Naval Point, QRA & Multi-Hazard Review

Christchurch City Council

Naval Point, QRA & Multi-Hazard Review

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Executive Summary

Christchurch City Council (CCC) wish to review land use options in Naval Point, Lyttelton as part of their intended land development in this area. A number of studies have been compiled to assist CCC in their decision-making such as a Quantitative Risk Assessment (QRA) as provided by oil companies in the area, and a multi-hazard review of natural hazards.

CCC has engaged Jacobs to review these studies and combine QRA risk contours and hazard areas to provide a spatial understanding of where risk and hazards may co-exist.

Areas of note have been highlighted in this report having a co-existence of multiple natural hazards and/or in proximity to higher risk QRA risk contours. In two of these areas, higher risk QRA risk contours occupy public space with risk contours equal to and exceeding 1×10^{-5} per year. These two areas in particular should be of priority for the council to resolve.

Risk mitigation options and recommendations have been compiled to allow CCC to consider future steps in addressing high risk area at Naval Point to the public and other users. Recommendations are;

1. Council should seek legal advice as to what obligations they have to act on mitigation options knowing the QRA results and the current case of risk exposure occupying public land

2. Council should confirm its acceptable limit of risk it wishes to reach. This would ideally be done with advice from legal and QRA Specialist resources.

3. Obtain from oil company owners/operators a copy of their safety cases as these are likely to provide cases where the risk contours will be reduced over public land and therefore remove applicable mitigation options currently provided.

4. Engage a QRA Specialist to review oil company owners/operators safety cases and mitigation options in order to best understand which options are best for CCC in reducing public exposure to risk on CCC land (“outside the fence”).

5. In lieu of a QRA consultant it is recommended Council begin implementing risk mitigation measures which inform and/or reduce the population in areas occupied by risk contours of 1 x 10-4 and 1 x 10-5 (purple and red contour lines respectively in the QRA) in ‘Areas of Note’ 1 and 2 as provided in Table 5-1. Council should begin on implementing immediate measures as listed in Table 4-1 (e.g. signage, and education measures) in occupying these areas while short and longer term planning is progressed.

6. It is recommended council engage a QRA Specialist to provide an assessment of risk reductions scenarios with a cost benefit method. Ideally the analysis should consider both “inside the fence” safeguards by the terminal operators and “outside the fence” safeguards by the council. A structured, systematic approach between CCC and Oil Company owners/operators will avoid the potential for regretful costs. Refer example in Section 4, page 10 regarding a blast wall and increased tank instrumentation.

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Note: Neither of the authors are QRA or Process Safety specialists. Advice given on QRA and Process Safety topics is of a general nature and specialist QRA / Process Safety expertise should be sought for specific scenarios, mitigations and risk reductions related to the QRA.

1. Introduction

The Christchurch City Council (CCC) wish to review land use options in Naval Point, Lyttelton as part of their intended land development in this area. A number of studies have been compiled to assist CCC in their decision-making.

Key neighbours to CCC in the area of Naval Point are fuel companies with terminal facilities or bulk fuel storage sites. A Quantitative Risk Assessment (QRA) has been commissioned by oil companies and provided to CCC. This provides a current case of risk contours. This study entitled *Quantitative Risk Assessment of the Bulk Liquids Storage Facility at Lyttelton Port* identifies key areas susceptible to a life risk posed by petrochemical storage activities to the surrounding community.

A multi-hazard review has been completed by CCC which provides a co-locational map of natural hazards in the Naval Point area. CCC have provided a subject area of interest within Naval Point as the key focus area for this review. This area is shown on maps provided in the Appendices.

CCC has requested both the QRA risk contours and the multi-hazard mapping be combined to provide a spatial understanding of where risks may co-exist. The intention is so risk mitigation options and recommendations can further be developed on top of those already provided (by others) to understand the potential hazards that may restrict land use while CCC consider future development plans.

This report is to document findings and discuss risk mitigation options for areas of note at Naval Point, and presented to recommend the next steps forward for CCC to undertake.

2. Multi-Hazards Review of Natural Hazards – Background

A multi-hazard review of natural hazards has been completed for the Naval Point, Lyttelton area with the subject area defined by CCC. The report is referred to as *Naval Point, Multi-Hazards Review* dated 29 August 2017.

This multi-hazards review is a desktop analysis consisting of; reviewing available GIS databases for data on a number of natural hazards (and other inferred information) to determine whether they occur at Naval Point, mapping the extent and intensity of the individual hazards in the study area, mapping the spatial co-location of the hazards, and calculating the areas at risk from multiple hazards.

Hazards included in this review are;

- Tsunami Inundation
- Earthquake Liquefaction
- Earthquake Vertical Ground Displacement
- Slope Hazards Slope Hazards
- Depth to Groundwater
- Flooding (from a water course)

Hazards excluded from this report due to insufficient data available for Naval Point were;

- Coastal Erosion with 100 year Sea level Rise
- Coastal Inundation with 100 year sea level rise
- Inundation in a Regional Tsunami

Outputs from this hazard analysis provide a series of maps spatially locating each hazard within the subject area. A combined map providing a co-location of hazards has been produced to identify potential problematic areas within the subject area. This co-location map, Map 7: Spatial Co-existence of Multiple Natural Hazards is provided in Appendix A.

The outcome of this analysis indicates that while there are a number of natural hazards that are present at Naval Point, there is not a large area exposed to a wide range of multi hazards that would limit land-use in the area. The exception to this is along the cliff edge due to slope rock fall and cliff collapse hazard which is already recognised as a management area providing land-use controls. Development in this area will require resource consent under the Replacement District Plan (2015) due to these slope hazards, specifically, rockfall and cliff collapse.

Tsunami hazards are best dealt by CDEM responses of preparedness and evacuation planning. It is understood that Environment Canterbury are currently working on tsunami evacuation zones for the Banks Peninsula communities, which includes Naval Point as part of the Lyttelton, community.

Other hazards that are present within Naval Point can be mitigated via engineering design standards.

It is unlikely based on natural hazard information reviewed, that there would be a requirement for any significant changes to future land use or activities in the Naval Point area as these hazards can be addressed using accepted mitigation measures.

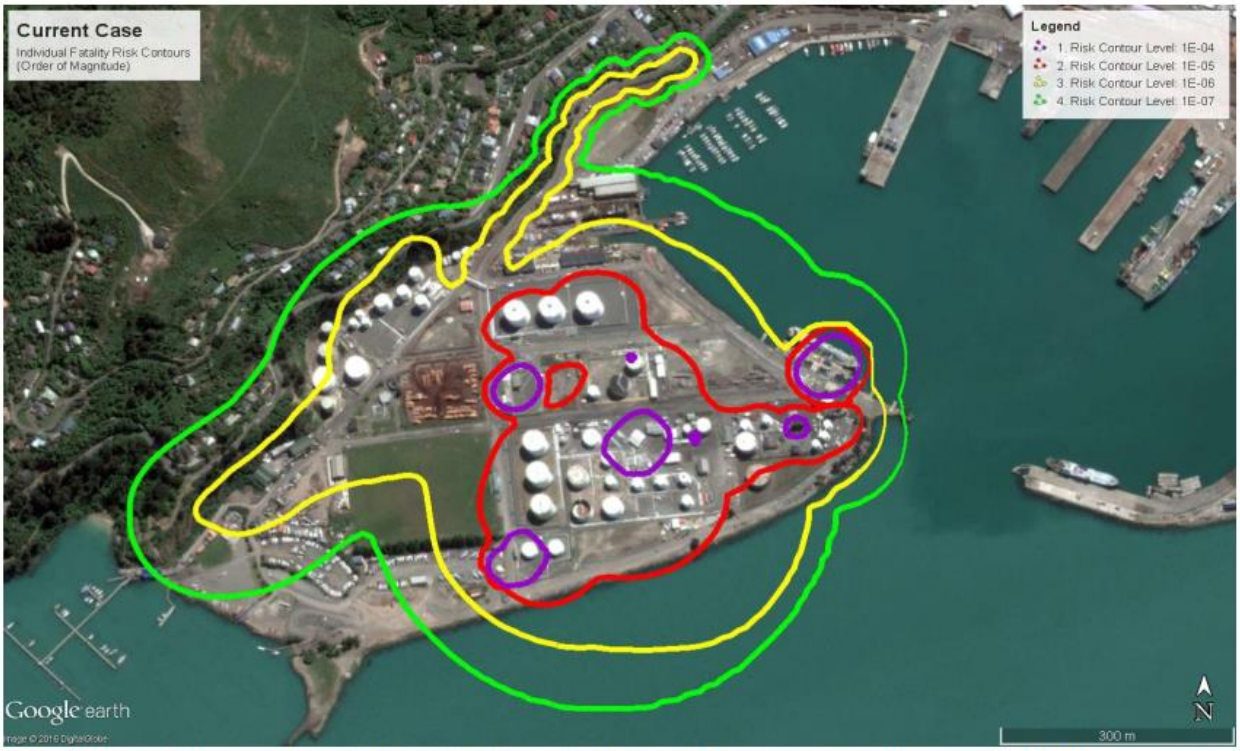
3. QRA for Bulk Liquids Storage – Background

The Quantitative Risk Assessment of the Bulk Liquids Storage Facility at Lyttelton Port Report was completed by Sherpa Consultants and is dated 20 September 2016.

The Quantitative Risk Assessment (QRA) process is a NSW government requirement for evaluating Risk Criteria for Land Use Safety Planning under the Hazardous Industry Planning Advisory Paper No.4 (HIPAP 4).

The QRA report scope presents the risk as individual fatality risk contours with order of magnitude 1 x 10^{-4} (greater risk) to 1 x 10^{-7} (lesser risk). Individual Risk represents the likelihood that a person will sustain a fatal injury by all of the hazardous events to which he or she may be exposed. For example, a contour of 1 x 10^{-6} is a location at which the fatality risk level is one in a million per year, i.e. one fatality every 1 million years.

Risk contours for the current case at Naval Point are provided below in Figure 1 as provided in the Sherpa QRA;



NOTE: 'Individual fatality risk' is defined for land use safety planning as the annual risk of fatality to a notional person at a particular point assuming exposure to the risk 24 hours a day and 365 days per year.

Figure 1: Individual fatality risk, Current Case from Sherpa QRA Report (page 14)

The QRA report should be viewed as starting point. The QRA report exclusions section 2.7 should be viewed as the next steps in the process and include:

- Demonstration that risks have been reduced to a level as low as reasonably practicable
- Evaluation of risk results against risk criteria.
- Assessment of risk reductions scenarios with a cost benefit method (refer below).

4. QRA and Multi-Hazard Risk Mitigation Options

A Memorandum dated 18 November 2017 has been provided by the Worley Parsons Group with the subject of Risk Mitigation Suggestions in relation to the Sherpa QRA. The memo is provided for the purpose of "assisting CCC to begin to develop a risk management plan for Naval Point considerate of short and long term plans for the area". This memo is attached in Appendix C.

These suggestions are still relevant as it is understood none have currently been implemented. However, in providing for any or all of these "suggestions" it is not known how contours will be affected and/or reduced (it is presumed the memo is not scoped to cover this). A QRA Specialist will need to be engaged to revisit such suggestions to quantify the reduction in risk a given suggestion actually provides.

Following recent discussion with the CCC, it is also considered that not all of the suggestions provided by Worley Parsons are practical at this time. Based on these discussions, Table 4.1 below provides a short list of the practical mitigation options from the suggestions made in the Worley Parson Memo (covering QRA related risk), and for the natural multi-hazards. Some additional measures have also been added following other discussion with CCC.

For simplicity Worley Parsons suggestions have been abbreviated so that these can be captured in the below table. Short term suggestions have been provided ahead of longer term options. Following this review some Worley Parsons suggestions have been elevated to "immediate" to reflect options that can be provided now with little additional information needed.

Additional information is provided on the relative cost for each option to be implemented via a scale $, $$, $$$, or N/A.

Table 4 -1: Short list of Mitigation Options from QRA and Multi-Hazard Reviews.

	No.	Hazard	Mitigation Option	Source	Relative Cost
Immediate Options		***QRA Risk Contours***	***Inform/Reduce the population in the higher risk areas***		
	1		Review and improve signage for access restrictions to facilities including delineation of property boundaries adjacent to public access areas.	1.1.4 Worley Parsons Memo	$
	2		Limit parking in higher risk areas including the length of Godley Quay.	1.1.3 Worley Parsons Memo	$
		QRA Risk Contours	***Inform and equip workers on CCC assets in the higher risk areas of expected safe procedures, policies, and practices appropriate to worker risk exposures***		
	3		Include risks in scoping and/or task analysis for any CCC workers or contractors doing works in the area. e.g. parks staff, road maintenance.	2.1.1 Worley Parsons Memo	$
	4		Maintain a risk register for CCC assets that workers/contractors can reference to.	2.1.2 Worley Parsons Memo	$

	No.	Hazard	Mitigation Option	Source	Relative Cost
Short Term Options		***QRA Risk Contours***	***Inform/Reduce the population in the higher risk areas***		
	5		Use of physical barriers such as gate access control	1.1.1 Worley Parsons Memo	$
	6		Temporary traffic management options be discussed with operators	1.1.2 Worley Parsons Memo	$
	7		Establish ability to quickly restrict access to Godley Quay south of Voelas Road in an incident. Install electronic warning signs.	1.1.5 Worley Parsons Memo	$
	8		Decommission the sports changing rooms nearest the tank farm and arrange temporary facilities elsewhere.	1.1.6 Worley Parsons Memo	$$
	9		Install physical deterrents (trees, walls, fence etc.) along the east end of the field to reduce the number of people accessing the field from this location.	1.1.7 Worley Parsons Memo	$$
	10		Consider shore signage for marine traffic.	1.1.8 Worley Parsons Memo	$
		QRA Risk Contours	***Work with operators and Port to coordinate activities timing in order to minimise risks***		
	11		Minimise peak user occupancy and higher risk activities in the area. I.e. scheduling fuel loading operations to not coincide with sports events.	5.1.1 Worley Parsons Memo	$
	12		Minimise tanker movements and peak public traffic movements coinciding. i.e. restrict tanker movement on certain days or times	5.1.2 Worley Parsons Memo	$
		Natural Hazards	***Provide management areas for wider spread natural hazards***		
	13	Tsunami inundation	Rely on soon to be defined ECan evacuation zones	Multi-Hazards Review	N/A
	14	Slope Hazard	Use existing land-use controls in currently	Multi-Hazards	N/A

	No.	Hazard	Mitigation Option	Source	Relative Cost
			managed area	Review	
Long Term Options		***QRA Risk Contours***	***Reduce the population in the higher risk areas***		
	15		Establish pedestrian evacuation routes	1.2.3 Worley Parsons Memo	$$
	16		Consider exclusion zones for marine traffic.	1.1.8 Worley Parsons Memo	$
		QRA Risk Contours	***Provide civil infrastructure to protect against threat of hazard from "inside the fence"***		
	17	Explosion (blast force and debris)	Construct a "blast wall" along the length of Godley Quay where higher risk contours intersect and occupy public land	CCC discussion	$$$
		Natural Hazards	***Use engineering design standards to overcome threat from natural hazards***		
	18	Tsunami inundation	Continue to rely on soon to be defined ECan evacuation zones Raise local ground levels to appropriate level	Multi-Hazards Review	$ $$$
	19	Slope Hazard	Continue to use existing land-use controls in currently managed area Secure entire cliff management area	Multi-Hazards Review	$ $$$
	20	Liquefaction	Use engineering design solutions for new structures	Multi-Hazards Review	N/A
	21	Ground water	Use engineering design solutions	Multi-Hazards Review	N/A
	22	Vertical Displacement	Use engineering design solutions for new structures	Multi-Hazards Review	N/A

The inclusion of a "blast wall" has been provided as a possible mitigating option in the event of an explosion following discussion with CCC. A blast wall is a physical barrier designed to provide protection of people or assets from the effects of a nearby explosion. The type of explosion and its proximity to the wall are largely the

determining factors for the size and type of blast wall. A QRA specialist would be required to give an assessment of the applicability of a blast wall for a particular area.

Review of the above options generally splits mitigation options into three groups, typically being either;

- Infrastructure – physical designing and building of assets to secure or contain, minimise hazard consequence, or provide increased access/egress to the area for emergencies or otherwise
- Education/training – educating tenants, operators, CCC and Utility workers, public etc. on the risk of conducting activities in higher risk areas and/or Naval Point as a whole. This includes signage and emergency exercises
- Planning – planning activities to reduce the likelihood of exposure the public or others may be subject to by the activities of fuel owners or operators

Infrastructure options that may provide a physical barrier and/or reduced exposure to risk are understandably more expensive in their implementation (construction) than education and training exercises. Should the Council wish to seek which options will provide the best value in reducing risk contours in the area then a cost-benefit analysis should be carried out by a QRA Specialist.

For example, an expensive blast wall adjacent to an oil facility may be proven to reduce the risk to persons “outside the fence” should an explosion occur, however a less costly safeguard to lower the frequency of occurrence of a scenario (such as a tank high level instrument trip implemented “inside the fence”) may reduce the risk by the same or greater amount and so be a more cost effective solution. Therefore, the later safeguard would be a much more sensible safety mitigation measure.

5. Combining the QRA and Multi-Hazard Review

Combining of QRA risk contours and the multi-hazard mapping has been carried out to provide a visual understanding of where hazards co-exist and there proximately to risk contours. It is important to note that the QRA and multi-hazard review use very different methods of assessing hazards, the most obvious is the QRA contours which provide a varying degree of risk with a correlated and defined exposure. The higher risk contours are driven by events in the fuel facilities. The multi-hazard review provides locational information on the areas affected by singular and multiple natural hazards with varying return periods for each event. To understand the likelihood and contributors to each individual risk in more detail, both reports should be reviewed and any limitations on data or exclusions understood.

In combining both QRA and multi-hazard maps (and inside the Council's provided area of interest) a number of locations become apparent as areas of note by looking at the darker shade of red (i.e. more natural hazards co-existing in the same location) and their proximately or inclusion inside higher risk QRA contours.

This map of combined reviews Map 8: Multi-hazard & QRA Contour is provided in Appendix B. Table 5.1 below provides a focus on areas of note extracted from Map 8. Relevant mitigation options/suggestions from Table 4.1 are provided for each Area of Note.

Table 5 -1: Areas of Note following combining of QRA and Multi-Hazard reviews with relevant mitigation options

Area of Note	South end of Godley Quay adjacent to sports field
1	
QRA	QRA risk contours of 1 x 10^{-4} and 1 x 10^{-5} intersect and occupy an area of public land on the lower reaches of Godley Quay. The highest risk contour (1 x 10^{-4} in purple) is driven by storage and fill point of methanol owned by Hexion. The red contour (1 x 10^{-5}) follows the same however extends north also in public space
Multi-Hazard (natural hazard)	A co-location of 2 – 3 natural hazards are present in this area. These hazards are; tsunami inundation (>0.5m), vertical displacement (+/- 200mm), and liquefaction occurrence. Tsunami risk is likely to be mitigated through Civil Defence initiatives, ground displacement and liquefaction can be accommodated via engineering design

Mitigation Options Table 4-1	1**, 2**, 3**, 4**, 5*, 6*, 7*, 8*, 9*, 10*, 11*, 12*, 13*, 15, 16, 17, 18, 19, 21
Comments	Numerous mitigation options for this area have been identified. Short term mitigation options are largely associated to reducing access and population around this area and specifically the sports field. The QRA risk contours and their drivers are the focus for this area that would impede future development options. These risks are driven from “inside the fence” of private land. Natural hazards in this area are able to be either designed out through engineering design practices or managed through emergency planning (tsunami risk).

Area of note	**Godley Quay between Cryus Williams and Charlotte Jane Quay**
2	
QRA	North of the above area of note a similar occurrence of the red risk contour (1 x 10^{-5}) occupying and/or being very close to public land.
Multi-Hazard (natural hazard)	A co-location of 2 – 3 natural hazards are present in this area. These hazards are; tsunami inundation (>0.5m), vertical displacement (+/- 200mm), and liquefaction occurrence.
Mitigation Options Table 4-1	1**, 2**, 3**, 4**, 5*, 6*, 7*, 9*, 10*, 11*, 12*, 13*, 15, 17, 18, 20, 22
Comments	Similar to the above, numerous mitigation options for this area have been identified. Short term mitigation options are largely associated to reducing access and population around this area and access though Godley Quay. The QRA risk contours and their drivers are the focus for this area that would

	impede future development options. These risks are driven from “inside the fence” of private land. Natural hazards in this area are able to be either designed out through engineering design practices or managed through emergency planning (tsunami risk).

Area of note	Naval Point cliff below Brittan Terrace
3	
QRA	QRA risk contours of 1 x 10^{-6} (yellow) and 1 x 10^{-7} (green) generally follow the contour of the cliff above Naval Point. It is not clear whether these contours are generated by fuel/vapour risk or slope stability. The black line is CCC provided boundary for the area of interest
Multi-Hazard (natural hazard)	A co-location of 2 – 3 natural hazards in this area. These hazards are; vertical displacement (+/- 200mm), slope hazard (rockfall & cliff collapse) and liquefaction (flooding) occurrence. This area is already a CCC managed area having land-use controls and resource consent requirements under the Replacement District Plan (2015)
Mitigation Options – Table 4-1	14*, 19, 20, 22
Comments	Natural hazards relating to the slope hazard (includes rockfall and cliff collapse) are considered significant potential hazards in this area and will be costly to remove or mitigate should this area wish to be developed. This slope hazard area already has land-use controls in place. It is not known to what limit Council has evaluated its acceptable limit of risk to the public. The QRA risk contour of 1 x 10^{-6} (yellow) is predominant in this area. The area “below” the yellow contour is of greater risk. Risk contours occupy public land and therefore QRA mitigation options still apply.

Area of note	Marina Access and surrounding area
4	
QRA	QRA risk contour of 1 x 10^{-6} (yellow) is located inside the area of interest. It is not clear whether these contours are generated by fuel/vapour risk or slope stability.
Multi-Hazard (natural hazard)	A co-location of 2 – 4 natural hazards in this area however this is relatively small. These hazards are combinations of; vertical displacement (+/- 200mm), slope hazard (rockfall & cliff collapse), liquefaction occurrence, and ground water. As with Area 3 above, part of this area is already a CCC managed area having land-use controls.
Mitigation Options – Table 4-1	14*, 19, 20, 21, 22
Comments	Natural hazards relating to the slope hazard (includes rockfall and cliff collapse) are considered significant potential hazards however at this location is confined solely in proximity to the cliff. This slope hazard area already has land-use controls in place. Council has not formally confirmed their evaluated acceptable limit of risk for public exposure however relatively speaking this area would be of lesser concern in providing land use restriction due to shown risks (contours and natural hazards).

** denotes immediate mitigation option*

*** denotes short term mitigation option*

6. Discussion

CCC has been provided with numerous mitigation options for both hazard management and risk contour reduction; however, not all options may be feasible or desirable in both cost and duration to achieve a reduction in risk exposure.

For natural hazard mitigation, decision making is relatively simpler than those associated to the QRA risk contours. For the natural hazards existing and co-existing in the Naval Point area the majority of these can be designed out by standard engineering practices and are provided for in New Zealand design standards. Vertical displacement, liquefaction and ground water effects are all captured under current design guides. Of the options provided for tsunami inundation, reliance on soon to be defined ECan evacuation zones would be appropriate as currently adopted for other parts of Christchurch's coastal areas. Significant cost would be likely to resolve hazards associated to the Naval Point cliff area however this would only be required should the area directly underneath the cliff was wanting to be developed. If the later was envisioned, engineering design practices are likely to be engaged for the design and construction of the solution to secure the cliff face to reduce the potential of harm to activities occupying the area below the cliff over designing buildings/facilities/activities that could survive a cliff collapse.

For QRA risk contours it is important to note that oil companies are required by new legislation "Health and Safety at Work (Major Hazard Facilities) Regulations 2016" to submit safety cases demonstrating they have reduced any risk to as low as reasonably practicable. Safety cases for operators of MHF have to be completed by April 2018 in which case it is likely that owners in the area of Naval Point have already started (and may be finished) producing this documentation. The risk criteria applied to the MHF "inside the fence" is less onerous to "outside the fence" (i.e. it is accepted that there is a higher risk within a MHF). Any reduction in the risk "inside the fence by the fuel owner/operators will reduce the risk contours "outside the fence" resulting in less risk for CCC to mitigate.

CCC should obtain a copy of all safety cases from all oil companies (who are legally obliged to share with their neighbours). It can then be determined whether as a result of the legislation oil companies are required to make any modifications and if so, the results of the QRA would need revisiting (i.e. risk contours will change). This may effect Council's requirement on mitigations options simply because high risk contours may be reduced to inside the fence.

Further, it is not presently known to what limit CCC has evaluated its acceptable limit of risk to the public working, visiting, playing within risk contours provided by the QRA report. Council should seek advice from a QRA Specialist and potentially legal advice, to assist in determining the acceptable limits they wish to work towards. Once this is realised, and oil companies safety cases known, CCC can begin to make meaningful decisions around the mitigation options. Delivering mitigation options without understanding what acceptable limit is appropriate (or legally required) to be reached may, despite best intentions, not provide a reduction to risk as intended.

In the absence of risk criteria to be used for evaluation of risk acceptability, CCC should be aware of the results in the QRA report that have identified areas where the fatality risk levels significantly exceed 1×10^{-5} per year. It is possible CCC have an obligation to act immediately on these particular locations to reduce the risk whilst preparing a short and long term strategy. In lieu of QRA Specialist advice, implementing risk mitigation measures which either inform people of an increased risk in the area, or reduce the population in these areas should be given priority.

7. Recommended Further Actions

From review of potential natural hazards and QRA risk contours provided in the Naval Point area, and mitigation strategies provided to date, the following recommendations are made to allow CCC to better reduce public risk. We recommend these actions are completed and have suggested an order in which to complete;

1. Council should seek legal advice as to what obligations they have to act on mitigation options knowing the QRA results and the current case of risk exposure occupying public land

2. Council should confirm its acceptable limit of risk it wishes to reach. This would ideally be done with advice from legal and QRA Specialist resources.

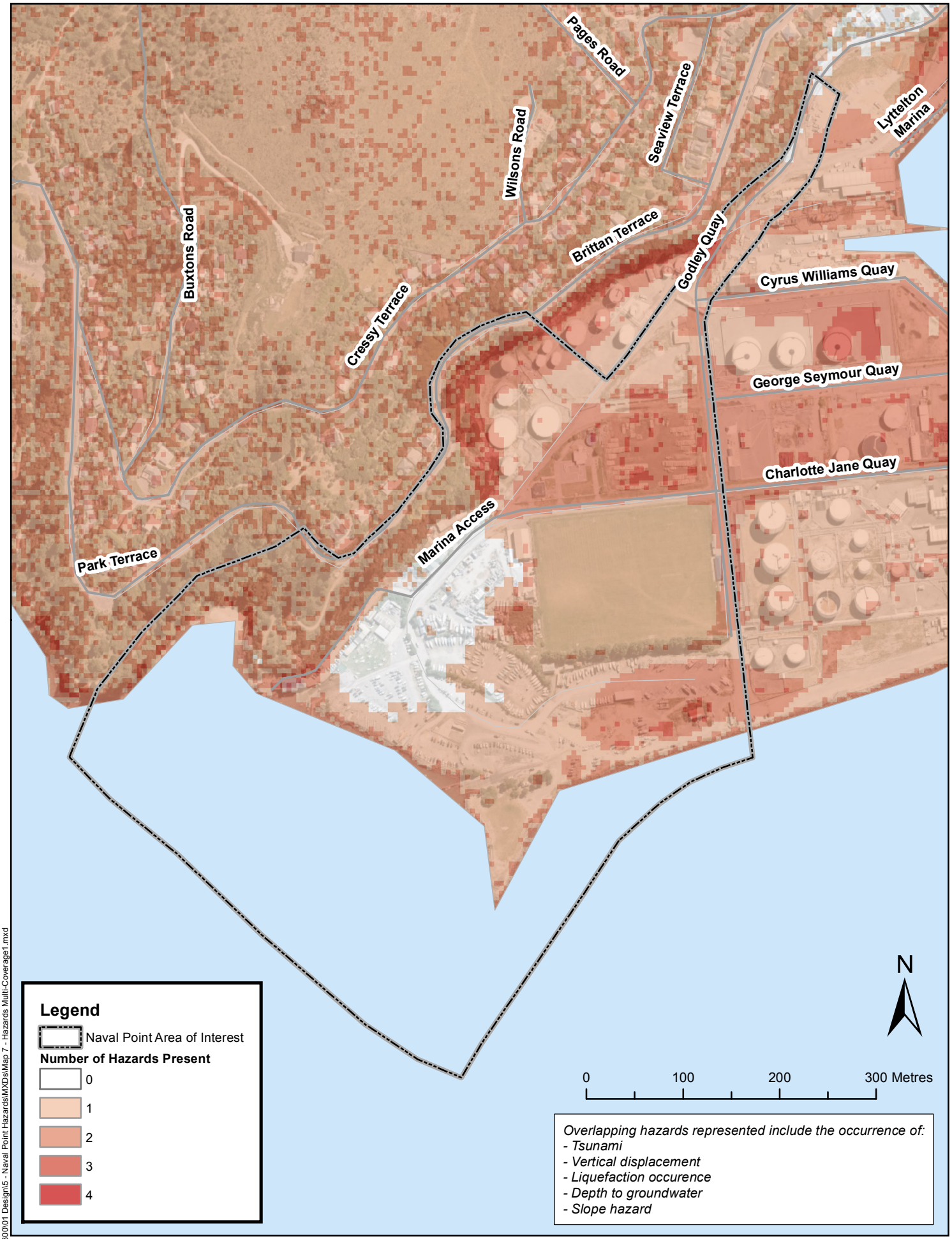
3. Obtain from oil company owners/operators a copy of their safety cases as these are likely to provide cases where the risk contours will be reduced over public land and therefore remove applicable mitigation options currently provided.

4. Engage a QRA Specialist to review oil company owners/operators safety cases and mitigation options in order to best understand which options are best for CCC in reducing public exposure to risk on CCC land (“outside the fence”).

5. In lieu of a QRA consultant it is recommended Council begin implementing risk mitigation measures which inform and/or reduce the population in areas occupied by risk contours of 1 x 10-4 and 1 x 10-5 (purple and red contour lines respectively in the QRA) in ‘Areas of Note’ 1 and 2 as provided in Table 5-1. Council should begin on implementing immediate measures as listed in Table 4-1 (e.g. signage, and education measures) in occupying these areas while short and longer term planning is progressed.

6. It is recommended council engage a QRA Specialist to provide an assessment of risk reductions scenarios with a cost benefit method. Ideally the analysis should consider both “inside the fence” safeguards by the terminal operators and “outside the fence” safeguards by the council. A structured, systematic approach between CCC and Oil Company owners/operators will avoid the potential for regretful costs. Refer example in Section 4, page 10 regarding a blast wall and increased tank instrumentation.

Appendix A. Map 7: Spatial Co-existence of Multiple Hazards



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Date: 18/08/2017

CCC - Naval Point Hazards

Map 7: Spatial Co-existence of Multiple Natural Hazards

JACOBS SPATIAL
Carlaw Park
12-16 Nicholls Lane
Parnell, Auckland
Tel +64 9 928 5500
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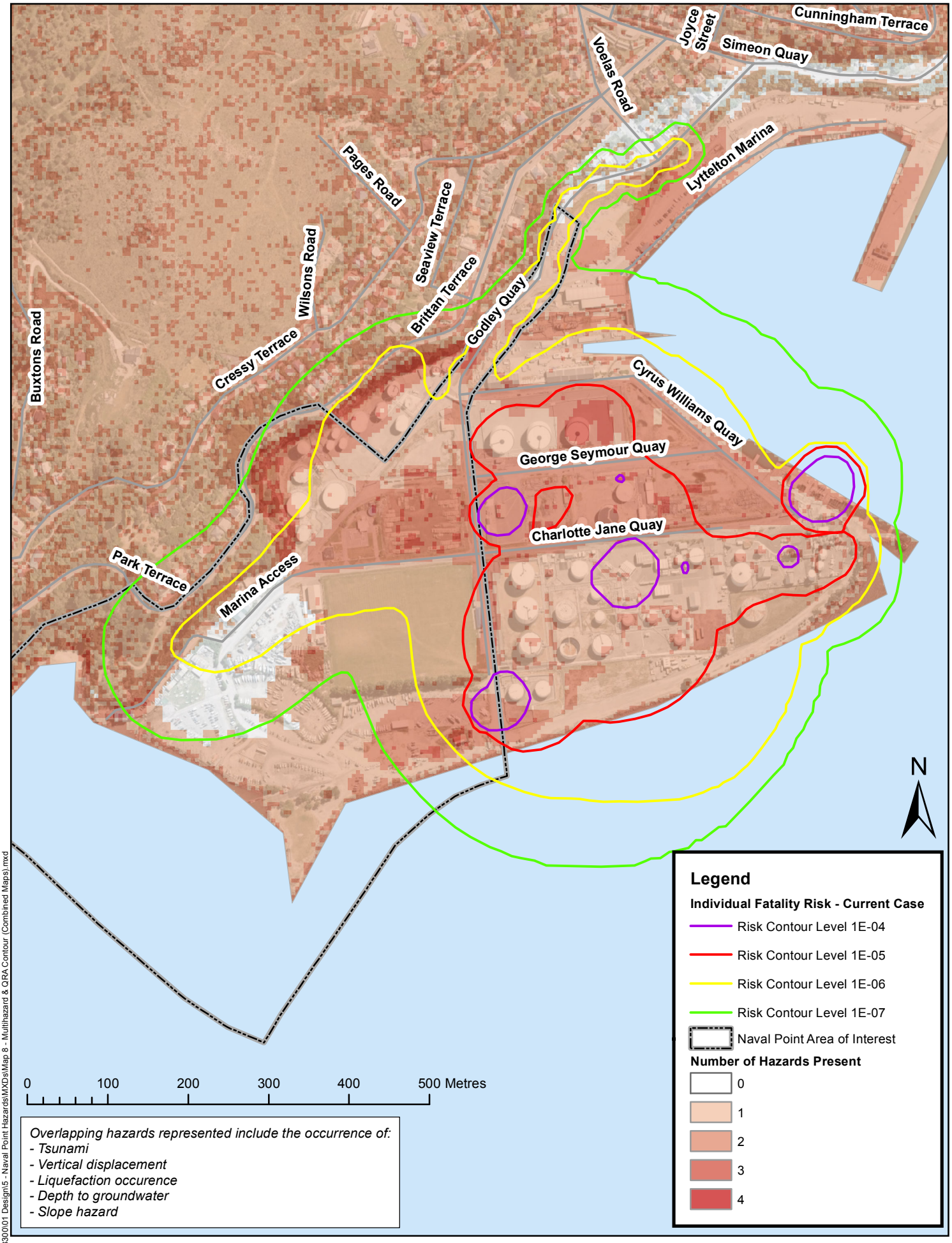
Appendix B. Map 8: Multihazard & QRA Contour



Overlapping hazards represented include the occurrence of:
- *Tsunami*
- *Vertical displacement*
- *Liquefaction occurence*
- *Depth to groundwater*
- *Slope hazard*

Date: 18/08/2017

CCC - Naval Point Hazards

Map 8: Multihazard & QRA Contour (Combined Maps)

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Appendix C. Worley Parsons Memo – QRA Mitigation Suggestions

Advisian
WorleyParsons Group

Memorandum

To:	Richard Osborne	**Date:**	18 November 2016
CC:	Markus Benter-Lynch, Eric Banks, File	**From:**	Kristin Hoskin
Doc No:	170396-MMO-C0005	**File Loc:**	Y:\Chch\170396\Admin\Correspond\MMO
Subject:	Risk Mitigation Suggestions	**Project:**	170396

Following discussions to date, below are some examples of initiatives that CCC could progress to reduce risk exposures related to the QRA report findings. These suggestions may be used for discussion internally and in consultation with stakeholders should CCC decide risk mitigation is warranted. As discussed, ideally a cohesive strategy that includes immediate needs, interim solutions and permanent changes should be developed.

The suggestions are provided for the purpose of assisting CCC to begin to develop a risk management plan for Naval Point considerate of short and long term plans for the area.

Suggestions are customised for Naval Point but are based on initiatives implemented in various localities where high risk activities and residential communities are close to one another. Implementation of these initiatives will not affect the PCBU(terminal operators)'s duty of care to ensure, so far as reasonably practicable, that people are not put at risk..

In the following sections individual suggested actions are listed in order of likely impact in reducing risk.

1 Reduce the population in the higher risk areas.

1.1 Short Term Risk Management

1.1.1 Use of physical barriers such as gate access control (e.g. locks, gatemen) be used by operators.

1.1.2 Temporary traffic management options be discussed with operators, and appropriate TMPs be encouraged to be submitted by operators.

1.1.3 Limit parking in the higher risk area including the length of Godley Quay.

1.1.4 Signage for access restrictions to facilities be reviewed and improved where appropriate, including delineation of property boundaries adjacent to public access areas.

1.1.5 Establish ability to quickly restrict access to Godley Quay south of Voelas Road (except for emergency vehicles) in an incident. Install electronic warning signs on Godley Quay at Voelas Road and Simeon Quay.

1.1.6 Decommission the sports changing rooms nearest the tank farm and arrange temporary facilities at the opposite end of the sports field.

1.1.7 Consider installing physical deterrents (tree line, walls, fence, cameras, etc.) along the east end of the public field to reduce the number of the public parking / accessing the field from this location.

1.1.8 Consider shore signage and exclusion zones for marine traffic (based on consultation with operators, LPC and other relevant stakeholders).

1.2 Long Term Risk Management

1.2.1 Conduct a traffic study to confirm ingress/egress capability for area.

1.2.2 Begin discussions with the LPC regarding longer term strategy for access/egress to Naval Point through land swaps and easements for the purpose of reducing recreational traffic adjacent to the tank farm.

1.2.3 Install a new pedestrian and cycle connection from Te Ana Bay to Naval Point for access/egress between the two recreational areas and for emergencies.

1.2.4 Provide a new alternative route to Naval Point for marina traffic and users of the reserve.

2 Inform and equip workers on CCC assets in the higher risk areas of expected safe procedures, policies, and practices appropriate to worker risk exposures.

2.1 Short Term Risk Management

2.1.1 Include risks in scoping and/or task analysis for any CCC workers or contractors doing works in the area. E.g. parks staff, roading maintenance.

2.1.2 Maintain a risk register for CCC assets that workers/contractors can reference to.

2.2 Long Term Risk Management

2.2.1 Consider land swap as outlined in 1.2.2 to minimise need for CCC to commission work in higher risk areas.

3 Work with operators and Port to educate tenants and users about risk exposures and risk management related to risk exposure

3.1 Short and Long Term Risk Management

3.1.1 Educate CCC tenants on appropriate response to an incident.

3.1.2 Educate tenants on minimising risk exposure.

3.1.3 Require regular drills of tenant emergency procedures in recreation area.

3.1.4 Ensure tenants are aware and have appropriate controls to make buildings emergency plans safe.

3.1.5 Install wind socks and audible/visible alerts that can help hasten evacuation to places of safety.

3.1.6 Encourage and participate in multiagency emergency exercises related to QRA scenarios.

4 Define acceptable risk exposure limits and requirements.

4.1 Short Term Risk Management

4.1.1 The operators at the tank farm are currently transitioning towards meeting the Major Hazard Facilities Regulations that came into effect with the Health and Safety at Work Act. The transition period extends through into 2018. Until transition to meet the MHF Regulations is complete, alignment with acceptable risk criteria as per HIPAP 4 (as is used in Australia) could be considered a reasonable measure for determining high risk area for the next two years. As indicated in the QRA, societal risk is generally within the as low as practicable (ALARP) range, close to the HIPAP4 acceptable level. The geographic area bordering Godley Quay and the east end of the sports field is outside the limit for HIPAP4 recreational individual fatality risk. Adoption of suggestions presented elsewhere in in this memo can contribute to reducing public exposure to that risk.

For such purposes the QRA Report Table 5.2 outlines risk criteria. Following HIPAP4 the sports field boundary limit would be an individual fatality risk of $1x10^{-5}$. For societal risk the risks of current operations are presented in Figure 7.1 (blue line) and figure G2.1 (as the red line).

4.1.2 Ensure that Council records (and other utility operators) outline the assets, hazards, and restrictions in activities around the terminal (e.g. pipeline easements, restrictions to roadworks, electricity infrastructure repair / maintenance in high risk areas).

4.2 Long Term Risk Management

4.2.1 Anticipate impact of MHF Regulations compliance as part of planning for activities in areas adjacent to the tank farm in the future.

5 Work with operators and Port to coordinate activities timing in order to minimise risks.

5.1 Short Term Risk Management

5.1.1 Aim to minimise peak user occupancy and higher risk activities in tank farm coinciding. This may include scheduling loading operations so that they do not coincide with sports events.

5.1.2 Aim to minimise tanker movements and peak public traffic movements coinciding. This may include agreeing to restrict tanker movement on certain days or at certain times of day.