASMANIA) INC.

[redacted]

1 November 2021

Mr Michael Stretton
General Manager
Launceston City Council
Town Hall
St John Street
LAUNCESTON TAS 7250

By email to Michael.stretton@launceston.tas.gov.au

Dear Sir,

Re: DA0486/2021. Business and Professional services, General Retail and Hire, Food Services - Construction of a mixed use development involving partial demolition of existing buildings at 89-93 Cimitiere Street, Launceston (CT 90992/1, CT 248431/1 & CT 112123/1) including the construction of a pedestrian walkway across 34 Cameron Street, Launceston (CT 226231/1).

The present site comprises 3 Titles and this application does not seek to amalgamate the Titles. It is unclear how this can be achieved or the implications on this Development Application as if considered without any amalgamation it is simply not possible to be assessed and ultimately constructed.

It is our submission that the development cannot properly occur as planned, until the amalgamation of Titles is completed.

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The proposed development land is significantly compromised by being held in 3 Titles, and additionally Title Vol. 2918 Fol. 24 (the Church Grounds and Sunday School Hall) is burdened by the location of the grave of Archdeacon Rev. Francis Hale (1900) and his wife, Mrs Hale (1887). The Hale graves are located within the bitumen paved areas and the stone monument was relocated to the landscaped area adjacent to the church in 1980's to allow for construction of the present car park area (Refer to CoL Development Permit files for details). It is unknown whether other graves are located within the land, or whether there are First Nation's Peoples relics also there.

This land area also contains the Sunday School Hall, which pre-dates the present Holy Trinity Church, and was also the site of the former Cameron Street Public School, demolished for the construction of the present church. The proponent makes no comment on an intention to undertake any archaeological investigation of the land.

It is our submission that no permit be issued for work on this land until a comprehensive archaeological investigation is undertaken and any discoveries found has been taken into consideration.

There has been negative press comment in Launceston opposing tall buildings. Sample correspondence includes:

Richard Hill, The Examiner October 30 2018 said: ***The last thing Launceston needs is to become like Melbourne, Sydney or the other state capitals, where magnificent and historic buildings that are part of our heritage are overpowered and diminished by adjacent high rise office blocks, hotels etc.***
I think that maybe adding another floor or two (say a maximum of eight floors) at the most no more than the Myer building is more than enough.

Jack Birrell, The Examiner August 9 2018 said: ***Many cities compete on the world stage for which has the tallest edifice.***
High-rise tower height they think makes them look better off than the next place. In truth these cities all end up looking the same.
Launceston city centre is unique because of the mix of excellent examples of low-rise Georgian, Arts and Craft, Art Deco and 20th Century modern buildings.
Launceston has an intact skyline viewed from within the city. Cameron Street and Cimitiere Street align City Park, Civic Centre and Queen Victoria Museum and Art Gallery, draw the line and they are on an axis with the picturesque Cataract Gorge.
Cities like Washington DC and Paris have similar alignments and consistent low-rise heights. As landmark cities they are protected by height limits so tall buildings cannot detract from their character.
Launcestonians generally agree that Myer and Telecom edifice, at 21 metres high, are the tallest eyesores blighting our city.
Launceston has a relatively uniform look and most people that live here and visit love the city for its buildings.
It's a standout landmark city characterised by low-rise architectural styles.
Developers like Fragrance want 70-metre high towers.[This was later reduced to 48M] ***These developments and heights are killing the golden egg that is Launceston.***
Come on Launceston, stand up and protect your unique city.

The proponent argues variously, that the topography of the land and the location of existing and yet-to-be developed tall buildings somehow warrants a higher building that otherwise relative to surrounding land. The proponent also argues that prospect tenant/operators of the proposed building require a large building with 'outstanding city views'. This proposal will provide for the bulk of the floor area to be commercial rental/investment floor areas, and so have nothing to do with the (espoused highly moral and virtuous) reasons why St Luke's wishes to amalgamate its present 4 locations to this building. St Luke's will actually only occupy Levels 6 & 7, meaning there is no justification for St Lukes to build such an extensive floor area.

The Launceston City Council commissioned report *Launceston CBD Building Height and Massing Study* by Paul Davies Pty Ltd released in 2018, specifically studied potential development sites, and concluded that the major portion be limited to

constructions to a maximum height of 15m and this particular site be limited to 12m. This report was publicly presented at a Town Hall Public Information Session in 2018, and no-one in the audience gave any support that a maximum height beyond 14-15m be considered with the Launceston Central Study Area. Mr Davies presented copious evidence concerning the fact that there are very few "tall" buildings within Launceston that exceed 5 storeys in height, noting that through the central area and fringe commercial and warehousing areas, the predominant existing height is around 12 metres. Overall he cites that within his study area there is a consistent height of built forms between 9 and 15 metres. Of the taller contemporary buildings such as The Telstra Building, the Myer Building and Grand Chancellor Hotel, he said theses are NOT seen as desirable in terms of their contribution to the character of the city. He says ***"Launceston is not seen as a city of tall or large buildings but rather a unique collection of buildings of generally very consistent scale and form that sets Launceston apart from other cities in Australia. Scale and general homogeneity of form is one of Launceston's greatest assets that sets it apart from other cities and adds to its desirability as a place to live and work."*** Throughout his Report, he establishes without question the importance of views and vistas around the city, that are key to the character and liveability of the city, and draws attention to the deficiencies in the Planning Scheme for not protecting the extensive private views afforded by the siting of mainly residential developments on the hills that overlook the city. He particularly makes comment on how comparing one building height in one section of the city cannot be the means of setting a height limit that may in fact be appropriate in one location but would be less appropriate in another. Using a *modus operandii* that establishes the unique character of each quadrant or precinct of the city, he concluded on a particular recognition of the heritage and civic characters of Launceston in establishing his recommendations of particular height limitations for new building developments. He reported that the project brief given to him by Launceston City Council was their desire to both protect the quality and character of the city for its heritage and liveability values and to facilitate development. Mr Davies does not support the notion of the adopting of a stepped or pyramidal form stepping back beyond the formal setback line for a site, preferring the adoption of built forms that are consistent with the pattern of development within the locality. Accordingly, he advises that ***"where no setback is indicated, that setback be a minimum of 15 metres so as to generally protect the scale and form of existing significant streetscapes so that any new built form in excess of 12 metres does not visually dominate views and vistas within streets and across the city".*** Interestingly, Mr Davies does not support the amalgamation of Lots without careful consideration of controlling and limiting changes in the pattern of developments because of the outcomes where larger buildings not respectful of heritage and visual streetscape values would eventuate. In summary, Mr Davies expresses a detailed understanding of the character of the city and how this important quality must be preserved and enhanced with evaluating new developments.
Launceston City Council staff and Councillors will recall the privilege awarded the City by interest taken by international expert Professor Gehl. It would be respectful and beneficial in the assessment of this Development, for Professor Gehl to be invited to comment on the merits of what is proposed.

Noting recent considerations by RMPAT in relations to applications modified/overturned by the Tribunal, the impact on an immediate area of 100M

appears to be particularly relevant. Within a distance of 100M there exists a number of heritage-listed buildings, including the following:
Holy Trinity Church and Sunday School Hall;
Crown Mill Building;
Former Baptist Tabernacle;
Commercial Hotel;
Sports Garden Hotel (was Lloyd's Hotel),

And, nearby including within the proponent's 200M distance:
Albert Hall;
Former Women's Prison;
Websters Woolgrowers;
Former CTA Club (34 George St);
Former residence of Peter Mills;
And Cornwall Hotel.

The absolute domination of the proud profile of Holy Trinity Church, is by far the greatest impact that will be caused by this proposal, easily likened to the detrimental impact of the Telstra Building on our proud Centenary Clock Tower of the celebrated Launceston Post Office.

It is our submission that this proposed building is too high and that only because of the lower land form should it be permitted to be constructed to a maximum height of say 12m-15m, an increase on the usual maximum height prescribed by the Planning Scheme. We do not accept the contrary arguments presented by the proponent which appear to be so contrary to the prevailing situation as to appear to be 'from another planet'. With great respect for the professional integrity of the consultants engaged by the proponent, it is very difficult to get beyond a feeling that these expert consultants are presenting 'self serving' opinions and assessments to accord with their commissions to support this application.

For some time, many residents of Launceston have been trying to reconcile high-rise development with protecting the amenity and heritage character of the central area. From our research of cities world-wide, in almost every city where Tall Building Policies have been implemented, such policies were introduced only as a consequence of public outrage sparked by the construction of an individual building popularly perceived as violating the character of the city. Since 1977, Launceston City Council has promoted restraint in the construction of tall buildings in the central area. The LCC's *Launceston National Estate Conservation Study* promoted low-level developments of 2-3 storeys, and when taller buildings were proposed, these were to have a 3-3.5 storey podium at the street alignment, with the upper 5-6 storeys of taller buildings set back below a 35 ^{0} line projected from the property boundary on the opposite side of the street.

The HPS(T)Inc. subscribes to the views and philosophies expressed in The Australia ICOMOS Charter for Places of Cultural Significance, ***The Burra Charter***, where the Charter *advocates a cautious approach to change : do as much to care for the place and to make it useable, but otherwise change it as little as possible so that its cultural significance is retained*.

Launceston is Australia's third oldest city, and an essential cornerstone of its cultural heritage significance is its limitation in the height of new developments. Tasmanian tourism authorities and including Launceston City Council itself, commonly describe Launceston as having the best preserved cityscape and with a fascinating history traced in its beautiful old buildings and streetscapes. It has been a long established planning principle in Australian cities, that it is symbolic of poor planning when taller buildings are constructed along river and water frontages. The principle of stepping down building heights towards these foreshore frontages is to be encouraged, however, in this instance, the contrary situation is evident.

To many people, the understanding of Launceston as a place of cultural heritage significance, may be difficult to express in words and whilst remain important and essential to their sense of well-being, can remain somewhat elusive and difficult to readily define. Quite recently, on 7th. April 2017, Historic England published a highly regarded and commendable research document ***UNDERSTANDING PLACE*** content.historicengland.org.uk that, we submit, may readily be applied to undertaking an historic area assessment here in Launceston. Last year, and again even earlier, we called upon Launceston's planners to investigate this document and follow the advice therein to establish the qualities and contributions to urban planning that gives Launceston its cultural heritage significance.

The failings of the Launceston Interim Planning Scheme 2015 have been well stated and agreed, including the failings and incompleteness of its heritage provisions. Your planners have still not finalised Launceston's version of the Statewide Planning Scheme to rectify and complete the task, and only by formulating an ***understanding of place,*** can a sound foundation for the sustainable cultural heritage development of Launceston, be achieved.

Prior to the establishment of modern planning controls in Tasmania and Launceston in particular, from around the early 1960's , a number of adverse developments have been allowed in Launceston. These buildings are regularly referred to by notable visiting cultural experts, with the question put "How ever did you allow the construction of these buildings to occur ?"

The list of inappropriate developments include:

- The Telstra Building in St John Street, (constructed as the Telephone Exchange to half this height in 1960's and then doubled in height in the 1970's) so as to alternatively prevent the demolition of the historic Johnstone & Wilmot buildings next door, previously acquired by the Commonwealth Government as a site to expand the telephone exchange. It is an interesting note that during this period the Commonwealth Government was exempt from Local Government planning provisions.
- Grand Chancellor Hotel, Cameron Street, (constructed as Launceston International Hotel in 1984) but illegally constructed to an additional height 2m in excess of the permit conditions.
- 93 York Street (constructed as MLC Building in1958)
- Queen Victoria Maternity Hospital (constructed in the 1960's on a very restrictive site as a part of the older maternity hospital complex and limited by encircling residential development.

- Henty House, Cameron Street Civic Square (constructed 1983 to a much reduced height following very widespread public objection and condemnation of the State Government's 1970's proposed office tower 12 storeys high). The present building was begrudgingly accepted by the public as a less-damaging concept.
- Quest Hotel 16 Paterson Street,(constructed as D W Murray, originally only 3 storeys, then significantly raised to 6 storeys due to commercial expansion of the Murray warehousing business early in the 20th. century.

Launceston is a low level city with only a handful of church spires, the Post Office Centenary clock tower and the celebratory tower of Albert Hall punctuating the townscape. Some industrial chimney stacks at the Railyards, Launceston General Hospital, Patons and Baldwin, (several now demolished), and industrial structures such as the Vertical Retort at the Gasworks, the Grain Silo's at King's Wharf, and brewing equipment at Boags Brewery, remain and if not still in operation, are recycled for new and adventurous purposes.

The pressure for increased density for development in our current day cities does not always demand high rises. In enlightened communities, where the level of living and working amenity is not so highly respected or regulated, high-rise development spores a 'Geography of Nowhere'.

Paris, a much adored low-rise city referred to as ***le ville lumiere*** (city of light, where daylight and sunlight penetrates deeply into its apartments and workplaces right down to pavement level) has a well-researched benefit of a lower level of sufferers of depression, due to the positive influence of light on the wellbeing of Parisiennes. Paris outlawed tall buildings in the city centre in 1974, and in the Tsarist Russian capital of Saint Petersburg, (now identified by UNESCO) buildings could not be taller than the Winter Palace. In old Rome there cannot be a building higher than St Peter's Basilica. Even in the highly commercialised city of Bali, Indonesia, following the unpopular construction of the tall Bali Beach Hotel, nothing can now be built higher than a coconut tree at 12m !

There are spectacular views to be gained from low level developments on Launceston's surrounding hills, so unlike the 'flat' featureless terrains of many other cities, Launceston does not need to build up to gain elevation and outlooks. Please don't gamble with the 200-year old legacy that exhibits the cultural heritage of Launceston. The present height limit at around 12m for Launceston may be the single most powerful thing that has made our city so amazingly fulfilling. Once you make a change, in any place or regard, it is essentially irrevocable, and you have stepped on a slippery slope that makes other undesirable changes more likely.

The irreverent prize for Britain's worst building the ***Carbuncle Cup*** is awarded each year, with such places as the building dubbed the "Walkie Talkie" because of its obvious likeness, being one of the notable recipients. In Launceston circles, the construction now completed for the highly-criticised Verge Hotel on Council's Cimitiere Street Car Park site fronting Tamar Street, and our much-valued Albert Hall, had already been dubbed the "Noodle Box".

This is an extensive application, and a mere 14 days is very inadequate to give the community a fair and reasonable time to do so. In any event, Council and its officers appear to have had months to be making assessments of this proposal (since at least prior to the preparation of the infamous Fragrance Hotel proposal), because the depiction of a non-existent building of this scale was mysteriously depicted in the background of the Fragrance presentation drawings, referred to by those representors, but never explained.

The proponent clearly expects that appeals against a Development Permit will be inevitable, given the references to previous determinations by RMPAT, the 'Tribunal'. It may be a cynical view within the community, but it causes contemplation that Launceston City Council will not be seriously considering any representations it may receive, and 'hand ball' a final determination to the Tribunal, abrogating its duty under the LUPA Act and responsibility expected by its community to fairly deal with their concerns.

The style and form of this proposed building has been likened to paying homage to the area's industrial heritage. This is a great mystery to us, particularly as the industrial heritage of the area is characterised by single and two-storeyed wool stores and the like, featuring south-facing saw-toothed roofs, and not expressed framing and bracing elements that are featured in this proposal. The only example of such construction, is the Vertical Retort structure at the old Gas Works site, which notably is a piece of patented machinery constructed of brick and steel, complete with clerestory roof designed 1932.

The "box design" and lack of traditional roof form detracts from the local industrial constructions, example the nearby Crown Mill Building.

Summation.

This Development Application, in spite of its voluminous content, does not adequately address all necessary impacts, and accordingly is not suitable for adequate assessment for approval.

A building of this height is too high for Launceston and the application must be refused.

Yours faithfully

P. W. Reynolds

For and on behalf of
Heritage Protection Society (Tasmania) Inc.

From: "Jim Collier" [redacted]
Sent: Mon, 1 Nov 2021 16:38:35 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: Representation Re Development Application DA0486/2021
Attachments: St Lukes Reprsesentation.pdf

Mr Michael Stretton,
Chief Executive Officer,
Launceston City Council
Dear Mr Stretton,
Attached is my Representation, (St Lukes Representation) in respect of Development Application DA0486/2021.
Kind regards,
_Jim Collier
[redacted]

Representation regarding Development Application DA0486/2021
Construction of a mixed use development involving partial demolition of existing building at 89-93 Cimitiere Street, Launceston (CT 90992/1, CT248431/1 & CT 112123/1) including the construction of a pedestrian walkway across 34 Cameron Street, Launceston (CT 226231/1).

I object to the above Development Application submitted by Commercial Project Delivery (CPD) on behalf of St. Lukes Health and believe it should be rejected, or amended, by Launceston City Council for the following reasons:

HEIGHT (3.2.2):
Despite the considered 'give and take', the apparent 'reduced bulk' and the 'sensitive and appropriate manner' with which this building has been designed the proposal still exceeds the permitted building height of the Launceston Interim Planning Scheme as acknowledged in the DA when it says;

'as *the buildings exceed the height limit of 12 metres.'*

The DA then goes on to say:
"However, there are several factors associated with this particular site and the proposal which indicate that development on this site, when arranged in a sensitive and appropriate manner, may exceed the permitted height limits without creating detriment to the public domain of the street, nor to surrounding buildings or sites."

In 2018, following community feedback and other pressures, a number of changes were made to the original DA for the **Verge Hotel r**esulting in the proponents reducing its proposed height by 3.7 metres to 23 metres and reducing the proposed number of floors from eight to seven storeys. (The Examiner 19 Jan 2018)

This proposed St. Lukes development is described as being 31.01 metres (3.2.1) and 8 storeys (including a basement); … the original number of storeys planned for the Verge Hotel and an increase in height by 7 metres over the now existing Verge Hotel.

It can clearly be seen in the Building height comparison (DA Figure 5) that the proposed St Lukes building will most definitely be significantly higher than the Hotel Verge and 'will' partially obscure the desirable view of the Holy Trinity Church to the South.

The ‘height creep’ in relation to the nearby Verge Hotel can be even more clearly seen in Photomontage View 2 of 8 Appendix D - Proposal Plans

Will the next proposed high rise building in inner Launceston be higher still and one has to ask if ‘height creep’ continues where will it ultimately end?

In view of this one is bound to query why were the proponents of the Verge Hotel were pressured to reduce the number of storeys in the first place and will proponents of this project be allowed to retain their desired height; …if so why, …what is the difference?

The Development Application refers on numerous occasions to *‘the recently approved Fragrance Hotel’* and while there is no arguing this project has been approved until such times as it has been constructed, and that may never happen, there is currently nothing there to compare to.

As recently as November 2018 Architects Heritage Consultant Paul Davies said in his Launceston CBD Building Height and Massing Study:
“We remain convinced that a height limit is necessary and desirable. It could remain as set out in the study or could be simplified to a single height of 24 metres. This height limit allows for approximately 7 storeys of development which we assess would cover most potential developments within the city area. More importantly it establishes a limit that can be managed in terms of retaining the character and scale of the city.”

Mr Davies backed this up by stating in recommendation 5 (ii) of his Study
Introduce an absolute maximum height limit of 24 metres across the city area.

Gehl Architects recommended in their 2011 report for Launceston City Council that Launceston should:
“Develop Planning controls for the inner city area to maintain the presence average building height of maximum 5 storey (approx. 15 metres with a general height of 3 or 4 storeys.”

Launceston City Council continually ignores the contents of these two very credible and important Reports and Studies and it is time this ceased before any future studies/reports Launceston City Council commissions loose credibility and integrity before they even start!

Launceston City Council should either reject the referred to Development Application as it is clearly outside the the permitted building height within the Launceston Planning Scheme or request the proponent to reduce the height to that of the Hotel Verge; a height suitable for the area recommended by Paul Davies.

CONSTRUCTION MATERIAL Appendix D:

The architects are to be congratulated on their forward thinking in deciding that timber should be the main material used in construction of most of the supporting structure of the proposed building.

There are certainly numerous environmental benefits from this choice, as listed in the DA, however nowhere is the issue of FIRE mentioned; …this is of concern to me, especially over a period of time as the timber dries out, how fire proof will this building be?

Submitted by

Jim Collier

of

[redacted]

From: "Linda Collier" [redacted]
Sent: Mon, 1 Nov 2021 20:32:57 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: For the Chief Executive Officer
Attachments: CPD DA04862021.pdf

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Mr Michael Stretton,
Chief Executive Officer,
Launceston City Council.
Dear Mr Stretton,
The Representation I recently submitted in respect of Commercial Project Delivery's Development Application DA0486/2021 contained some errors so would you please cancel that Representation and replace it with this attached version, …I apologise for any inconvenience and confusion.
Kind regards,
Linda Collier
[redacted]

Representation regarding Development Application DA0486/2021
Construction of a mixed use development involving partial demolition of existing building at 89-93 Cimitiere Street, Launceston (CT 90992/1, CT248431/1 & CT 112123/1) including the construction of a pedestrian walkway across 34 Cameron Street, Launceston (CT 226231/1).

I object to the above Development Application submitted by Commercial Project Delivery (CPD) on behalf of St. Lukes Health and believe it should be rejected, or amended, by Launceston City Council for the following reasons:

HEIGHT (3.2.2):
Despite the considered 'give and take', the apparent 'reduced bulk' and the 'sensitive and appropriate manner' with which this building has been designed the proposal still exceeds the permitted building height of the Launceston Interim Planning Scheme as acknowledged in the DA when it says;

'as *the buildings exceed the height limit of 12 metres.'*

The DA then goes on to say:
"However, there are several factors associated with this particular site and the proposal which indicate that development on this site, when arranged in a sensitive and appropriate manner, may exceed the permitted height limits without creating detriment to the public domain of the street, nor to surrounding buildings or sites."

In 2018, following community feedback and other pressures, a number of changes were made to the original DA for the **Verge Hotel r**esulting in the proponents reducing its proposed height by 3.7 metres to 23 metres and reducing the proposed number of floors from eight to seven storeys. (The Examiner 19 Jan 2018)

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In view of this one is bound to query why were the proponents of the Verge Hotel were pressured to reduce the number of storeys in the first place and will proponents of this project be allowed to retain their desired height; …if so why, …what is the difference?

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Launceston City Council continually ignores the contents of these two very credible and important Reports and Studies and it is time this ceased before any future studies/reports Launceston City Council commissions loose credibility and integrity before they even start!

Launceston City Council should either reject the referred to Development Application as it is clearly outside the the permitted building height within the Launceston Planning Scheme or request the proponent to reduce the height to that of the Hotel Verge; a height suitable for the area recommended by Paul Davies.

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The architects are to be congratulated on their forward thinking in deciding that timber should be the main material used in construction of most of the supporting structure of the proposed building.

There are certainly numerous environmental benefits from this choice, as listed in the DA, however nowhere is the issue of FIRE mentioned; …this is of concern to me, especially over a period of time as the timber dries out, how fire proof will this building be?

Submitted by

Linda Collier

of

[redacted]

From: "Isabel De Jersey"[redacted]
Sent: Fri, 29 Oct 2021 16:04:09 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Subject: DA0486/2021 - notice of objection

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To whom it may concern,

Ref: DA0486/2021

Please find below my objection to the proposed building development outlined by DA0486/2021 at 89~93 Cimitiere Street. Herein referred to as the 'proposed building'

For reference purposes, the basis of this objection is around the Launceston Interim Planning Scheme 2015 section 15.4.1.

Background:

'I' am the owner o[redacted] My name is Isabel De Jersey and I've owned this property since the 1980's.

The Proposed Building:

Whilst I have no objection to the mentioned site of 89~93 Cimitiere Street being developed and I like the aesthetics of what is being proposed I have a serious objection to the height of the proposed building.

Objection - does not comply with building height:

The building zoning is marked as an urban mixed zone. According to the Launceston planning scheme section 15.4.1 the building must be no greater than 12m or no greater than the average building heights on the site or adjoining lots. Given the tallest adjoining building is a the church on the corner of George Street and Cameron Street, the narrow spire of the church could be rendered insignificant in terms of the bulk of the height. Given most churches around Launceston have prominent spires doesn't mean we should build high rise building next to them all that match or exceed the minimal visual bulk of their spires. The narrow tip of the church spire is not of enough visual bulk that it should be used as the height marker for all new development, thus the main roof of the church should be used when determining the average height of surrounding buildings.

The next highest adjoining building is the MAIB building in George Street. The proposed building exceeds the MAIB building by four levels plus the roof top screening.

Given the visual bulk of the church roof averaged with the larger bulk but lower height of the MAIB building it could be argued that the average building height of adjoining buildings would be no greater than one story above the MAIB building. So in summary the average height of buildings on adjoining lots is well below the height of the proposed building.

Objection - no protection to amenity of adjoining lots:

This proposed building height does not protect the amenity of adjoining lots in that it will be a towering building that overshadows all surrounding lots.

Objection - not in keeping with the Streetscape:

While one could try to argue that the proposed building is in keeping with the streetscape, the proposed building is far enough away from the development of other buildings of significant height further to the east along Cimitiere Street that this proposed building will stand out like a sore thumb amongst the moderate height of existing buildings in the street.

The visual bulk and form of this proposed development will be a blight on the streetscape when viewed from most elevated locations around Launceston. The overshadowing caused to the adjoining lots provides restricted access to natural sunlight for the purpose of the welfare of the staff using the adjoining property.

In summary:

While the proposed building will be a positive for Cimitiere Street the proposed height does not comply with Launceston Interim Planning Scheme 2015 and is not a fitting look for both the streetscape and local amenity.

If you have any questions about this objection then please don't hesitate to contact me.

Kind regards,
Isabel De Jersey
[redacted]

From: "Maurice De Jersey[redacted]
Sent: Fri, 29 Oct 2021 15:08:55 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Cc: [redacted]
Subject: DA0486/2021 - notice of objection

You don't often get email from [redacted] Learn why this is important

To whom it may concern,

Ref: DA0486/2021

Please find below our objection to the proposed building development outlined by DA0486/2021 at 89~93 Cimitiere Street. Herein referred to as the 'proposed building'

For reference purposes, the basis of this objection is around the Launceston Interim Planning Scheme 2015 section 15.4.1.

Background:

'We' are the owners o[redacted] Our names are Maurice and Asha De Jersey and have owned this property since 2008, with it having been in the family since the 1970's.

In 2015 we spent a considerable amount of money on the redevelopment of this property and in 2018 we took out a loan to reduce our carbon footprint and improve our green credentials by installing a large commercial solar system - as large as our roof could accommodate. The solar system is designed to be repaid within the life of the panels with the savings in electricity to go toward paying off a commercial loan taken out for the installation. The solar panel installation and its ongoing upkeep and servicing are designed set to ensure an ongoing reduced carbon footprint for our building and its tenants.

The Proposed Building:

Whilst we have no objection to the mentioned site of 89~93 Cimitiere Street being developed and we like the aesthetics of what is being proposed we have a serious objection to the height of the proposed building. Given that St Lukes are proposing to only occupy two levels, why is there a need to increase the number of levels to a point that far exceeds the recommended planning scheme height of 12m.

Objection - does not comply with building height:

The building zoning is marked as an urban mixed zone. According to the Launceston planning scheme section 15.4.1 the building must be no greater than 12m or no greater than the average building heights on the site or adjoining lots. Given the tallest adjoining building is a the church on the corner of George Street and Cameron Street, the narrow spire of the church could be rendered insignificant in terms of the bulk of the height. Given most churches around Launceston have prominent spires doesn't mean we should build high rise building next to them all that match or exceed the minimal visual bulk of their spires. The narrow tip of the church spire is not of enough visual bulk that it should be used as the height marker for all new development, thus the main roof of the church should be used when determining the average height of surrounding buildings.

The next highest adjoining building is the MAIB building in George Street. The proposed building exceeds the MAIB building by four levels plus the roof top screening.

Given the visual bulk of the church roof averaged with the larger bulk but lower height of the MAIB building it could be argued that the average building height of adjoining buildings would be no greater than one story above the MAIB building. So in summary the average height of buildings on adjoining lots is well below the height of the proposed building.

Objection - no protection to amenity of adjoining lots:

This proposed building height does not protect the amenity of adjoining lots in that it will be a towering monstrosity that overshadows all surrounding lots.

Objection - not in keeping with the Streetscape:

While one could try to argue that the proposed building is in keeping with the streetscape, the proposed building is far enough away from the development of other buildings of significant height further to the east along Cimitiere Street that this proposed building will stand out like a sore thumb amongst the moderate height of existing buildings in the street.

The visual bulk and form of this proposed development will act as an out of place monstrosity on the streetscape when viewed from most elevated locations around Launceston. The overshadowing caused to the adjoining lots provides restricted access to natural sunlight for the purpose of the welfare of the staff using the adjoining property.

Objection - Overshadowing:

We have gone to considerable expense for a small business to fund and install solar panels in order to help reduce our carbon footprint. Given the shading that this building will cast over our property, the existing solar panels will be rendered near to useless for their intended purpose. The type of panels we have installed mean all three strings will not generate electricity until the whole string has full sunlight. Given that the majority of our solar panels are installed on the eastern side of our pitched roof, this means we lose the majority of the power we normally generate and use throughout the day. This sunlight shadowing will essentially render our solar installation 100% useless until well into the afternoon as our roof structure will not receive full sunlight until after 12pm.

We currently have sunlight on our solar panels at/or within an hour of sunrise depending on the minimal shadowing cast by distant larger buildings to the east. According to the shading diagrams in the proposed building plans, our solar panels will be rendered useless in winter from sunrise (approximately 7:30am) through to after 12pm before the final full string of panels have no shade on them and they can generate full power. Given the majority of our solar panels are on the eastern side in order to access the morning sun we will lose almost 4.5 hours of solar capacity in the shortened winters day. The subsequent low sun angle and early sunset in winter means we will have very few hours of electricity generation.

According to the shading drawings provided this extreme level of shading is present even through September. A solar panel string cannot generate power until all cells are free of any shading. The proposed September shading diagram means we will now miss sunlight from a 6:00am sunrise right through to just before 12pm - a massive 6 hours of potential solar generation rendering our panels useless during this period.

Moving on to the December shading drawings we are now losing direct power generating solar power from sunrise of 5:30am through to just before 11am, a further 5.5 hours of valuable solar power generating sunlight is lost.

Note, our Western panels do not start generating power currently until after they have an angle of sunlight much greater than the pitch of the western facing roof section. This western string of solar panels represent only a third of the panels we have installed and are subject to afternoon shading from the protected tree in the Commercial hotel therefore the majority of our power is generated during the morning period between sunrise and midday - pretty much the whole period our building will be in shade from the proposed development.

The efficiency of a solar panel is at its maximum when the sun is directly perpendicular to the panel. Given the pitch angle of our eastern facing roof which contains 2/3's of our electricity generating panels the shadowing of the proposed building will ensure 100% of the panels will never see maximum efficiency as any and all perpendicular sun angle on our panels will be eliminated. The economic modelling used to justify our installation of solar panels and ensure the installation is paid for before the end of life of our solar panels is now null and void and the solar system installation will end up being a liability from the day the proposed building is erected. We might be a small building however all the small contributions to carbon minimisation adds up. We might be small but our attempt to have a positive effect on carbon neutralisation should not be thwarted by a David vs Goliath development.

Future:

We are currently having plans drawn up for an inner city apartment in the upper floor of our building. While this proposal is not in front of council the proposed building will have a negative impact on our upper level apartment due to the expected shading and lack of privacy.

In summary:

1. The proposed building will render our solar panel installation virtually useless during the majority of the day. This will add a significant and ongoing financial burden on our business and our carbon footprint neutralisation efforts.

2. While the proposed building will be a positive for Cimitiere Street the proposed height does not comply with Launceston Interim Planning Scheme 2015 and is not a fitting look for both the streetscape and local amenity.

3. Our proposed upper level apartment will be negatively impacted by the shading and lack of privacy.

If you have any questions about this objection then please don't hesitate to contact us.

Regards,

Maurice & Asha De Jersey
[redacted]

From: "Registry[redacted]
Sent: Mon, 25 Oct 2021 16:45:12 +1100
To: "Contact Us" <contactus@launceston.tas.gov.au>
Cc: "Dane Courtney"[redacted]
Subject: Development Application DA0486/2021
Attachments: Letter to Launceston City Council re DA0486 2021.pdf

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Dear Michael

Attached is a letter from Mr James Oakley, Secretary of the Trustees of the Diocese of Tasmania in relation to DA0486/2021.

Kind regards

Claire Upton | EA to the Registrar | Anglican Diocese of Tasmania
[redacted]

A church for Tasmania, making disciples of Jesus.

THE TRUSTEES OF THE DIOCESE OF TASMANIA

ANGLICAN DIOCESE OF TASMANIA

Monday, 25 October 2021

Michael Stretton
Chief Executive Officer
Launceston City Council

By email: contactus@launceston.tas.gov.au

Dear Michael,

St Luke's Health Development Application DA0486/2021

I write to you in regards to the above development application which has included the carpark on the Trustees [redacted] property at Holy Trinity, 34 Cameron St, Launceston.

While the Trustees are supportive of the application, they are not a partner in the development, and would make the following comments:

- An in principle agreement has been reached to grant a licence for a pedestrian walkway for a period of 5 years initially, and for carparking spaces during office hours on a commercial basis;
- The granting of permanent access in any form (including as an emergency exit) is not something the Trustees would entertain and should not be relied upon as a condition of consent to the development;
- The granting of permission to allow delivery vehicle traffic through the carpark will not be entertained by the Trustees. The Trustees would not wish to agree to any intensification of vehicular traffic through their car park;
- The plans appear to show an awning over the church property. This has not been agreed to;
- The Trustees would be willing to negotiate temporary access for heavy vehicles during the period of construction.

I can be contacted as the Trustees representative on either [redacted] or [redacted]u should you wish to discuss the above.

A church for Tasmania, making disciples of Jesus.

[redacted]

Yours Faithfully,[redacted]

[redacted]

James Oakley

Secretary

CC Ven Dane Courtney, Rector, Holy Trinity Launceston

A church for Tasmania, making disciples of Jesus.

[redacted]