31 October 2025

Alice Blackwell
s7(2)(a) [redacted]

Tēnā koe Alice,

Request for Information – Local Government Official Information and Meetings Act (LGOIMA) 1987

We refer to your official information request dated 6 October 2025, seeking information related to the Hutt City Council District Plan. Specifically, you requested:

> *Can you please provide me with the following information*:
>
> 1. *A copy of the Fuel Companies draft submission on the HCC District Plan? (it is noted that this feedback is referenced in the Fuel Companies primary submission).*
>
> 2. *Any information that informed, with respect to the Hazardous Substance Risk Management Overlay, including its*
>   *a) location*
>   *b) extent*
>   *c) risk category.*

Answer:

In response to your request, please refer to the appendices below, which detail the documents in scope and our decision on their release. Some information has been withheld under section 7(2)(a) of the LGOIMA, to protect the privacy of natural persons.

In addition, the Section 32 Evaluation Report for the Hazardous Substances chapter of the Proposed District Plan is publicly available and can be accessed at the following link: **Section 32 Evaluation Report**.

Some of the documents provided in **Appendix 3** are specialised spatial data files (e.g., GIS shapefiles). These have been included for completeness. Please note that these files may require specialist software to open and view. Council is not required to create new information to respond to a request, which includes converting or reformatting data into a different form. For this reason, the files are provided in their original format.

You have the right to seek an investigation and review by the Ombudsman of this response. Information about how to make a complaint is available at: **Office of the Ombudsman - Complaints**, or freephone 0800 802 602.

Please note that this response to your information request may be published on Hutt City Council's website: **Proactive releases - Hutt City Council**.

Ngā mihi nui

Lakna Siriwardena
Legal Operations Advisor

Appendix 1: Documents for release – 2021 to 2022

Number	Date	Document Type	Title/Subject Line	Redaction Grounds
1	2 November 2021	Email	Oil Industry Mapping	Some information has been withheld under s7(2)(a)
1(a)		Letter	Lower Hutt District Plan Review – Explanation of Seaview Wharfline and Terminal Risk Contours Plan	Some information has been withheld under s7(2)(a)
1(b)		Planning Document	Seaview Wharfline and Terminal Risk Contours	Some information has been withheld under s7(2)(a)
1(c)		Table Document	Terminal List LFL Comparison	Released to you in full

Appendix 2: Documents for release – 2024 (to May)

Number	Date	Document Type	Title/Subject Line	Redaction Grounds
1	15 May 2024	Letter	Fuel Companies further feedback to Hutt City Council (HCC) in relation to the Draft Hutt City District Plan – Iteration 2 (risk management framework)	Some information has been withheld under s7(2)(a)
1(a)	1 November 2012	Document Pack	Appendix A: BP Seaview Terminal QRA	Some information has been withheld under s7(2)(a)
1(b)	1 February 2018	Document Pack	Appendix B: Z Energy Seaview Terminal QRA	Some information has been withheld under s7(2)(a)
1(c)	25 June 2018	Document Pack	Appendix C: Mobil Seaview Terminal QRA	Some information has been withheld under s7(2)(a)
1(d)	1 September 2022	Document Pack	Appendix D: NZOSL Hutt City Terminal MAPP	Released to you in full
1(e)	15 May 2024	Planning Document	Appendix E: Risk Contour Plan (2024)	Some information has been withheld under s7(2)(a)
1(f)	15 May 2024	Document Pack (Excerpt)	Appendix F: Chapter 4.1 of the CDP	Released to you in full
1(g)	Date unknown	Document Pack (Excerpt)	Appendix G: Chapter E29 of the AUP	Released to you in full

Appendix 3: Documents for release – 2024 (to October)

Number	Date	Document Type	Title/Subject Line	Redaction Grounds
1	25 October 2024	Email	Fuel Companies Letter 5 - Draft Hutt City District Plan	Some information has been withheld under s7(2)(a)
1(a)		Letter	Fuel Companies further feedback to Hutt City Council (HCC) in relation to the Draft Hutt City District Plan – Iteration 5	Some information has been withheld under s7(2)(a)
1(b)		Report	BP Oil New Zealand Risk Assessment Report	Some information has been withheld under s7(2)(a)
1(c)		Planning Document	Hutt City Contour Plan	Released to you in full
1(d)		Document	Draft Hutt City District Plan - Summary of Fuel Co feedback to date	Released to you in full
1(e)		Risk Contour Spatial Data (Shapefiles)	Includes GIS files showing risk contour polygons and flammable limit lines used for the Hazardous Substance Risk Management Overlay	Released to you in full

Appendix 4: Documents for release – 2025 (November onwards)

Number	Date	Document Type	Title/Subject Line	Redaction Grounds
1	25 October 2024	Email	Fuel Companies Letter 5 - Draft Hutt City District Plan	Some information has been withheld under s7(2)(a)
1(a)	22 November 2024	Report	Report - Hutt City Terminal Quantitative Risk Assessment For New Zealand Oil Services Ltd (NZOSL)	Some information has been withheld under s7(2)(a)
2	25 October 2024	Email	Hutt City District Plan - NZOSL QRA and Wharfline Risk Corridor	Some information has been withheld under s7(2)(a)
3	27 January 2025	Email	Hutt City Proposed District Plan Notification Date and Feedback on Comments	Some information has been withheld under s7(2)(a)

Appendix 5: Documents for release – Fuel Companies Feedback on Draft District Plan

Number	Date	Document Type	Title/Subject Line	Redaction Grounds
1	15 December 2023	Email	Fuel Companies' Comments on the Draft Hutt City District Plan	Some information has been withheld under s7(2)(a)
1(a)	15 December 2023	Document Pack	Comments by the Fuel Companies on the Draft Hutt City District Plan	Some information has been withheld under s7(2)(a)
1(b)	15 December 2023	Document Pack	Comments by Z Energy on the City of Lower Hutt Draft District Plan	Some information has been withheld under s7(2)(a)
2	25 October 2024	Email	Fuel Companies Letter 5 - Draft Hutt City District Plan	Some information has been withheld under s7(2)(a)
2(a)	Date unknown	Report	Cultural Impact Report – NZ Oil Services Terminal Sea View, Lower Hutt	Released to you in full
2(b)	Date unknown	Email	Hutt City Plan Item 19 on Located on 55 Port Road	Some information has been withheld under s7(2)(a)
2(c)	28 March 2018	Document Pack	Hutt City Plan Item 19 (Significant Cultural Resource Site)	Some information has been withheld under s7(2)(a)

Number	Date	Document Type	Title/Subject Line	Redaction Grounds
3	3 July 2024	Email	Fuel Companies' Comments on the Draft Hutt City District Plan	Some information has been withheld under s7(2)(a)
3(a)	9 August 2024	Letter	Fuel Companies further feedback to Hutt City Council (HCC) in relation to the Draft Hutt City District Plan – Iteration 4 (response to Council's email dated 9 July 2024)	Some information has been withheld under s7(2)(a)
3(b)	September 2017	Document Pack	Worley Parsons – NZOSL Hutt City Safety Case – Tank Overflow Vapour Dispersion and Blast Effects Assessment	Some information has been withheld under s7(2)(a)
3(c)	Date unknown	Memo	P + P Technical Note: Controls for Location Classification Change	Some information has been withheld under s7(2)(a)

From: David Le Marquand <DavidI@s7(2)(a) >
Sent: Wednesday, 3 November 2021 9:27 am
To: Nathan Geard
Subject: [EXTERNAL] FW: Oil Industry Mapping
Attachments: Seaview Wharfline and Terminal Risk Contours_v1.0_22.10.2021_low res (1).pdf; Hutt City Risk Contour Plan Letter (1).pdf; Terminal List LFL Comparison.pdf

Categories: SHORT TERM RESPONSE

Hi Nathan – apologies – should have copied you in on this.

Cheers Dave

David le Marquand
Principal Planning and Policy Consultant
Mobile: s7(2)(a)
4Sight.Consulting

From: David Le Marquand
Sent: Tuesday, 2 November 2021 11:07 am
To: Hamish Wesney <Hamish.Wesney@huttcity.govt.nz>
Subject: Oil Industry Mapping

Hi Hamish

Please find attached letter and plan showing risk information for the Seaview area relating to the four fuel company terminals (Major Hazardous Facilities) and some potential pipeline route options. I am aware there is some sensitivity around the identification of the pipeline route options from some local occupancies and have been requested by the fuel companies to request Council to advise us if there are any disclosure requests.

I am also happy to clarify or contextualise any of the matters we have presented in this information package. Maybe if you can look to give me a call once you have digested the information.

Cheers Dave

David le Marquand
Principal Planning and Policy Consultant

Mobile: s7(2)(a)

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Document 1(a)

4SIGHT CONSULTING

2 November 21

Hamish Wesney
Divisional Manager District Plan Policy
Hutt City Council
Private Bag 31-912
Lower Hutt 5040

By e-mail: Hamish.Westney@huttcity.govt.nz

Dear Hamish,

Re: Lower Hutt District Plan Review – Explanation of Seaview Wharfline and Terminal Risk Contours Plan

The attached Risk Contour Plan (the Plan) has been produced on behalf of the fuel companies at the request of the Hutt City Council as part of the input into its District Plan Review. It is of relevance to the consideration of hazardous substances, appropriateness of zoning and compatibility of land use activities for the current industrial Seaview area.

Within the Seaview area are four fuel company bulk storage terminals. These facilities are Major Hazardous Facilities under the Health and Safety at Work (Major Hazardous Facilities) Regulations 2016. All are lower tier facilities.
They are:

a. Mobil Seaview Terminal (Seaview Road)
b. BP Seaview Terminal (Port Road)
c. Z Seaview Terminal (Seaview Road)
d. Hutt Terminal (a joint owned terminal (BP and Z) operated by NZ Oil Services Ltd

These terminals receive their fuel supplies from regular ship deliveries via the Seaview wharfline. The wharfline runs from the Seaview wharf and connects to each terminal. The current wharfline has been undergoing resilience upgrading in and along the waterfront area. The next stage of the wharfline project is to reroute the section of wharfline running along Barnes Street (between the Z Terminal and Hutt Terminal) to either traverse around the rail corridor (from the Z terminal) or construct a new line around Port Road to the Hutt Terminal. Decisions have yet to be finalised on the preferred route.

Three of the terminals have had a Quantitative Risk Assessment (QRA) undertaken. Risks at each terminal have been assessed against New South Wales risk acceptance criteria (Hazardous Industry Planning Advisory Paper No 4 Risk Criteria for Land Use Safety Planning). There are currently no NZ risk acceptance standards and the HIPAP criteria have been used in other New Zealand jurisdictions. The risk models used for the QRA's have generated a series of individual fatality risk contours for each terminal (the point at which there may be a chance of fatality if one were to stay in that location for an entire year). Different contours reflect the level of risk suitable for certain land use types. To avoid undue clutter within the Plan we have elected to show only the sensitive land use criteria contour of 0.5×10^{-6} (this pertains to hospitals, childcare facilities, old age housing etc) around the terminals. Other criteria (residential 1×10^{-6}, commercial 5×10^{-6} and open space 10×10^{-6}) will be inside the contour we have shown.

We have also used the 0.5×10^{-6} contour for the wharfline options, and which equates to a 40m offset distance either side of the wharfline centreline for each route. AS2885.6 (the relevant pipeline standard) makes the comment that overseas data (i.e., the data used in the 2009 Lloyds report) has

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I would be happy to discuss these matters further with you.

Kind Regards,

David Le Marquand
Principal Planning and Policy Consultant
4Sight Consulting Ltd

Encl: Annexure 1 – Table 1 Terminal List LFL Comparison

Annexure 2 – Seaview Wharflines and Terminal Risk Contours v1 22 10 21

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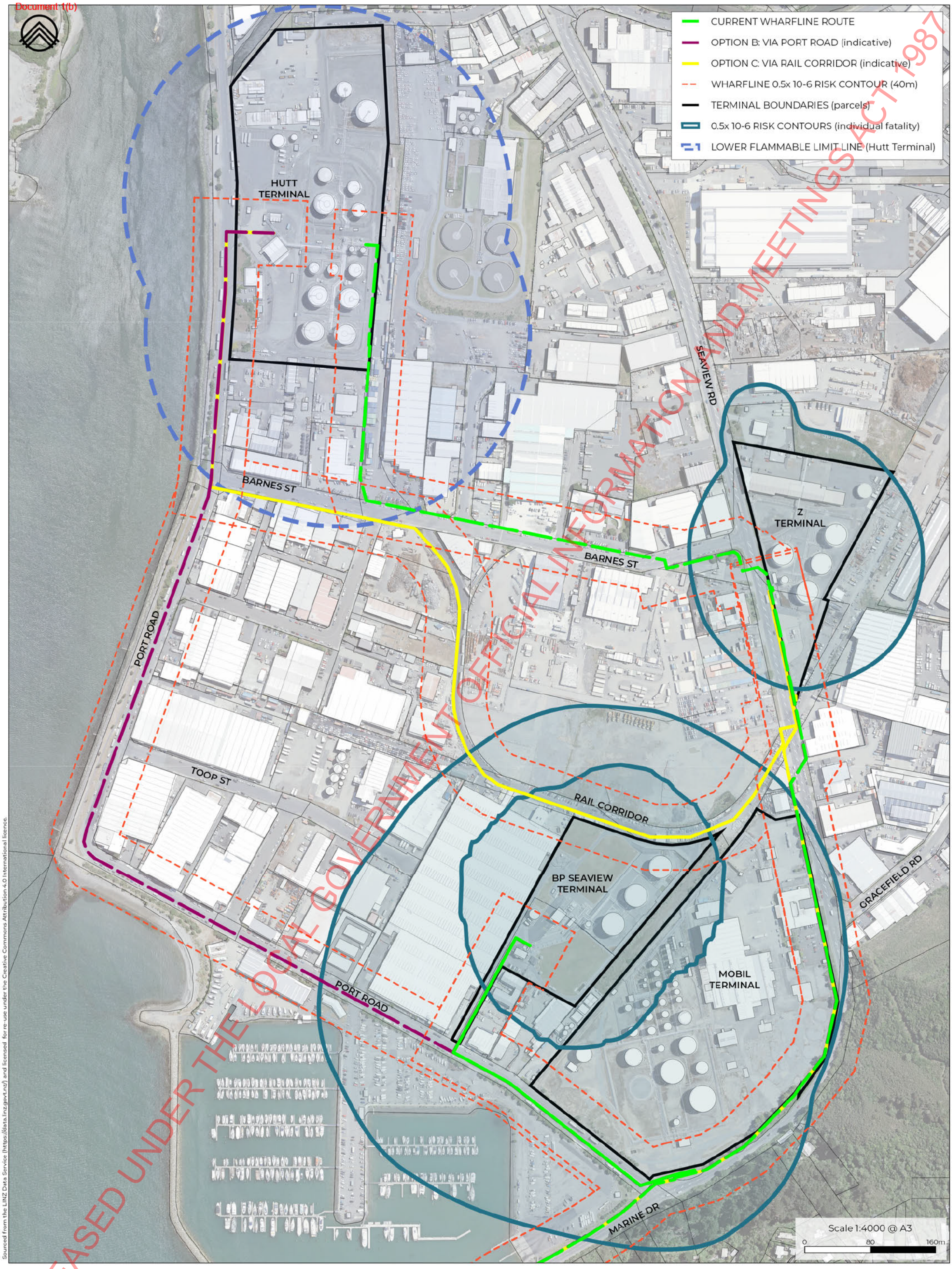
Document 1(b)



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4SIGHT CONSULTING

8510 - Hutt City District Plan Review (OIEWG)

SEAVIEW WHARFLINE AND TERMINAL RISK CONTOURS

Figure prepared for HCC by 4Sight Consulting.

Date: 22/10/2021
Version 2.0
Drawn: s7(2)(a)
Checked: s7(2)(a)
Approved: s7(2)(a)

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TABLE 1: Terminal Comparisons for LFL from Tank Overfill

MOBIL SEAVIEW TERMINAL*[1]					
Tank	Product	Diameter (m)	Height (m)	Lower Flammable Limit LFL (m)	Distance (m) to Risk Contour 0.5 x10^{-6} from tanks
T53	91	31.6	14.6	380	As per LFL
T54	91	14.6	14.6	290	As per LFL
T64	Premium	21.9	14.7	334	As per LFL
T86	91	22.0	14.5	334	As per LFL
T84	91	22.0	14	330	As per LFL
Z TERMINAL SEAVIEW ROAD/BARNES STREET*[2]					
T519	91	26.5	11.1	363	105 – 145
T524	Premium	23.5	11.1	339	
BP TERMINAL PORT ROAD*[3]					
T2	91	27.2	14.5	163 (2009 report) 231 (10min) 327 (20min)	100-200
T3	98	27.2	14.5	163 (2009 report) 231 (10min) 327 (20min)	100-200
HUTT TERMINAL (NZOSL)					
WP1	91	25.1	12.8		
WP4	91	25	14.1		
WP2	91	25.3	13.2		
WP5	Premium	25	14.1	223 (10min) 316 (20min)	Using only LFL
WP10	91	25	14.1		

*[1]Mobil fill rate assumed at 650m^3/hr. 30min overfill (325m3)

*[2]Z Fill rate assumed at 900m3/hr 30min overfill (450m3)

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*[3] BP fill rate assumed at 1237m^3. 20min overflow (408 m3)

*[4] Hutt fill rate assumed at 1237m^3. 10min overflow (204 m3) (they do also model a 20min release)(408m3)

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SLR Consulting New Zealand
□□□ Victoria Street □ est □uc□land □□□□□□e□ □ealand

□□ May □□□□

SLR Ref □o□□Draft □utt City District Plan Fuel Companies□Feedbac□ □Iteration □□v□□□

□ttention□□amis□ □ esney □ Step□en Davis

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Via email□
Step□en□Davis□ □uttcity□govt□n□
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SLR Pro□ect □o□□□□□V□□□□□□□□□□□

RE: Fuel Companies further feedback to Hutt City Council (HCC) in relation to the Draft Hutt City District Plan – Iteration 2 (risk management framework)

Dear □amis□ □ Step□en□

In December □□□□t□e Fuel Companies provided feedbac□ in relation to t□e Draft □utt City District Plan □draft plan□□Subse□uently□t□e Fuel Companies □Dave Le Mar□uand and P□il Bro□n of SLR□met □it□ bot□ of you on □ February □□□□ to discuss t□is feedbac□□particularly regarding establis□ing a ris□ management frame□or□ in relation to t□e fuel terminals in Seavie□□□ number of ot□er matters □ere also discussed□

During t□e meeting□it □as agreed t□at t□e Fuel Companies □ould provide furt□er feedbac□ to □CC by May □□□□□and t□at t□is is li□ely to be an iterative process□□ e understand t□at Council intends to notify t□e proposed district plan in t□e □rd □uarter of □□□□□

T□e first iteration response addressed t□e □atural □a□ards C□apter and some □ey definitions proposed in t□e draft plan□sent to you in a letter dated □ May □□□□□

T□is second iteration response addresses ris□ management in relation to t□e fuel terminals□

Health and Safety at Work (Major Hazard Facilities) Regulations 2016

T□e □ealt□ and Safety at □or□ □Ma□or □a□ard Facilities□Regulations □□□□ □M□F Regs□ mandate specific duties relating to process safety t□at apply to designated Ma□or □a□ard Facilities □M□Fs□and outline re□uirements for potential M□Fs□

T□ere are t□o types of M□Fs – □pper Tier and Lo□er Tier□T□e difference bet□een t□em is t□e aggregated □uantities of specified □a□ardous substances on site□□pper Tier facilities are re□uired to □ave a safety case □Regulation □□ of M□F Regs□and provide general information to t□e local community about its operation □Regulation □□□□Lo□er Tier M□Fs are not sub□ect to t□ese re□uirements□but must □ave a Ma□or □ccident Prevention Policy □M□PP□in place□ and are re□uired to notify t□e local community of a ma□or incident □Regulation □□□and provide general site information to t□e public □Regulation □□□□□ □ile not re□uired under t□e M□F Regs□t□e terminal operators regularly consult □it□ neig□bouring properties via information letters and pamp□lets□T□e Fuel Companies □ould be open to □or□ing □it□ Council to e□plore opportunities for furt□er consulting □it□ neig□bouring properties□

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Document 1

recognising t□at alt□oug□ it is not re□uired under t□e M□F Regs□consultation is beneficial from a ris□management perspective□

□ll four of t□e bul□fuel terminals in Seavie□ are classed as Lo□er Tier M□Fs and □ave M□PPs in place□ Publicly available information in relation to eac□ of t□ese terminals □in accordance □it□ t□e M□F Regs□can be found □ere□ □ttps□□□□□□or□safe□govt□n□topic□and□industry□ma□or□□a□ard□facilities□m□f□public□information □□T□ree of t□e Seavie□ terminals also □ave □uantitative Ris□ □ssessments □□R□s□in place □□ □ic□ are attac□ed as **Appendices A to C**□□T□e fourt□ terminal□t□e □□OSL □utt City Terminal□does not □ave a □R□ in place but does □ave a M□PP □also attac□ed as **Appendix D**□□ □ic□ is t□e best collated document available in t□e absence of a □R□ to understand ris□□

Risk Contour Plan

The Fuel Companies' feedback on the draft plan included a Ris□Contour Plan □□ic□ □as originally sent to □CC in October □□□□□ and determined ris□contours around t□e four terminals and □□arfline as follo□s□

- Ris□contours relative to t□e bp Seavie□□□□ Seavie□□Mobil Seavie□ Terminals □ere determined using t□e sensitive land use criteria contour of □□□ □ □□[1] □pertains to □ospitals□c□ildcare facilities□old age □ousing etc□modelled in t□e □R□s for eac□ of t□e terminals□Copies of t□ese □R□s□□ □ic□ remain accurate as of t□e date of t□is letter□are provided to Council in **Appendix A** □bp Seavie□ Terminal□□**Appendix B** □□ Seavie□ Terminal□□and **Appendix C** □Mobil Seavie□ Terminal□□T□ese □R□s are industry recognised documents[2] □ □ic□ □ave been prepared in accordance □it□ t□e □e□ Sout□ □ ales ris□acceptance criteria □□a□ardous Industry Planning □dvisory Paper □□IP□P□□o □ Ris□Criteria for Land □se Safety Planning□□T□ere are currently no specific □□ ris□ acceptance standards and t□e □IP□P criteria □ave been used in many ot□er □e□ □ealand □urisdictions□
- Given t□at no □R□ □as been prepared in relation to t□e □□OSL □utt City Terminal□a lo□er flammable limit line □as determined relative to t□is terminal using information from t□e September □□□□ □ orley report□□□OSL □utt City Safety Case Tan□Overflo□ Vapour Dispersion and Blast □ffects □ssessment□T□is Safety □ssessment conducted for t□e □utt City Safety Case remains valid and supports t□e M□PP□Given t□at t□e Safety □ssessment contains commercially sensitive information□□e are not in a position to s□are it□□ copy of t□e □□OSL □utt City Terminal M□PP is □o□ever provided to Council in **Appendix D** to t□is letter□
- Ris□contours relative to t□e industry □□arfline route □as of □□□□□□□□ere based on t□e BP Seavie□ □R□ □□ic□ assessed t□e ris□from t□e terminal including t□e relevant section of □□arfline□T□e sensitive land use criteria contour □□□□ □ □□[3]□□as c□osen□T□is e□uates to a □□m offset distance eit□er side of t□e □□arfline and □as e□trapolated to apply to t□e centreline for eac□ route under consideration at t□at time□T□e industry □□arfline is currently being upgraded and re□routed□□it□ t□e Barnes Street route sc□eduled to be decommissioned and t□e rail corridor route already no longer under consideration□T□e proposed □□arfline route □as no□ been finalised□□ e also note t□at □e are presently in

[1] T□e bp Seavie□□□□ Seavie□□Mobil Seavie□□and □□OSL □utt City Terminals are all lo□er tier M□Fs □source□ □ttps□□□□□□or□safe□govt□n□topic□and□industry□ma□or□□a□ard□facilities□m□f□public□information□□□

[2] Appendix A of the Fuel Companies' feedback on the draft Hutt City District Plan, dated 15 December 2023.

[3] T□e □ Seavie□ Terminal and Mobil Seavie□ Terminal □R□s □ere prepared by S□erpa□and t□e bp Seavie□ Terminal □R□ □as prepared by Lloyds□Bot□are reputable consultants t□at □ave e□perience □or□ing on ris□ matters in relation to fuel terminals in □e□ □ealand□T□e bp Seavie□ Terminal □R□ □as gone t□roug□ a resource consent process□and so □as been revie□ed by Council□

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communication □it□ pipeline Specialists regarding setting ris□management provisions in relation to t□e industry □□arfline□T□is is because t□ey do not generally use QRA's for pipelines but rat□er rely on relevant standards □e□g□□S □□□□□□□□T□is □or□may alter t□e approac□ta□en □it□ t□e pipeline ris□management frame□or□and is a matter t□at □ill be e□plored in our ne□t letter to Council □before t□e end of May□□

□n updated version of t□e □□□□ ris□contour plan□s□o□ing t□e same ris□contours around t□e terminals□but updated to reflect t□e final proposed □□arfline route □□e□removal of t□e Barnes Street and rail corridor options□□is provided in **Appendix E** to t□is letter□

Please note t□at t□e Fuel Companies □ave endorsed s□aring t□e □R□s and M□PP □it□ Council□T□ere may be restrictions on s□aring furt□er information due commercial sensitivities□

To avoid undue clutter □it□in t□e ris□contour plan□□e □ave elected to s□o□ only t□e sensitive land use criteria contour around t□e terminals□Ot□er criteria □residential □ □ □□[1]□ commercial □ □ □□[1] and open space □□ □ □□[1]□□ill be inside t□e contour □e □ave s□o□n□□ e consider t□at adopting a conservative approac□ □it□ respect to t□e ris□contours is appropriate□given t□at t□e □R□s informing t□ese ris□contours did not account for cumulative ris□associated □it□ □□□pro□imity to ot□er bul□fuel storage terminals and □□□ pro□imity to t□e industry □□arfline□

Risk Management Overlay

T□e Fuel Companies consider t□at t□e best met□od to establis□a ris□management frame□or□in t□e district plan is via a Ris□Management Overlay□establis□ed using t□e contours provided in t□e **Appendix E** ris□contour plan□T□o district plans provide □elpful e□amples of □o□ suc□ an overlay could □or□□

- T□e Ris□Management □rea in t□e C□apter □□□ □□a□ardous Substances□of t□e C□ristc□urc□ District Plan □CDP□□T□is is attac□ed as **Appendix F** to t□is letter□
- T□e □mergency Management □rea Overlay in t□e □uc□land □nitary Plan □□□P□□T□is is attac□ed as **Appendix G** to t□is letter□

T□e Ris□Management □rea in t□e CDP □**Appendix F**□□□ □ic□sets a ris□management frame□or□around t□e □ oolston pipeline and Mobil □ oolston Terminal □a Lo□er Tier M□F□□ is considered to be a particularly good comparison to t□e Seavie□ scenario□T□e policy frame□or□see□s to *avoid sensitive activities locating within the Woolston Risk Management Area where these have the potential to be exposed to unacceptable risk and/or may otherwise constrain the development, operation, upgrading or maintenance of bulk fuel and gas terminals*□and sets a non□complying activity status for any sensitive activity located □it□in t□e □ oolston Ris□Management □rea□

T□e conte□t of t□e □mergency Management □rea in t□e □□P □**Appendix G**□□□ □ic□provides a frame□or□to manage t□e ris□of adverse effects on activities located in pro□imity to t□e □ iri Oil Terminal□and □ iri LPG Depot□is different to t□e CDP □ oolston and Seavie□ scenarios□T□e □ iri Oil Terminal is an □pper Tier M□F facility and is immediately ne□t to a prison so □as □ig□er levels of ris□□Regardless□it provides ano□er □elpful e□ample of □o□ ris□management provisions could □or□□It sets a pro□ibited activity status for *activities sensitive to hazardous facilities*[1]□along □it□a policy frame□or□see□ing avoidance of suc□ activities□□ e consider t□at a non□complying pat□□ay may be acceptable in t□e Lo□er □utt □ Seavie□ scenario □similar to t□e CDP □ oolston approac□□□along □it□an avoidance policy□It

[1] □ e intend to propose a definition for *activities sensitive to hazardous facilities* in our ne□t iteration of feedbac□ □once □e □ave received Specialist input in relation to t□e industry □□arfline□□

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also re□uires t□at t□e ris□to activities □it□in t□e □mergency Management □rea is managed to acceptable levels by restricting sensitive and incompatible activities and t□roug□ preparation of emergency management plans and design □layout of buildings□

T□e Ris□Management Overlay □ill encompass most of t□e Seavie□ Marina □in t□e Seavie□ Marina Precinct and Industrial □one□□and so provisions □ill need to ensure t□at incompatible and sensitive activities □it□in t□is marina are restricted□and activities are carefully managed to reduce ris□□

Next Steps

Our ne□t iteration of feedbac□ □ill□

- □ddress t□e matter of establis□ing a ris□management frame□or□around t□e industry □□arfline□□ e e□pect t□at our suggested approac□ □ill be to restrict certain sensitive activities in pro□imity of t□e □□arfline□□s indicated□□e are currently eliciting information from Specialists to determine t□e nature of t□e ris□management provisions for t□e □□arfline□
- Build on t□is feedbac□and provide more detail in relation to a ris□management frame□or□around t□e fuel terminals and □□arfline□T□is includes a proposed definition for *activities sensitive to hazardous facilities*□

T□an□you for revie□ing and considering t□is feedbac□□□ e □ould be □appy to discuss t□is feedbac□ □it□you at a time t□at suits and e□pect to provide t□e final iteration of feedbac□ before t□e end of May□

Regards□

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SCANDPOWER Risk Management

Lloyd's Register

BP Seavie□ Terminal □R□ □pdate

Proposed butane storage and blending facility

for BP Oil □e□ □ealand Limited

Report no. □□S□□□□□□□ □□□□□□P□R□□□
Date □□ovember □□□□
Client BP Oil □e□ □ealand Limited

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Rev□no□	Prepared by□	Revie□ed by□	□pproved by□	Date□
Draft □	s7(2)(a)	s7(2)(a)	s7(2)(a)	□□ □ul □□□□
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Title:

BP SEAVIEW TERMINAL QRA UPDATE

Client: BP Oil □e□ □ealand Limited

Client specification:

□ □□

Summary:

BP Oil □e□ □ealand Limited □BP□ operates a petroleum li□uids terminal at Port Road□Seavie□□ □ ellington□T□e terminal stores and loads out bul□ automotive fuels□BP is currently investigating t□e feasibility of adding a butane storage and blending facility□

BP engaged t□e services of LR Scandpo□er to update t□e □R□ study of t□e e□isting terminal □it□ t□e ne□ butane storage and blending facility□T□e main ob□ective of t□is □R□ is to identify □a□ards and assess t□e ris□ of fatality to people offsite from t□e butane storage and blending facility □it□in t□e conte□t of e□isting consented activity and provide and necessary recommendations for improvement□

T□e scope of t□e □R□ covers t□e proposed butane storage and blending facility□ T□e study considered t□e impact on safety outside t□e boundary of t□e Seavie□ Terminal from t□e ne□ butane storage and blending facility□T□e study also considers t□e cumulative impact from t□e butane storage and blending facility and t□e previous □R□ scenarios □□□to e□ternal surrounding areas□

T□e ris□ assessment □as met t□e re□uirements of t□e □utt City Council District Plan□and □e □ave determined t□at t□e ris□ level associated □it□ t□e proposed development is considered acceptable□

T□erefore□based on t□e results of t□e ris□ assessment and using a conservative approac□□it can be concluded t□at t□e addition of t□e ne□ butane storage and blending facilities to t□e consented Seavie□ Terminal site is acceptable and □ill remain compatible □it□ t□e surrounding land uses□It can also be concluded t□at t□e proposed controls for t□e butane storage and blending facility are ade□uate□

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ACRONYMS

Abbreviation	Description
ALARP	As Low As Reasonably Practicable
BLEVE	Boiling Liquid Expanding Vapour Explosion
BP HSE MS	BP Health, Safety and Environmental Management Systems
BP	BP Oil New Zealand Limited
DCS	Distributed Control System
ESD	Emergency Shutdown System
HAZOP	Hazard and Operability study
HCCDP	Hutt City Council District Plan
IR	Infra Red
kPa	Kilopascals
kW/m^2	Kilo Watts per metre square
LFL	Lower Flammability Limit
LPG	Liquefied Petroleum Gas
lpm	Litre's Per Minute
LR	Lloyd's Register
LSIR	Location Specific Individual Risk
LUP	Land Use Planning
m	Metre
m^3	Cubic metres
mins	Minutes
mm	Millimetre
NR	Not Reached
NSW	New South Wales
P & ID	Piping and Instrumentation Diagram
QRA	Quantitative Risk Assessment
RMS	Regular Motor Spirit
SIL	Safety Integrity Level
TWFS	Tank Wagon Filling Station
UFL	Upper Flammability Limit
URS	URS New Zealand Limited
UV	Ultraviolet

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Abbreviation	Description
VCE	Vapour Cloud Explosion

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Appendices

Appendix A: HAZID Minutes and Attendance Sheets

Appendix B: Isolatable Sections

Appendix C: Failure Frequency Data

Appendix D: Event Tree Data

Appendix E: Consequence Assessment Results

Appendix F: Comments from URS and LR Responses

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1. INTRODUCTION

1.1 Background

BP Oil □e□ □ealand Limited □BP□operates t□e BP Seavie□ Fuels Terminal in Lo□er □utt□ □e□ □ealand□

Due to t□e □a□ardous nature of t□e substances □andled at t□e terminal BP □ad commissioned t□e services of LR Scandpo□er to conduct an independent □uantitative ris□ assessment □□R□□ in □□□□ □□□□ T□e □R□ included t□e Seavie□ tan□ terminal and its associated □□arflines and concluded t□at t□e development □as compatible □it□ t□e surrounding land uses□

Currently□BP is investigating t□e feasibility to install a semi□mounded butane tan□ at t□e facility to be able to receive□store and blend butane □also □no□n as Li□uefied Petroleum Gas □LPG□□ into t□e petrol dispatc□ed at t□e terminal□ In order to understand t□e significance of t□is modification in terms of ma□or accident ris□s□BP □as re□uested LR Scandpo□er to update t□e □R□ to incorporate t□is facility□

T□is report documents t□e results of t□e ris□ assessment of t□e butane storage and blending facility and t□e impact it □as on t□e e□isting e□ternal ris□s of t□e terminal□

1.2 Objectives

T□e main ob□ective of t□is □R□ is to identify □a□ards□assess t□e ris□ of fatality to people offsite and provide recommendations for improvement□

T□e □R□ must demonstrate t□at□

- □ll □a□ards □it□ impacts to people offsite □ave been identified□
- □ll controls □ave been identified□
- T□e conse□uences of t□e identified □a□ards □ave been □uantified□and t□e potential impacts to people offsite t□e facility □ave been assessed□
- T□e probability of occurrence of all t□e □a□ards □ave been assessed□
- T□e cumulative ris□ of t□e Seavie□ Terminal and t□e proposed butane storage and blending facility □ave been considered□
- □ppropriate and tec□nically sound assumptions □ave been made□
- T□ere are sufficient controls in place to reduce t□e ris□s belo□ t□e fatality ris□ criteria□

Table □ s□o□s t□e ris□ criteria of □S□ Department of Planning for Land □se Planning □L□P□ □□ic□ □as been accepted by t□e □utt City Council District Plan □□CCDP□ for assessing t□e original development of t□e terminal in □□□□ □□□□

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Table 1: Risk Acceptance Criteria for LUP

Land Use	Maximum Acceptable Location Specific Individual Risk (LSIR) [x10-6 per year]
Hospitals, schools, child-care facilities, old age housing	0.5
Residential, hotels, motels, tourist resorts	1
Commercial developments including retail centres, offices and entertainment centres	5
Sporting complexes and active open space	10
Industrial	50

For further details of the risk criteria selected please refer to the previous QRA report [2].

1.3 Scope

The scope of the QRA covers the proposed butane storage and blending facility and considers the impact on people outside the boundary of the Seaview Terminal. The study also assesses the cumulative risks of the existing terminal and the proposed butane storage and blending facility.

The QRA has been prepared according to the criteria provided in Chapters 6B (Special Business Activity Area) and 14D (Hazardous Substances) of the HCCDP.

For further information please refer to the previous QRA report [2].

1.4 Facilities Covered

The facilities which have been considered in this study are:

1. The road wagons delivering the LPG to site,
2. The LPG unloading facility (i.e. flexible hose) and associated piping from the unloading bay to the storage tank,
3. The LPG storage tank, and
4. The underground piping from the LPG storage tank to the butane injection point.

Figure 1 shows the location of the above facilities on the site plan.

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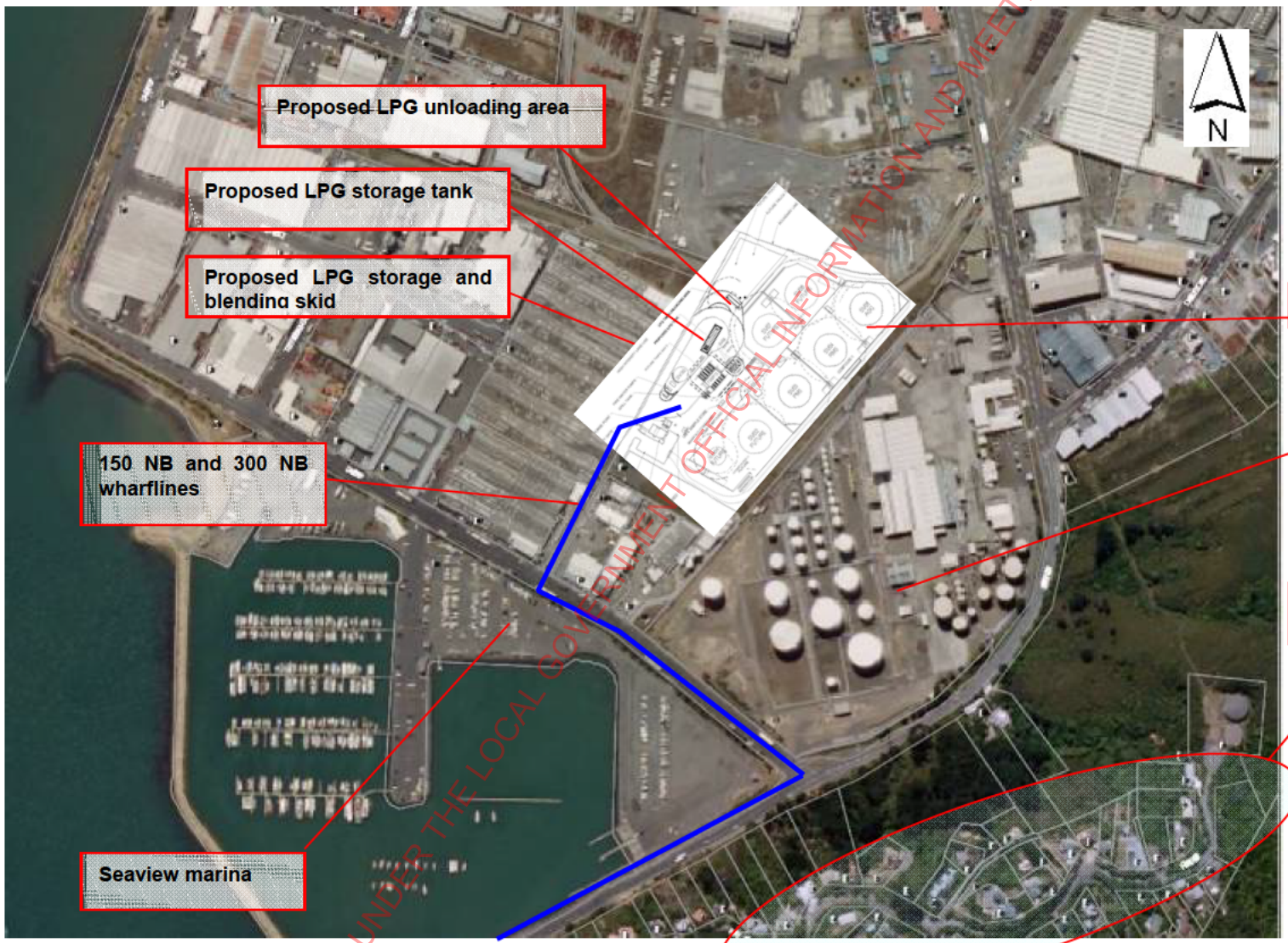
Figure 1: Aerial of Seaview area and location of proposed butane storage and blending facility location



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2. PROJECT DESCRIPTION

BP operates a petroleum terminal at Port Road, Seaview, Wellington. The terminal stores and loads out bulk automotive fuels. BP is investigating the feasibility of dosing of regular motor fuel with liquid butane.

The main functionality required of the new site is outlined in Table 2 below.

Table 2: Functionality of Butane Storage and blending Facility

Item	Description
1	Receive product from LPG road tank wagons into bulk storage
2	Supply product from bulk storage to the existing tank wagon filling shelter at the design pressure and flow rate for: • One loading arm initially • Future provision for expansion to ultimately three additional loading arms

A brief description of the facilities covered in the QRA study is given in the sections below. For further information please refer to the project concept design report [1].

2.1 LPG Road Wagon

LPG road wagons will access and leave the terminal via the same entrance/ exit on Port Road as the fuel tank wagons. The selected location of the unloading point allows the LPG tanker to terminate a delivery and exit from the site should there be an incident at the bulk fuel storage tanks.

2.2 LPG Unloading Station

A LPG unloading bay will be formed to the east of the existing tanker turnaround area. The unloading bay will be separated from the tanker turnaround by a concrete island. The unloading bay will have a flexible unloading hose which will be connected to the road wagon for unloading. The pump inside the road wagon will unload the LPG at a maximum flowrate of 5.6 kg/s.

2.3 LPG Storage Tank

The LPG storage tank will be semi-mounded approximately 50% below existing grade and covered with soil to a minimum depth of 600 mm in a semi-mounded configuration. The LPG tank will be located in the grassed area in the centre of the existing truck turnaround. The LPG tank will have a capacity of 112 m^3 and will be designed to contain propane.

2.4 LPG Dosing

Butane will be blended into the regular motor spirit (RMS) at the gantry at a rate of about 4% on average but not exceeding 7% by volume (about 120 lpm). The flow of butane

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dosed is □□□ □g□s assuming t□at □ petrol road □e□g□□ loading arms□are being loaded simultaneously□

T□e butane □ill be li□e an additive in□ection system□T□ere □ill not be any bul□ load out facilities for butane□

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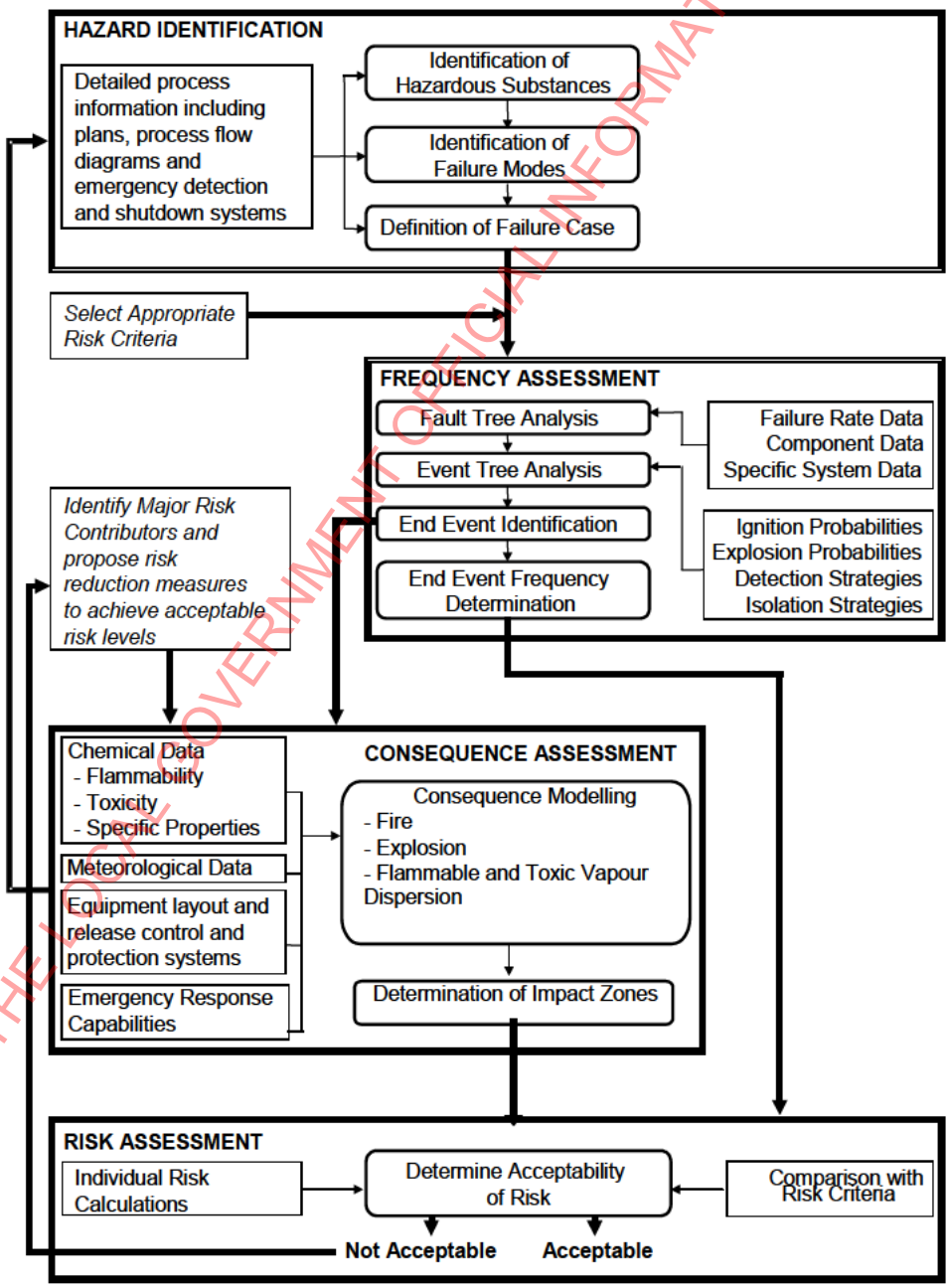
3. METHODOLOGY

The methodology applied is summarised in the following diagram (Figure 2). The major steps of the QRA study are as follows:

- Hazard identification
- Frequency assessment
- Consequence assessment,
- Risk assessment.

Figure 2: QRA Methodology Flow Diagram



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Please refer to t□e previous □R□ report □□□for detailed information on t□e met□odology□

3.1 Main assumptions

□ ris□ assessment re□uires modelling of real conditions using idealistic appro□imations □assumptions□□ T□is may relate to lea□ si□es□representative materials□ etc□ T□is is a necessary part of t□e assessment□and t□e □uality of t□e assumptions influences t□e outcome□as □ell as t□e level of uncertainty in t□e ris□assessment□

T□e main assumptions ta□en for t□is study are as follo□s□

□□ T□e piping do□nstream of t□e dosing station □as been e□cluded from t□is □R□ study□T□is is because t□is section of piping □containing gasoline□ □as considered and covered in t□e previous □R□ study □□□□□lt□oug□ t□ere □ill be butane □ma□imum □□ by volume□added to t□e gasoline□it is not e□pected t□at ris□s associated □it□ t□at section of t□e gasoline piping □ill c□ange significantly□

□□ Lea□s from road □agons on site □ave not been included in t□e □R□ as t□is ris□ is very lo□ due to a very lo□ li□eli□ood i□e□t□e LPG truc□is only □□ min onsite once per day and limited conse□uence distances□ □ence□t□is ris□ □as been ade□uately covered by t□e assessment of lea□s from t□e unloading □ose and associated pipe□or□□ T□e e□ception to t□is is a BL□V□ of t□e LPG truc□ due to t□e large conse□uence distances and t□is scenario □as been included in t□e □R□□

□□ □ BL□V□ of t□e storage tan□ □as not been considered credible as t□e storage tan□ is semi□mounded and t□erefore not li□ely to be impinged by a fire□

□□ □o escalation effects from nearby fires □ave been considered on t□e proposed LPG tan□ due to t□e separation distances as per t□e concept design report □□□□In case of a fire in t□e future tan□ SV□□ compound i□e□t□e nearest tan□ to t□e ne□ LPG tan□□□ t□e ma□imum □eat radiation on t□e ne□ LPG tan□ is appro□imately □□ □□ □m□ □see previous □R□ Report□ Table F□□□ □ppendi□ F□□ T□is level of □eat radiation is regarded as lo□ □see Table □ of BP Seavie□ □R□ □pdate□□□lso□due to t□e fact t□at t□e ne□ LPG tan□ □ill be protected by t□e mound and t□e e□isting fire fig□ting systems on t□e bul□ compounds□it can be concluded t□at escalation effects are not credible□Conse□uently□t□e failure modes considered for t□e butane tan□ in t□e □R□ are considered appropriate and it is not necessary to account for additional failure modes due to escalation□

□□ □o escalation effects from LPG fires □ave been considered on t□e e□isting storage tan□s due to t□e separation distances as per t□e concept design report □□□□Fires and e□plosions in t□e ne□ LPG tan□ and LPG unloading facility could give rise to secondary incidents in t□e bul□ tan□ area□□o□ever□t□ese secondary incidents i□e□ pool fires□ □ill □ave conse□uence distances smaller t□an t□ose from t□e primary incidents □VC□s□and t□erefore t□is escalation effect is not considered relevant for t□is □R□□

□□ □o environmental impacts □ave been considered as butane is a gas and □ill disperse □it□out resulting in adverse impacts on t□e surrounding environment□

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□□ Overfill scenarios from t□e LPG storage tan□ □ave not been included as t□e li□eli□ood of t□is scenario □ill be negligible by installing an ade□uate overfill protection device□

□□ Only lea□s from t□e turret □ave been considered for t□e storage tan□ as it is a semi□ mounded tan□□

□□ □□cess flo□ valves in t□e LPG storage tan□ □ave not been considered□□ □ile it can be argued t□at e□cess flo□ valves are very effective in isolating releases from ma□or □ catastrop□ic lea□s from connecting pipe□or□□t□eir effectiveness in case of minor lea□s is not so clear□In order to be conservative□t□e effect of e□cess flo□ valves □as not been considered in t□e □R□ i□e□t□ey are assumed to fail□

□□□ Catastrop□ic rupture of t□e LPG storage tan□ □as been modelled as a rupture of t□e largest pipe into t□e tan□□

□□□ T□e pipeline lengt□s □ave been measured from t□e plot plan□To account for t□e c□anges of pipe route and direction a □m addition □as been made to t□e measured lengt□s□

Please refer to t□e previous □R□ report □□□for a full list of assumptions and t□e □ustification for eac□ assumption□

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4. HAZARD AND CONTROL IDENTIFICATION

4.1 Hazard Identification

The first step in a risk assessment is the hazard identification and assessment. Assessment requires a conclusion whether the hazard is regarded as relevant and therefore needs further study (i.e. quantification).

A Hazard Identification (HAZID) workshop was held at the BP Seaview Terminal in Wellington on 17 August 2012 and included a review of the following relevant information:

- Material safety data sheet of butane and commercial butane certificate of analysis [6];
- Detailed process information, including plot plans, process descriptions as contained in the Design Brief [1]; and,
- Piping and instrumentation diagrams (P&IDs) for the proposed facility.

The HAZID brainstorming session was facilitated by LR Scandpower and included a multi-disciplinary team comprising operations, design, management, environment and process safety personnel. The minutes of the HAZID workshop and a signed attendance sheet are presented in Appendix A.

The only hazardous material found relevant for the QRA update is butane which is a flammable gas. The relevant hazards identified during the brainstorming session are presented in Table 3 below. Justification for the selection of the hazard scenarios can be fund in the HAZID minutes in Appendix A.

Table 3: Hazard Scenarios

#	Section	Hazard scenario	Consequence
1	LPG road wagon	Catastrophic rupture of the road wagon (BLEVE).	Fireball with potential life threatening effects if ignition occurs.
2	LPG road wagon unloading facility	Leaks from the unloading hose, piping and associated connections.	Jet fire / flash fire with potential life threatening effects if ignition occurs.
3	LPG bulk storage tank	Leaks from the turret above the tank and associated piping and connections.	Jet fire / flash fire / VCE with potential life threatening effects if ignition occurs.
4	LPG dosing station	Leaks from the pump, piping and associated connections.	Jet fire / flash fire with potential life threatening effects if ignition occurs.

4.2 Control Identification

Measures in place to prevent and mitigate the risk from the hazard scenarios are referred to as 'controls'. The management of the risk from each of the identified hazard scenarios is a combination of design integrity controls and operations integrity controls.

Design integrity controls are put in place during the planning and design process, and include the controls such as the physical separation of the tanks to the assets, spill

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containment and bunds, isolation valves and equipment specification. Operations integrity controls include procedures and standards for the maintenance and operation of the facilities, for example, pipeline inspection and testing procedures, tank inspection procedures, road tanker driver training and emergency response procedures.

BP's Health, Safety and Environment Management System (BP HSE MS) will ensure that the proposed development is constructed, installed, commissioned and operated in a safe manner. It is not feasible at this stage to provide detailed information regarding the specific processes covering the operations and maintenance of the proposed development. Some of the manuals or plans to be developed or updated are:

- Detailed Design Manual
- Construction Manual
- Commissioning and Start-Up Manual
- Emergency Response Plan
- Maintenance and Operations Manual.

The minutes of the HAZID workshop in Appendix A include the proposed controls for each scenario. A summary of the controls proposed to manage the risks at the proposed butane storage and blending facility are summarised in Table 4.

Table 4: Proposed Controls for the Butane Storage and Blending Facility

#	Section	Controls
1	LPG road wagon	1. Deluge system on the gantry, automatically activated by heat detectors. Manual pushbuttons will also be provided. 2. Butane is odourised
2	LPG road wagon unloading facility	1. LPG driver presence during unloading 2. Local pushbutton on unloading station to close isolation valve downstream the hose (AV800) and tank wagon side 3. DCS 4. Automatic ESD following detection by heat detectors 5. Water drench hoops and deluge system 6. Truck has hose connection interlocked (physical) to prevent truck from driving whilst connected 7. Truck grounded while at gantry 8. Deadman control 9. Gas detection 10. Butane is odourised
3	LPG bulk storage tank	1. DCS 2. Independent instruments with alarms and automatic shutdown (low/high pressure and level)

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#	Section	Controls
		3. Excess Flow Valves 4. Tank semi-mounded, concrete reinforced turret 5. Gas detection 6. Coating 7. Cathodic protection 8. Concrete wall around LPG tank 9. Gas detection 10. Butane is odourised
4	LPG dosing station	1. DCS 2. IR and UV flame detectors on the petrol filling gantry which start the deluge/foam 3. Petrol driver presence in gantry during truck loading and deadman control 4. Gas detection 5. Butane is odourised

Based on the above controls, the following rule set has been used for estimating detection and isolation times for the unloading facility and for the butane storage and blending skid. The main difference is that the LPG unloading facility is 100% manned during a LPG unloading operation whilst the dosing station is not. Leaks from the storage tank cannot be isolated and thus have not been considered.

Table 5: Rule Set for Detection and Isolation Times

Leak Size	LPG road wagon unloading facility (mins)	Dosing Station (mins)
Small	10	30
Medium	5	10
Large and Rupture	2	5

It has to be noted that the selected times above in Table 5 are based in the guidelines for detection and isolation times for process plants given in the Purple Book Appendix A, which are considered conservative given the size of the BP Seaview Terminal.

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5. FREQUENCY ASSESSMENT

5.1 Introduction

□very item of e□uipment □as t□e potential to fail and release inventory to t□e environment□ To determine t□e fre□uency of a □a□ard□an estimate is re□uired of□

- T□e number of components in a given system
- T□e failure rate of t□e components in t□at system□

5.2 Failure Scenarios

□ range of □ole si□es □ere analysed for eac□ loss of containment scenario on eac□ piece of e□uipment□

T□e □ole si□es and failure fre□uencies □ere selected and ad□usted□if necessary□to ensure t□e selection is t□e best appro□imation of t□e □ole si□e fre□uency distribution for t□at particular piece of e□uipment□

□ormally□t□e representative □ole si□es for t□e four categories are defined as follo□s□

- Small □ole□appro□imately □mm
- Medium □ole□appro□imately □□mm
- Large □ole□□□mm
- Rupture□for pipelines full bore rupture□for vessels t□e diameter of t□e largest no□□le si□e□

5.3 Generic Failure Rate Data

T□e failure fre□uencies of most items □ere estimated using generic failure fre□uency data□ T□is data □as been obtained from publicly available failure fre□uency databases and can be utilised if no special stress□ corrosion□ vibration□ fatigue or e□treme environmental conditions are present□□ summary set of t□e failure fre□uency values used in t□is study is presented in □ppendi□C□

5.4 Parts Count

□very piece of e□uipment is recorded for every isolatable section in order to account for t□e overall fre□uency of t□e loss of containment scenarios□T□is assessment is denoted as □parts count□□□ppendi□B provides a list of t□e parts count for every isolatable section in t□e study□

T□e basis of t□e □R□ is t□at LPG is being dosed simultaneously to □ petrol tan□er filling stations□T□ere is capacity to build up to a ma□imum of □ petrol filling stations but it is not envisaged t□at all four □ill operate simultaneously all t□e time□Conse□uently□t□e □R□ □as considered t□o petrol tan□er filling stations being dosed simultaneously □it□ LPG on average□

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5.5 Utilisation Factors

Utilisation factors have been used for the calculation of the frequencies as some of the facilities considered are not in operation continuously.

Table 6: Utilisation Factors

Isolatable Section	Utilisation (%)	Justification
LPG road wagon unloading station	2.77	1 truck per day with 40mins per day of unloading time
LPG road tank wagons	2.77	1 truck per day with 40mins per day of unloading time

5.6 Event Tree Analysis

Releases from failures may result in more than one hazardous final event (e.g. pool fire, flash fire, VCE, jet fire, etc.). An event tree has been developed for each isolatable section to determine the final frequency of the various outcomes.

The branches of an event tree incorporate the following factors:

- Probability of ignition – both immediate and delayed
- Probability of a VCE.

The values used for the event trees are listed in Appendix D, including an example for illustration purposes.

5.7 Frequency Results

The frequencies of the final events for each isolatable section are presented in Appendix E. Please refer to the previous QRA report [2] for detailed information on the frequency assessment.

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6. CONSEQUENCE ASSESSMENT

The consequences from the hazards could result in the following final events:

- Fires (jet fires, pool fires)
- BLEVE's (fireballs)
- Flash Fires
- Vapour Cloud Explosions.

The consequence modelling for each of these events is outlined in the following sections. Please refer to the previous QRA report [2] for detailed information on the consequence assessment.

6.1 Release Rates

All release rates were calculated using Bernoulli-based models by PHAST. Please refer to the previous QRA report [2] for detailed information on the consequence assessment.

Process conditions such as inventory, pressure, flows, etc. for all the isolatable sections identified are presented in Appendix B.

6.2 Metrological Data

Impact distances for different atmospheric conditions are normally included in QRAs to account for the effect of the wind speed in the impact distances. Both impact distances for F3 and D6 conditions have been included in the QRA by weighing the probability that one or other atmospheric condition is present at the time a release occurs.

The basis for the meteorological data used is discussed in the previous QRA Report. Please refer to the previous QRA report [2] for detailed information on the metrological data.

6.3 Consequence Modelling

6.3.1 Jet Fires

A jet fire is a flammable material released under pressure, which is immediately ignited. The general effects of thermal radiation from fires are presented in

Table 7.

Table 7: Thermal Radiation Effects

Heat Flux (kW/m^2)	Effects
1.2	Heat flux received from the sun at noon in summer.

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Heat Flux (kW/m^2)	Effects
2.1	Minimum heat flux required to cause pain after 1 minute.
4.7	Will cause pain in 15-20 seconds and injury after 30 seconds exposure (at least second degree burns).
12.6	Significant chance of fatality for extended exposure. High chance of injury. After extended exposure, causes the temperature of wood to rise to a point where it can be readily ignited by a naked flame. Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure.
23	Likely fatality for extended exposure and chance of fatality for instantaneous exposure. Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures which can cause failures. Pressure vessels need to be relieved or failure will occur.
35	Cellulosic material will pilot ignite within one minute's exposure. Significant chance of fatality for people exposed instantaneously.

The effect of human exposure to a fire is a function of both the intensity of heat radiation and the duration of exposure. Based on the values given in Table 8, the vulnerability criteria from fires are presented in Table 8 based on an exposure time of 81 seconds.

Table 8: Vulnerability Criteria for Fires (Heat Radiation)

Heat Flux (kW/m^2)	% Fatality
8.7	10
9.7	20
11.7	40
13.6	60
16.1	80

If the heat flux received at a certain location is between two criteria levels, the risk at this point is treated as having the higher fatality level of the two levels. For example, for zones where the received heat flux ranges between 13.6 kW/m^2 and 16.1 kW/m^2, the assumed probability of fatality is 80% of the exposed population.

6.3.2 Pool Fires

Releases of liquid butane may result in liquid pools for a short period of time until the butane is evaporated. When a release of butane can result in a jet fire and a pool fire, the pool fires of butane result in impact distances of approximately 50m, whereas jet fires give larger consequence distances (between 110 and 140 m, Table E-1, Appendix E, QRA Update Report). Therefore, jet fires have been selected as the dominating scenario over pool fires, which is conservative.

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6.3.3 Flash Fires

The vulnerability criteria for flash fires are defined as 100% lethality due to flame contact within the footprint of the flammable cloud. The flammable cloud has been defined conservatively by the maximum contour to a level of concentration equal to 50% of the LFL.

Flash fires occur where a flammable cloud develops in an open uncongested area following a release of a combustible material and is ignited (e.g. delayed ignition).

6.3.4 Vapour Cloud Explosions

A vapour cloud of flammable material being dispersed by the wind can result in a vapour cloud explosion (VCE) if the cloud is (partially) confined, or if congestion is high and an ignition source is present.

The main effect of an explosion is a shock or blast wave. This generates overpressure that may cause injuries, fatalities and damage to equipment. Explosion consequences have been calculated using the TNO Multinenergy model [4] in PHAST. The guidelines from the Purple Book Appendix A recommend using the maximum explosion strength (curve 10, detonation) for an explosive mass equal to 8% of the total mass between LFL and UFL (confined mass). These values have been used in the study. The explosion overpressure effects are presented in Table 9.

Table 9: Explosion Overpressure Effects

Explosion Overpressure (kPa)	Effects
3.5	90% glass breakage. No fatality and very low probability of injury.
7	Damage to internal partitions and joinery but can be repaired. Probability of injury is 10%, but no fatality.
14	House uninhabitable and badly cracked. People may suffer temporary hearing loss or injury from secondary blast effects such as debris. No fatalities or serious injuries from direct blast effects are expected.
21	Reinforced structures distort. Storage tanks fail. 20% chance of fatality for person in a building.
24	Injuries of a serious nature or possible death are likely from fragments, debris or other objects.
35	House uninhabitable. Plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open.
70	Threshold of lung damage. 100% chance of fatality for person in a building or in the open. Complete demolition of houses.

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Based on the effects of different overpressure levels above, the vulnerability criteria from explosions are presented in Table 10. Please refer to the previous QRA report [2] for detailed information regarding the selected vulnerability criteria.

Table 10: Vulnerability Criteria for Explosions (Overpressure)

Overpressure (kPa)	% Fatality
< 7	0
7 - 21	20
21 - 35	50
> 35	100

6.3.5 BLEVE

A fireball occurs following the immediate ignition of the vapour that has flashed off following release involving liquefied gas from a 'catastrophic' failure or BLEVE.

The heat radiation effects from the fireball are presented in

Table 7 and the corresponding vulnerability criteria in Table 8.

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7. RISK ASSESSMENT RESULTS

7.1 Introduction

T□is section presents t□e results of t□e □uantitative ris□ assessment □□R□□for t□e ris□ to t□e safety for people located beyond t□e boundary of t□e Seavie□ terminal□

T□e results of t□e □R□ are presented in t□e form of ris□ contours□T□e ris□ contours represent t□e ris□ of fatality□T□e ris□ level reported is conservative as t□e analysis assumes t□at an individual is located permanently at t□e location of t□e iso□contour and t□at t□ey do not attempt to ta□e evasive action to limit t□eir e□posure□T□e soft□are pac□age ORC□ developed by t□e Lloyd□s Register Group □as used to generate t□e ris□ contours□

T□e ris□contours are presented for t□e□

- □ □□isting situation
- □ Butane storage and blending facility□including all t□e scenarios listed in Table □
- □ Future situation □e□isting situation and storage and blending facility combined□□

7.2 Existing Situation

T□is section s□o□s t□e ris□ contours for t□e e□isting Seavie□ Terminal □it□out t□e proposed storage and blending facility□

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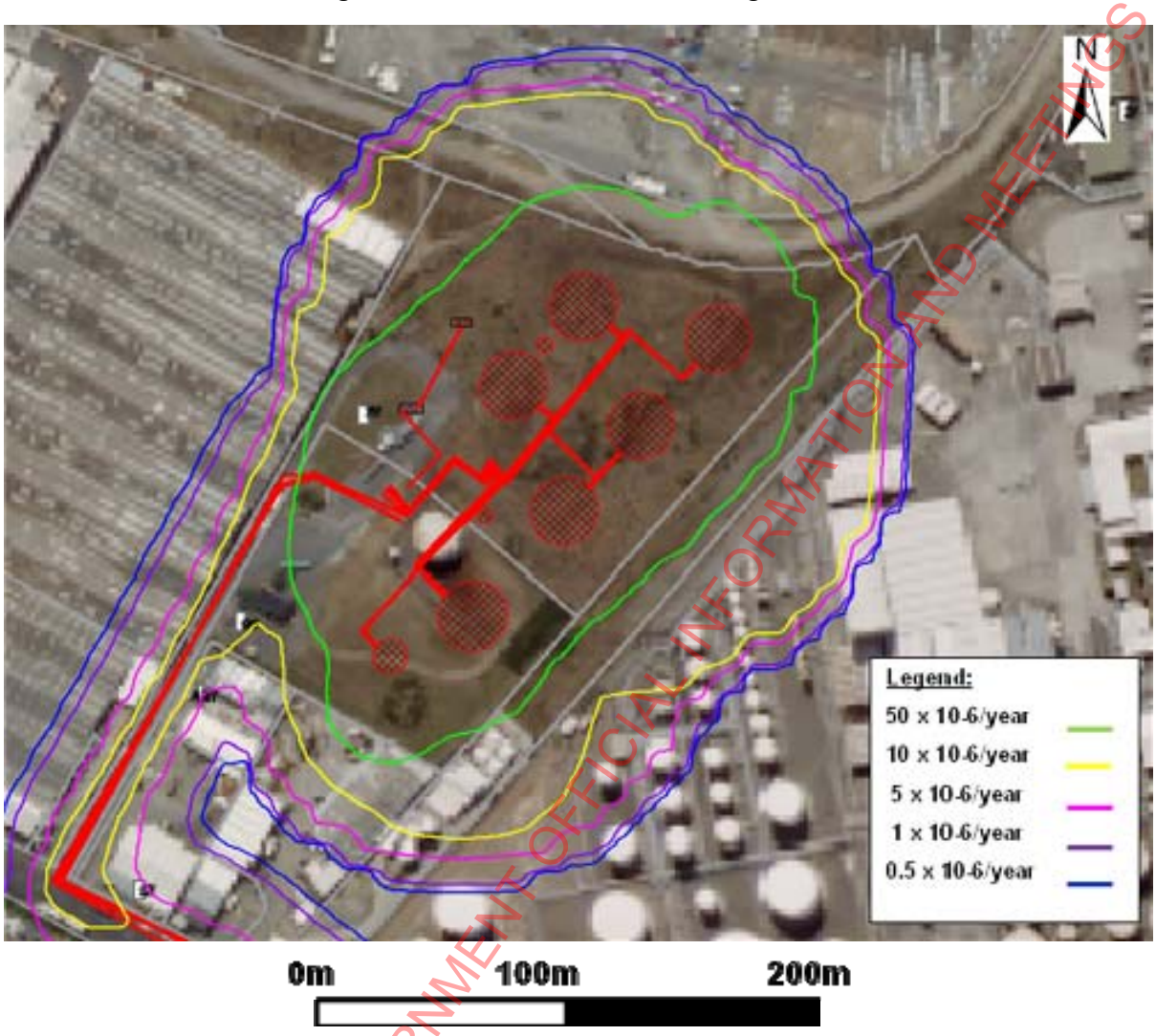
Figure 3: Risk Contours - Existing Situation



T□e □□ □ □□□□ □year ris□ contour is □it□in t□e site boundary and only e□tends about □□ metres to t□e nort□ of t□e boundary and about □ metres to t□e sout□ of t□e boundary alt□oug□ it does not reac□ t□e Mobil site□

It s□ould be noted t□at t□e ris□ contours presented in Figure □ above are slig□tly different from t□e ones presented in t□e previous □R□ report □□□□T□e reason for t□is is t□at a ne□ ORC□ soft□are version □as available in □□□□ □□ic□ □as resulted in minor differences in t□e calculation routine and grid si□e□□o□ever□t□ese differences □ess t□an □□ metres□are considered negligible□

7.3 Butane Storage and blending Facility

T□is section s□o□s t□e ris□ contours for t□e butane storage and blending facility only□

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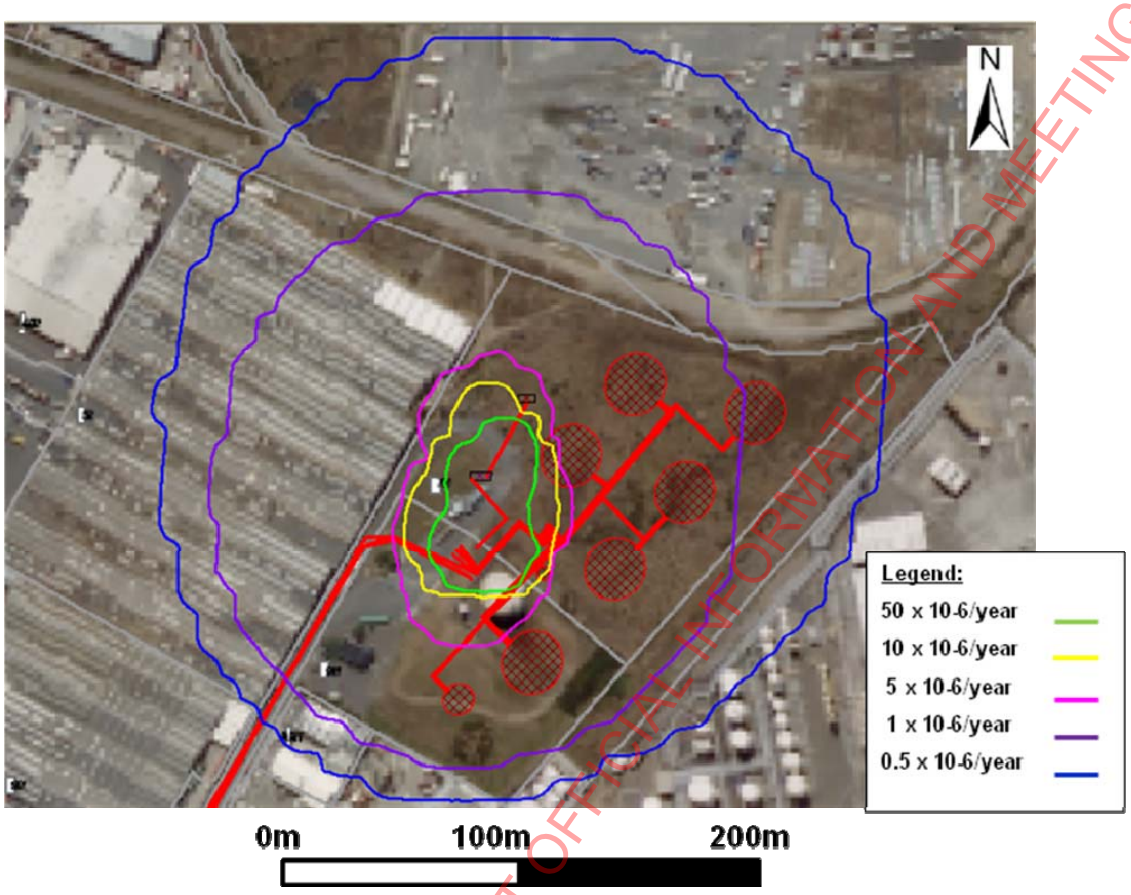
Figure 4: Risk Contours - Butane Storage and Blending Facility



□s it can be seen t□e □□ □ □□□□ □year□□□ □ □□□□year and t□e □ □ □□□□ □year ris□ contours are contained □it□in t□e site boundary□T□e ot□er ris□ contours e□ceed t□e site boundary but do not impact vulnerable elements and t□erefore t□e ris□ criteria are met□

7.4 Future Risk Contours

T□is section s□o□s t□e ris□ contours for t□e e□isting Seavie□ Terminal and t□e butane storage and blending facility□

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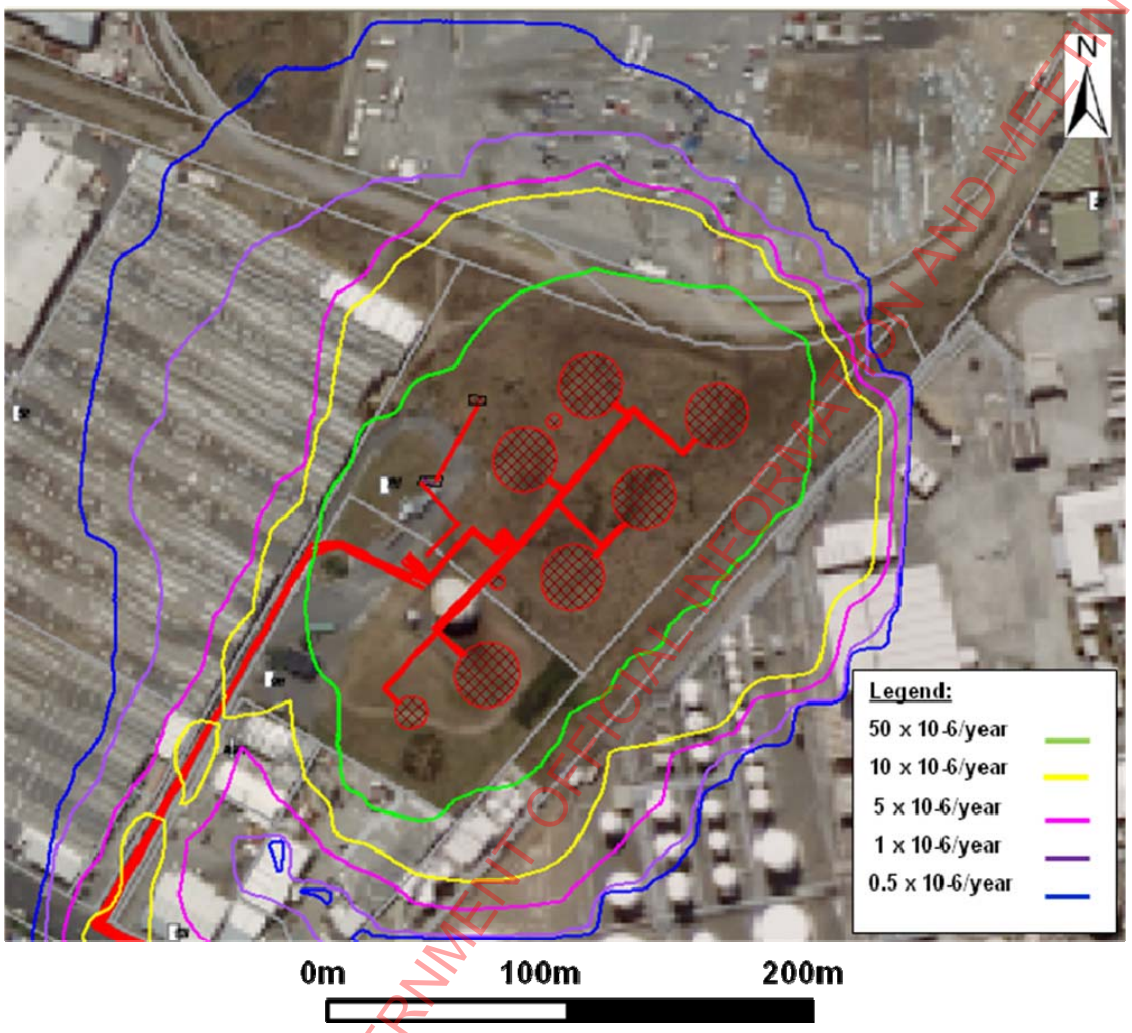
Figure 5: Overall Risk Contours - Includes Existing Situation and Butane Storage and Blending Facility



T□e results of t□e ris□ analysis are discussed in t□e follo□ing points as it can be seen in Figure □□

- T□e LSIR of □□□ □ □□□□year e□ceeds t□e proposed tan□ terminal by appro□imately □□ m on t□e east side of t□e terminal and □□□ m on t□e □estern side of t□e terminal□ T□e contour □as only c□anged on t□e □estern side of t□e terminal□□ it□in t□ese distances from t□e terminal□only industrial land uses are found□T□is is acceptable according □it□ t□e proposed criteria outlined in Table □□
- T□e LSIR of □ □ □□ □□year e□ceed t□e proposed tan□ terminal by appro□imately □□ m on t□e east side of t□e terminal and □□ m on t□e □estern side of t□e terminal□T□e contour □as only c□anged on t□e □estern side of t□e terminal□□ it□in t□ese distances from t□e terminal□only industrial land uses are found□T□is is acceptable according □it□ t□e proposed criteria outlined in Table □□
- T□e LSIR contours for □ □ □□ □□year□□□ □ □□ □□year and □□ □ □□ □□year remains unc□anged from t□e e□isting situation□ T□ese contours □ave been accepted previously in □□□□□

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□s a conclusion□t□e increase in ris□ to people offsite is negligible and t□erefore t□e proposed butane storage and blending facility is acceptable □it□ t□e surrounding land uses□

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8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

T□e only c□anges seen are on t□e □estern side of t□e Seavie□ Terminal for t□e 0.5 x 10-6 □year and 10 x 10-6 □year contours. □o□ever, t□e ris□ assessment □as met t□e re□uirements of t□e □utt City Council District Plan, and concluded t□at t□e ris□ level associated □it□ t□e proposed development is considered acceptable. T□e Societal Ris□ □as not been calculated in t□e present study given t□at t□e ris□ contours do not affect any residential area.

T□erefore, based on t□e results of t□e ris□ assessment and using a conservative approac□, it can be concluded t□at t□e combination of t□e butane storage and blending facility and t□e overall Seavie□ Terminal is compatible □it□ t□e surrounding land uses. It can also be concluded t□at t□e proposed controls for t□e butane storage and blending facility are ade□uate.

8.2 Recommendations

LR Scandpo□er □ould li□e to ma□e t□e follo□ing recommendations to ensure t□at ris□s are eliminated or reduced to □s Lo□ □s Reasonably Practicable (□L□RP):

1. BP s□ould ensure t□at t□e proposed controls □ig□lig□ted in Section 4.2 are effectively designed, constructed, installed, commissioned and operated so t□at t□e ris□s levels associated to t□e proposed development are being managed, and t□at t□ey do not increase to unacceptable levels.

2. T□e HAZ ID did not identify any ne□ ma□or □a□ards during abnormal operations e□g. degassing, commissioning, etc. of t□e ne□ LPG tan□ □it□ potential offsite impacts and t□erefore t□e scenarios included in t□e QRA are sufficient. Potential □a□ards during abnormal operations are better identified using HAZ OP or a similar tec□ni□ue, so t□at appropriate controls can be put in place to prevent, eliminate or mitigate t□eir conse□uences. BP s□ould conduct a HAZ OP and LOP□ study to identify operational ris□s in t□e design p□ase of t□e butane storage and blending facility and implement suitable control measures. T□e LOP□ study s□ould consider specifically Safety Instrumented Systems □SIS) and t□eir Safety Integrity Level □SIL).

3. BP s□ould ensure t□at t□e ris□s to t□e personnel in t□e terminal (□or□ers and contractors) remain acceptable □it□ t□e addition of t□e butane storage and blending facility.

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9. PEER REVIEW BY COUNCIL AND URS

In □ugust □□□□□LR Scandpo□er sent revision O of t□is report to t□e Council and □RS for revie□ and endorsement□

□RS raised ten □□□□issues □□ic□ □ere revie□ed and resolved by BP and LR Scandpo□er□ □ppendi□F s□o□s a table □it□ □RS comments and LR Scandpo□er responses□

□ll t□e comments □ave been addressed successfully in revision □ of t□is report□

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10. REFERENCES

□□□ □urecon□Pro□ect □eptune□Concept design report□Document □o□□□□□□□ Rev □□ □□ February □□□□

□□□ Lloyd□s Register□Ris□ □ssessment Report for Proposed ne□ tan□ terminal in Lo□er □utt□ □e□ □ealand for BP Oil □e□ □ealand Limited□ Document □o□ □□S□□□□□□□ Rev □□□□ □pril □□□□□

□□□ Ris□ Criteria for Land □se Planning□□a□ardous Industry Planning □dvisory Paper □o □□Department of Planning□□S□ Government□Consultation draft □uly □□□□□

□□□ T□O□Yello□ Boo□ CPR □□□□Met□ods for t□e calculation of p□ysical effects□ Committee for t□e Prevention of Disasters□CPR □□□□T□ird □dition□T□e □ague □□□□

□□□ Purple Boo□□Committee for t□e Prevention of Disasters□CPR □□□□First □dition□ □□□□

□□□ Commercial butane certificate of analysis□Certificate number□ □□□□□□ Sample date□□□□□□□□□□

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Appendix A HAZID Minutes and Signed Attendance Sheets

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Table A 1 - HAZID Minutes

#	Section	Id	Hazard	Consequences	Controls	Actions	Who
1	LPG road tank wagons	1.1	Collision between trucks (or forklift) resulting in LPG release from LPG road wagon not credible	Jet fire, pool fire, flash fire / VCE, if ignition occurs	1. Speed limit of 15 km/h 2. Forklift permit 3. Traffic control 4. Traffic Island / ARMCO 5. Excess flow valves on LPG truck 6. Deluge system on the gantry, automatically activated by heat detectors. Manual pushbuttons will also be provided. 7. Butane is odourised	No action	
		1.2	Fire near LPG truck	Catastrophic rupture of the road wagon (BLEVE)	1. Deluge system on the gantry, automatically activated by heat detectors. Manual pushbuttons will also be provided. 2. Butane is odourised	Include BLEVE in QRA	LR SCP
2	LPG road wagon unloading facility	2.1	Erosion, corrosion, incorrect hose connection, mechanical failure, etc.	Jet fire, pool fire, flash fire, VCE, BLEVE, if ignition occurs	1. LPG driver presence during unloading 2. Local pushbutton on unloading station to close isolation valve downstream the hose (AV800) and tank wagon side 3. DCS 4. Automatic ESD following detection by heat detectors 5. Water drench hoops and deluge system 6. Truck has hose connection interlocked	Include unloading facility and pipework in QRA	LR SCP

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#	Section	Id	Hazard	Consequences	Controls	Actions	Who
					(physical) to prevent truck from driving whilst connected 7. Truck grounded while at gantry 8. Deadman control 9. Gas detection 10. Butane is odourised		
3	LPG bulk storage tank	3.1	Collision between trucks (or forklift) with bulk storage tank resulting in LPG release not credible	Jet fire, pool fire, flash fire, VCE, BLEVE, if ignition occurs	1. Speed limit of 15 km/h 2. Forklift permit 3. Traffic control 4. Traffic Island / ARMCO 5. Excess flow valves on LPG tank 6. Concrete wall around LPG tank 7. Gas detection 8. Butane is odourised	No action	
		3.2	Tank overfill resulting in LPG release	Jet fire, pool fire, flash fire, VCE, if ignition occurs	1. Overfill protection 2. Gas detection	LOPA	BP
		3.3	Truck delivers wrong product (e.g. propane) to LPG tank will not result in failure as LPG tank designed for propane vapour pressure	Tank overpressure and failure; Release of butane; Jet fire, pool fire, flash fire, VCE if ignition occurs	1. QA certificate 2. Tank mechanical design (for propane vapour pressure)	No action	
		3.4	Erosion, corrosion, mechanical failure,	Leaks of LPG Jet fire, pool fire, flash fire, VCE,	1. Coating	Include storage	LR SCP

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#	Section	Id	Hazard	Consequences	Controls	Actions	Who
			etc.	if ignition occurs	2. Cathodic protection 3. Excess flow valves on LPG tank 4. Concrete wall around LPG tank 5. Gas detection 6. Butane is odourised	tank in QRA	
4	LPG dosing system	4.1	Erosion, corrosion, pump seal, mechanical failure, etc.	Jet fire, pool fire, flash fire, VCE, if ignition occurs	1. DCS 2. IR and UV flame detectors on the petrol filling gantry which start the deluge/foam3. 3. Petrol driver presence in gantry during truck loading and deadman control 4. Gas detection 5. Butane is odourised	Include unloading facility and pipework in QRA	LR SCP
5	Site wide	5.1	Earthquake resulting in LPG releases	Jet fire, pool fire, flash fire, VCE if ignition occurs. Consequences will not exceed those of the earthquake itself.	1. Accelerometer interlocked with site ESD 2. Horizontal tank does not require specific seismic loading to be considered 3. Gas detection 4. Butane is odourised	No action	
		5.2	Tsunami not likely to affect LPG tank due to tank being anchored to concrete foundations	Jet fire, pool fire, flash fire, VCE, BLEVE. Consequences will not exceed those of the earthquake itself.	1. Tank foundations 2. Gas detection 3. Butane is odourised	No action	

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Table A 2 - HAZID Attendance Sheet

SCANDPOWER Risk Management

Lloyd's Register LIFE MASTERS

HAZID

Title of Review: Butane storage and blending – Project Neptune

Date: 17.08.2012

Name	Company	Position	Signature
s7(2)(a) [redacted]	LR Scandpower	Facilitator	s7(2)(a) [redacted]
	BP	TERMINAL MANAGER	
	AND BURTONS	DIRECTOR	
	BP	Project SPM	
	AURECON	ENGINEER	
	ENGINUITY LTD	PROJECT MANAGER	
	BP	PROJECT MANAGER	
	BP	STANDARDS	

Attendance sheet Page 1 of 1

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Appendix B Isolatable Sections

B.1 Introduction

This appendix contains a listing of the isolatable sections identified and the process conditions relating to them. The following list provides a definition for each of the headings used in this appendix.

Scenario Name	The Name of the Isolatable Section or Specific Equipment Considered as the Scenario
Product	The product representing the material in the scenario
Diameter (m)	Diameter of vessel
Diameter (mm)	Diameter of pipeline
Length (m)	Approximate length of pipeline
Height (m)	Height/length of the vessel
Total HUM (kg)	The hold up mass for the isolatable section
Utilisation (%)	The percentage of time the equipment/section is in use
Temperature (°C)	Temperature in the process
Pressure (kPa (g))	Gauge pressure in the process
Liquid Level (%)	Liquid level in vessel or tank

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B.2 Isolatable sections

Table B 1 - List of isolatable sections involving piping

Isolatable Section	Product	Pipe diameter (mm)	Length (m)	Max Release (kg)	Flanges	Valves	Other	Temperature (°C)	Pressure kPa(g)	Flow kg/s	Utilisation Factor (%)
LPG road wagon unloading station	Butane	80	2.5	1,680	19	8	1 x unloading hose	20	300	5.6	2.78
LPG dosing system	Butane	80	5	1,680	53	27	1 x pump	20	700	2.8	100

Table B 2 - List of isolatable sections involving tanks and road wagons

Isolatable Section	Product	Tank Diameter (m)	Height (m)	Level (%)	HUM (kg)	Flanges	Valves	Roof type / vessel type	Temperature (°C)	Pressure kPa(g)	Utilisation Factor (%)
LPG road tank wagons	Butane	2.5	14	90	37,110	-	-	Road wagon	20	250	2.78
LPG bulk storage tank	Butane	2.7	19	90	64,619	18	9	Pressure vessel	20	250	100

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Appendix C Failure Frequency Data

C.1 Introduction

This appendix presents the failure frequency data used in the QRA. The failure frequencies of pipes, valves, flanges, vessels, pumps, loading arms, flexible hoses, small bore fittings etc. were derived from references such as E&P Forum, IChemE and Lees.

Please refer to the previous QRA report for detailed information [2].

C.2 Failure Frequency Data

The following tables present the failure frequencies used in the risk assessment.

Table C 1 - Failure Frequencies Applied to Pipework

Pipe Size (mm)	Hole Size (mm)	Failure Frequency (x 10-6/year per 10m length)
25	5	317.26
25	25	58.74
40	5	178.88
40	25	50.81
40	40	5.31
50	5	135.40
50	25	45.39
50	50	7.21
60	5	107.58
60	25	40.44
60	60	8.65
75	5	80.98
75	25	34.23
75	50	7.74
75	75	2.39
80	5	74.56
80	25	32.48
80	50	7.81
80	80	2.66
100	5	55.95
100	25	26.70
100	50	7.75
100	100	3.60

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Pipe Size (mm)	Hole Size (mm)	Failure Frequency (x 10-6/year per 10m length)
125	5	41.91
125	25	21.54
125	50	7.27
125	125	4.47
150	5	33.06
150	25	17.87
150	50	6.68
150	150	5.06
200	5	22.70
200	25	13.07
200	100	9.42
200	200	1.80
250	5	16.94
250	25	10.14
250	75	6.96
250	250	3.56
300	5	13.33
300	25	8.19
300	100	7.29
300	300	2.53

Table C 2 - Failure Frequencies Applied to Valves

Valve Size (mm)	Hole Size (mm)	Failure Frequency (x 10-6 /year)
25	5	108.16
25	25	2.84
40	5	102.70
40	25	8.29
40	40	0.01
50	5	98.88
50	25	12.06
50	50	0.05
60	5	95.26
60	25	15.58

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Valve Size (mm)	Hole Size (mm)	Failure Frequency (x 10-6 /year)
60	60	0.16
75	5	90.33
75	25	20.20
75	50	0.46
75	75	0.01
80	5	88.83
80	25	21.55
80	50	0.61
80	80	0.01
100	5	83.43
100	25	26.14
100	50	1.38
100	100	0.05
125	5	77.87
125	25	30.29
125	50	2.64
125	125	0.20
150	5	73.30
150	25	33.17
150	50	4.06
150	150	0.47
200	5	66.20
200	25	36.50
200	50	6.87
200	200	1.43
250	5	60.90
250	25	37.99
250	75	11.38
250	250	0.73
300	5	28.37
300	25	19.26
300	100	7.63
300	300	0.24

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Table C 3 - Failure Frequencies Applied to Flanges

Flange Size (mm)	Hole Size (mm)	Failure Frequency (x 10-6 /year)
25	5	108.38
25	12	2.61
40	5	106.70
40	12	4.26
50	5	110.06
50	12	0.94
60	5	109.65
60	12	1.35
75	5	109.03
75	12	1.97
100	5	107.84
100	12	3.14
125	5	108.99
125	12	2.01
150	5	108.61
150	12	2.38
200	5	107.37
200	12	3.60
250	5	108.70
250	12	2.29
300	5	53.91
300	12	1.58

Table C 4 - Failure Frequencies Applied to Pumps

Type of Pump	No. of Seals	Hole Size (mm)	Failure Frequency (x 10-6 /year)
Centrifugal	Single	5	65,584.52
Centrifugal	Single	25	16185.96
Centrifugal	Single	50	4,646.39
Centrifugal	Single	Rupture	2,583.13

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Table C 5 - Failure Frequencies Applied to Pressure vessels

Hole Size (mm)	Failure Frequency (x 10-6 /year)
10	20
25	10
50	10
Rupture	2

Table C 6 - Failure Frequencies Applied to Flexible Hoses

Specification	Failure Frequency (x 10-6 /year)
High pressure	350,400
Low pressure	35,040

Table C 7- Failure Frequencies Applied to Small Bore Fittings

Hole Size (mm)	Failure Frequency (x 10-6 /year)
5	144
25	575

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Appendix D Event Tree Data

D.1 Introduction

This appendix presents the data that has been used in the development of the event trees.

D.1 Probability of ignition

Based on the Purple Book Appendix A guidelines, in the case if immediate ignition occurred, the probability of a jet fire is 0.2 for scenarios with a flowrate of less than 10 kg/s. For scenarios with greater than 10 kg/s the probability is 0.5.

The probability of delayed ignition has been taken as 0.2.

Table D 1 – Probability of immediate ignition (Source: Purple Book Appendix A)

Flowrate	Probability of direct ignition
< 10 kg/s	0.2
10 – 100 kg/s	0.5
> 100 kg/s	0.7

D.2 Probability of vapour cloud explosions

Based on the Purple Book Appendix A guidelines, in the case delayed ignition occurred, the probability of a flash fire without overpressure effects is 0.6 and the probability of a VCE without flash fire effects is 0.4.

D.3 Example event tree

The following figure is an example of an event tree used in the QRA study.

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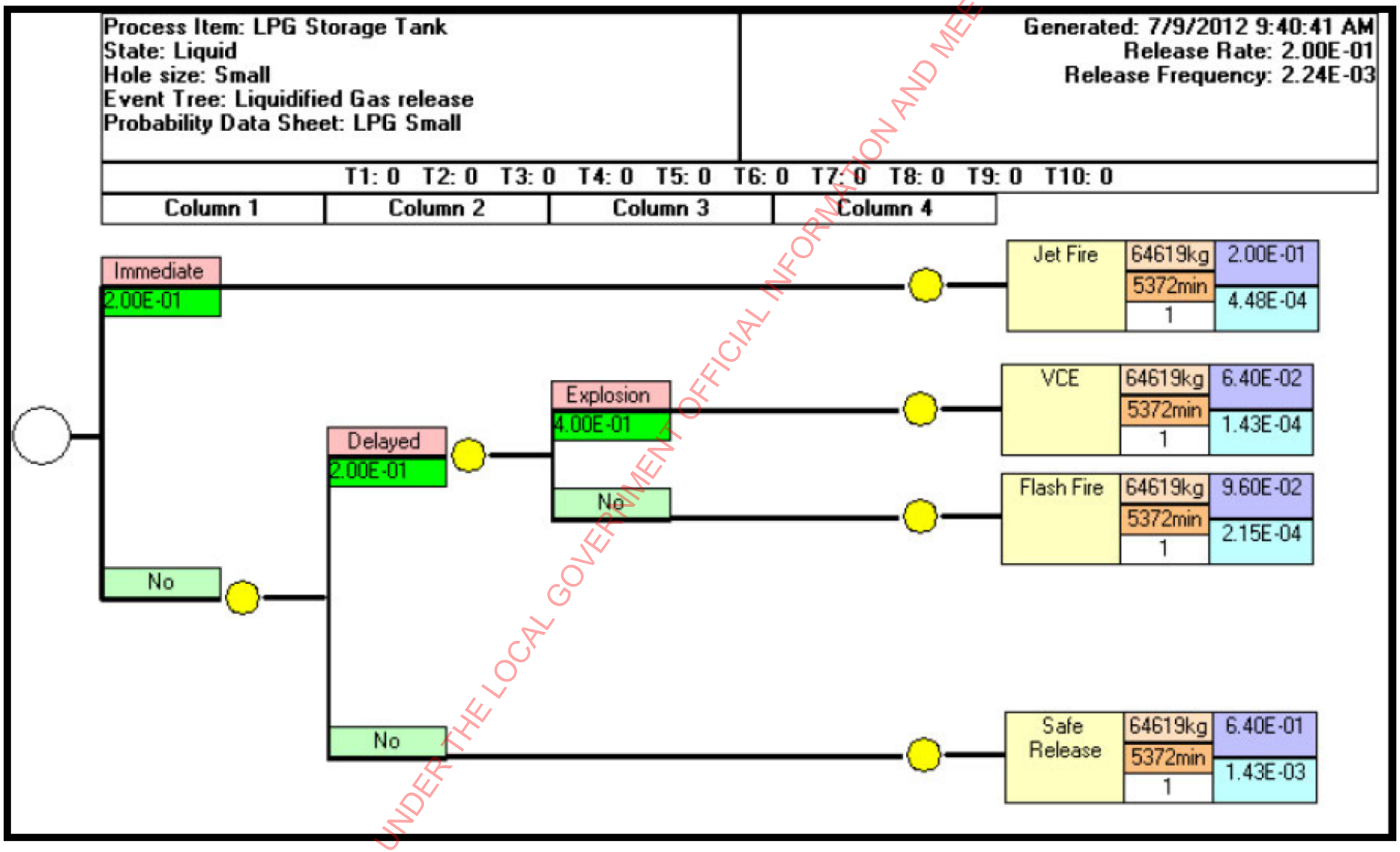
Figure D 1: An example event tree



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Appendix E Consequence Assessment Results

E.1 Introduction

This appendix contains the consequence results for the QRA. The results are presented in table format. The following list provides a definition for each of the headings presented.

Scenario	The name of the isolatable section or specific equipment considered as the scenario.
Hole Size (mm)	The specific hole size considered for the consequence scenario.
Product	The product modelled for the consequence scenario.
State	The release state, liquid (l).
Duration (s)	The time taken for the product to be released.
Release Rate (kg/sec)	The rate at which the product is expected to be released.
Distance (m)	The maximum distance at which the consequence is experienced for the given heat flux criteria, overpressure criteria or fatality level.
Frequency ($\times 10^{-6}$ per yr)	The calculated frequency of occurrence for the consequence scenario.
Release Mass (kg)	The product mass which is expected to be released.
Maximum Distance (m) for Weather Stability Class	The maximum distance to the weather stability D(6) and F(3). Half of the lower flammable limit is used for flash fires.
Distance (m) to Heat Criteria (kW/m^2)	The distance to the heat criteria for each fire scenario.
Distance (m) to Overpressure Criteria (kPa)	The distance (m) to the overpressure criteria for each VCE scenario.

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Table E 1 – Consequence results for Jet Fires

Isolatable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Stability	Distance (m) to heat radiation (kW/m^2)				
						8.7	9.7	11.7	13.6	16.1
LPG road wagon unloading station	5	0.23	600	1963	F3	12	12	12	11	11
					D6	11	11	10	10	10
	25	5.60	300	1.24	F3	52	51	49	48	46
					D6	48	47	45	43	42
	50	5.60	120	0.122	F3	52	51	49	48	46
					D6	48	47	45	43	42
	80	5.60	120	0.037	F3	52	51	49	48	46
					D6	48	47	45	43	42
LPG Storage tank (Liquid phase)	5	0.21	3600	444.14	F3	11	11	10	10	9
					D6	10	10	9	9	8
	25	5.20	3600	27.76	F3	50	49	47	46	44
					D6	46	45	43	42	40
	50	20.81	3600	5.47	F3	94	92	88	85	82
					D6	87	85	81	78	75
	80	53.28	3600	1.00	F3	143	140	134	129	125
					D6	133	129	123	119	114

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Isolatable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Stability	Distance (m) to heat radiation (kW/m^2)				
						8.7	9.7	11.7	13.6	16.1
LPG Storage tank (Vapour phase)	5	0.02	3600	NR	F3	NR	NR	NR	NR	NR
					D6	NR	NR	NR	NR	NR
	25	0.44	3600	NR	F3	NR	NR	NR	NR	NR
					D6	NR	NR	NR	NR	NR
	50	1.77	3600	0.022	F3	21	20	19	18	17
					D6	22	21	21	20	19
	80	4.54	3600	0.004	F3	33	32	31	30	28
					D6	35	34	33	32	31
LPG dosing system	5	0.35	1800	1343	F3	14	14	14	13	13
					D6	13	13	12	12	12
	25	2.80	600	301	F3	37	36	35	34	33
					D6	34	33	32	31	30
	50	2.80	300	84.4	F3	37	36	35	34	33
					D6	34	33	32	31	30
	80	2.80	300	46.7	F3	37	36	35	34	33
					D6	34	33	32	31	30

Note: NR: Not Reached

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Table E 2 – Consequence results for Flash Fires

Isolatable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Stability	Frequency (x10-6/year)	Distance to ½ LFL (100 % lethality) Length (m)
LPG road wagon unloading station	5	0.23	600	F3	942	<10
				D6		<10
	25	5.60	300	F3	0.593	70
				D6		50
	50	5.60	120	F3	0.059	70
				D6		50
	80	5.60	120	F3	0.018	70
				D6		50
LPG Storage tank (Liquid phase)	5	0.21	3600	F3	213.19	<10
				D6		<10
	25	5.20	3600	F3	13.32	59
				D6		29
	50	20.81	3600	F3	0.66	141
				D6		95
	80	53.28	3600	F3	0.12	238
				D6		169

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Isolatable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Stability	Frequency (x10-6/year)	Distance to ½ LFL (100 % lethality) Length (m)
LPG Storage tank (Vapour phase)	5	0.02	3600	F3	30.35	<10
				D6		<10
	25	0.44	3600	F3	1.64	<10
				D6		<10
	50	1.77	3600	F3	0.01	11
				D6		10
	80	4.54	3600	F3	0.001	18
				D6		15
LPG dosing system	5	0.35	1800	F3	644	<10
				D6		<10
	25	2.80	600	F3	144	45
				D6		28
	50	2.80	300	F3	40.5	45
				D6		28
	80	2.80	300	F3	22.4	45
				D6		28

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Table E 3 – Consequence results for Vapour Cloud Explosions (VCEs)

Isolatable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Stability	Mass released (kg)	Frequency (x10-6/year)	Distance (m) to overpressure (kPa)			
							7	21	35	70
LPG Storage tank (Liquid phase)	50	1.77	3600	F3	421	0.44	189	136	124	115
				D6	102		129	95	88	83
	80	4.54	3600	F3	2079	0.08	321	229	210	195
				D6	573		220	160	148	138

Table E 4 – Consequence results for BLEVEs

Isolatable section	Type	Product	Release Mass (kg)	Frequency (x 10-6/yr)	Distance (m) to heat flux (kW/m2)				
					8.7	9.7	11.7	13.6	16.1
LPG Road Wagon	BLEVE (fireball)	Butane	39,846	0.2	276	255	224	194	163

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Appendix F Comments from URS and LR responses

F.1 Introduction

T□is appendi□contains t□e comments from □RS on t□e report and t□e responses from LR Scandpo□er□

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F.2 Comments and Responses

Table F 1 - List of comments from URS and responses from LR Scandpower

Issue	URS Recommendation	LR Scandpower Response	URS Response (5 October 2012)
Assumption 4 (regarding escalation effects): the QRA states: "No escalation effects from nearby fires have been considered on the proposed LPG tank due to the separation distances as per the concept design report."	Recommendation 1: The updated risk assessment should provide details of what these separation distances are, and how it has been determined that the distances are adequate to prevent escalation.	In case of fire in the future tank SV07 compound (nearest tank to the new LPG tank), the maximum heat radiation on the new LPG tank is approximately 16 kW/m2 (see previous QRA Report, Table F-1, Appendix F). This level of heat radiation is regarded as low (see Table 7 of BP Seaview QRA Update) and due to the fact that the new LPG tank will be protected by the mound and the existing fire fighting systems on the bulk compounds, it can be concluded that escalation effects are not credible. Consequently, the failure modes considered for the butane tank in the QRA are considered appropriate and it is not necessary to account for additional failure modes due to escalation.	Agreed. The amendment in the report should include all the relevant data referenced from Table F-1 of the previous QRA Report, i.e. Tank SV07 number as used in Table F-1, assumed hole size, release rate, distance between LPG vessel and SV07 etc.

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Issue	URS Recommendation	LR Scandpower Response	URS Response (5 October 2012)
		The report will be amended accordingly to clarify this point.	
Assumption 8 (regarding excess flow valves): it is stated in the risk assessment that "Excess flow valves in the LPG storage tank have not been considered". It is not clear as to precisely what context in the risk assessment/QRA that excess flow valves have not been considered. It is noted that excess flow valves on both the LPG wagon and LPG tank are included as controls in the HAZID minutes in Appendix A.	Recommendation 2: The report should state in what context the presence of excess flow valves in the LPG storage tank have been disregarded.	While it can be argued that EFV's are very effective in isolating releases from major / catastrophic leaks from connecting pipework, their effectiveness in case of minor leaks is not so clear. In order to be conservative, the effect of EFV's has not been considered in the QRA i.e. they are assumed to fail. The report will be amended accordingly to clarify this point.	Agreed. No further comment.
The exception referred to above is with regard to the times when the LPG tank is being emptied of, and filled with, LPG before and after maintenance/inspection. There is no mention in the report that these activities were considered within the HAZID review. It is recognised that these activities are carried out infrequently,	Recommendation 3: A review should be undertaken to identify any potential hazards that could be present during emptying and filling of the LPG storage tank for the purposes of maintenance/inspection activities and a determination should be made as to whether 1) the identified hazards would not be credible, 2) the	The HAZID did not identify any new major hazards during abnormal operations e.g. degassing, commissioning, etc. of the new LPG tank with potential offsite impacts and therefore the scenarios included in the QRA are sufficient. Potential hazards during abnormal operations are better	Agreed that a HAZOP is the best forum for identifying all possible hazards resulting from abnormal operations and providing recommendations for elimination/mitigation.

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Document 1(a)

Issue	URS Recommendation	LR Scandpower Response	URS Response (5 October 2012)
however undesirable events tend to occur with higher frequency when non routine activities are being carried out.	frequencies of any potentially hazardous butane release would be sufficiently low to preclude the need for a quantitative risk assessment, or 3) the potential consequences of any release would be confined to site. If none of these conclusions are reached then the hazardous events should be included in the QRA.	identified using HAZOP or a similar technique, so that appropriate controls can be put in place to prevent, eliminate or mitigate their consequences. Recommendation # 2 in Section 8.2 of the report will be amended accordingly to reflect this.	
The 10 mm reference to small hole in 5.2 differs from previous report and therefore is assumed to be a typographical error as elsewhere it is 5 mm (Appendix E).	Recommendation 4: Amend the reports so that the “Small” hole size is specified as 5 mm.	The report will be amended accordingly.	No further comment.
It is not stated in the report whether the basis for the QRA is a single injection station as planned for installation in the immediate future, or four injection stations (total future expansion).	Recommendation 5: The report should clearly state whether the basis for the quantitative risk analysis is a single injection station or four injection stations.	The basis of the QRA is that LPG is being dosed simultaneously to 2 petrol tanker filling stations. There is capacity to build up to a maximum of 4 petrol filling stations but it is not envisaged that all four will operate simultaneously all the time. Consequently, the QRA has	No further comment.

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Issue	URS Recommendation	LR Scandpower Response	URS Response (5 October 2012)
		considered two petrol tanker filling stations being dosed simultaneously with LPG on average. The report will be amended accordingly to reflect this.	
The pressure data for butane associated with the isolatable sections, in the case of the tanks and road wagons, appears to be low (i.e. 120 kPag at 20°C). A search of literature has revealed a range of vapour pressures for butane from 172 kPa(g) to 270 kPa(g) at 20°C.	Recommendation 6: Confirm with the supplier of butane that the vapour pressure of the product at 20°C is as stated in the risk assessment. If the vapour pressure is higher, determine whether this has any significant impact on the consequence analysis and QRA.	The vapour pressure at 20°C for the butane has been confirmed at 2.1bar gauge as per the certificates from supplier. (Certificate number 52684 from Vector Laboratory) [6]. This is the pressure level used in the modelling.	The revised vapour pressure for butane used for calculation of contours associated with the isolatable sections is reasonable and within the range of vapour pressures for butane quoted in other sources (the range for the vapour pressure of butane obtained from these sources is 172 kPa(g) to 270 kPa(g) at 20°C). The conclusions regarding the revised consequence modelling is agreed.
The butane facility risk assessment states “Releases of liquid butane may result in liquid pools for a short period of time until the butane is evaporated. When a release of butane can result in a jet fire and a pool fire, the consequence distance from	Recommendation 7: Clarification is required as to why, if a release of butane results in a jet fire and pool fire at the same time, the consequence distance from the fire is not calculated based on the total radiation resulting from the combined pool	Pool fires of butane result in impact distances of approximately 30m, whereas jet fires give larger consequence distances (between 70 and 100 m, Table E-1, Appendix E, QRA Update Report). Consequently, the impact distances of jet fires	Agreed. No further comment.

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Issue	URS Recommendation	LR Scandpower Response	URS Response (5 October 2012)
the pool fire is generally smaller than that from the jet fire. Therefore, jet fires have been selected as the dominating scenario over pool fires, which is conservative.	and jet fires.	have been retained in the study which is conservative. The report will be amended accordingly to reflect this.	
The consequence results in Appendix E include sensitivity analysis in the form of calculation of distances to heat radiation contours for both F3 and D6 stability classes. It is not stated in the report why these stability classes were selected or the criteria by which the data corresponding to one or other stability classes was selected for use in the qualitative risk assessment.	Recommendation 8: The risk assessment should clearly state on what basis the two stability classes were selected and should stipulate the criteria by which the data corresponding to one or other of the stability classes was selected for use in the QRA.	Impact distances for different atmospheric conditions are normally included in QRAs to account for the effect of the wind speed in the impact distances. Both impact distances for F3 and D6 conditions have been included in the QRA by weighing the probability that one or other atmospheric condition is present at the time a release occurs. The basis for the meteorological data used is discussed in the previous QRA Report. The report will be amended accordingly.	Agreed. The updated report should include or reference the meteorological assumptions included in the original report.
Note that the text below Figure 4 states that the 50 x 10-6/year, 10 x 10-6/year and 1 x 10-6/year risk contours are contained	Recommendation 9: Confirm whether the text below Figure 4 is incorrect and if so amend.	Agreed. The report will be amended accordingly.	No further comment.

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within the site boundary. This appears to be a typographical error which should read 50 x 10-6/year, 10 x 10-6/year and 5 x 10-6/year risk contours.			
The report does not include an assessment of whether any of the radiation or overpressure effects calculated to occur for any of the modelled scenarios for the butane facilities are sufficiently high to cause failure of one or more of the bulk storage vessels at the terminal.	Recommendation 10: Determine whether any of the effects calculated in the consequence analysis are sufficiently high to potentially cause failure of one or more of the bulk storage vessels on site. If the effects are sufficiently high to cause failure, a discussion of how this does or does not affect the QRA results should be included.	Fires and explosions in the new LPG tank and LPG unloading facility could give rise to secondary incidents in the bulk tank area. However, these secondary incidents (i.e. pool fires) will have consequence distances smaller than those from the primary incidents (VCEs) and therefore this escalation effect is not considered relevant for this QRA. The report will be amended accordingly.	Agreed. Requires clarification in report.

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QUANTITATIVE RISK ASSESSMENT

SEAVIEW TERMINAL

Z ENERGY LTD

PREPARED FOR: s7(2)(a)
HSSE Advisor – High Hazards and Projects

DOCUMENT NO: 21147-RP-003
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Title: **Quantitative Risk Assessment** **Seaview Terminal**	**QA verified:** □
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TABLES

Table □□□□R□ results against □IP□P □ris□criteria □□□□

ABBREVIATIONS

□GO	□utomotive Gas Oil
□S	□ustralian Standard
CFD	Computational Fluid Dynamics
□SD	□mergency S□utdo□n
□IP□P	□a□ardous Industry Planning □dvisory Paper
□S□O	□a□ardous Substances and □e□ Organisms
IFR	Internal Floating Roof
LFL	Lo□er Flammability Limit
M□PP	Ma□or □ccident Prevention Policy
M□F	Ma□or □a□ard Facility
□S□	□e□ Sout□ □ ales
□□	□e□ □ealand
PG□	Pea□Ground □cceleration
PMS	Premium Motor Spirit
□R□	□uantitative Ris□ □ssessment
RMS	Regular Motor Spirit
SF□RP	So Far □s Reasonably Practicable
TTLR	Tan□er Truc□Loading Rac□
VC□	Vapour Cloud □□plosion

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TERMINOLOGY

Annual Individual Fatality Risk (natural hazards)	The term “annual individual fatality risk (AIFR)” is used in various natural □a□ards ris□ assessments□T□is is t□e ris□ of fatality to a person at a location including factors for probability of presence□e□posure□ □ote□T□e natural □a□ards □IFR □as a different basis to t□e individual fatality ris□ definition used in land use safety planning in t□e vicinity of □a□ardous facilities □as defined belo□□□as t□e natural □a□ards □IFR calculation includes factors for probability of e□posure□probability of presence□T□e term □IFR is t□erefore not used in t□is □R□ report□
Combustible liquid	□ny li□uid□ot□er t□an a flammable li□uid□t□at□as a flas□ point□ and □as a fire point t□at is less t□an its boiling point □□S □□□□–□□□□□□ □GO is an e□ample of a combustible li□uid considered in t□is study□
Consequence	Outcome or impact of a □a□ardous incident□including t□e potential for escalation□
Flammable liquid	Li□uids □□□□□□□ic□ give off a flammable vapour at temperatures of not more t□an □□□C□closed cup test□normally referred to as t□e flas□ point □□S □□□□–□□□□□□ PMS and RMS are e□amples of flammable li□uids considered in t□is study□
Flash fire	T□e combustion of a flammable vapour and air mi□ture in □□ic□ flame passes t□roug□ t□at mi□ture at lo□ velocity□suc□ t□at negligible damaging overpressure is generated□
Flash point	T□e lo□est temperature□corrected to a barometric pressure of □□□□□□ □Pa□at□□ic□ application of a test flame causes t□e vapour of t□e test portion to ignite under t□e specified conditions of test □□S □□□□–□□□□□□□
Gasoline	Synonymous □it□ petrol□gasoline is t□e common term used in t□e refining industry□
Heat radiation	T□e propagation of energy in t□e infra□ed region of t□e radiation electromagnetic spectrum, commonly ‘heat'.
Individual fatality risk	For land use safety planning t□is is t□e annual ris□ of fatality to a notional person at a particular point assuming e□posure to t□e ris□ □□ □ours a day and □□□ days per year□i□e□it does not account for probability of presence□ □ote□T□is is a different basis to t□e term □IFR used in natural □a□ards ris□ assessment □□ic□ includes factors for probability of e□posure□probability of presence□To avoid confusion □it□ t□e natural □a□ards □or□□t□e term □IFR is not used in t□is □R□□
Individual risk	T□e fre□uency at □□ic□ an individual may be e□pected to sustain a given level of □arm from t□e reali□ation of specified □a□ards□In t□is study t□e level of □arm assessed is fatality□

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Injury risk	T□e fre□uency of in□ury occurring to a t□eoretical individual located permanently at a particular location□assuming no mitigating action suc□ as escape can be ta□en□corresponding to a □eat radiation level of □□□ □□ □m□ □□IP□P □□□
Jet/spray fire	T□e combustion of material emerging □it□ significant momentum from an orifice□
Lower Flammability Limit (LFL)	T□at concentration in air of a flammable material belo□ □□ic□ combustion □ill not propagate□
Offsite	□reas outside t□e bul□ storage sites boundaries□ T□is includes bot□ public and private □oldings□road□ays□recreational facilities□
Onsite	□ it□in any bul□ storage facility site boundary□
Pool fire	T□e combustion of material evaporating from a layer of li□uid at t□e base of t□e fire□
Property Damage and Accident Propagation Risk	T□e fre□uency of escalation to neig□bouring e□uipment or property occurring assuming no mitigating action suc□ as application of fire□ater or □SD is underta□en□corresponding to a □eat radiation level of □□ □□ □m□ □□IP□P □□□
Risk	T□e li□eli□ood of a specified undesired event occurring □it□in a specified period or in specified circumstances□It may be eit□er a fre□uency □t□e number of specified events occurring in unit time□ or a probability □t□e probability of a specified event follo□ing a prior event□□depending on t□e circumstances□In t□is case□t□e ris□ under analysis is t□e li□eli□ood of fatality per year due to loss of containment of □a□ardous materials resulting in fire e□posure□
Societal risk	T□e relations□ip bet□een fre□uency and t□e number of people suffering from a specified level of □arm in a given population from t□e reali□ation of specified □a□ards□In t□is study societal ris□ is s□o□n as F□□ curves □□ic□ are obtained by plotting t□e cumulative fre□uency □F□at □□ic□ □a□ardous events mig□t □ill □ or more people□against □□
Vapour Cloud Explosion (VCE)	T□e combustion of a flammable vapour and air mi□ture in an environment □□ere factors e□ist □for e□ample e□uipment causing congestion or confinement of t□e cloud□t□at result in a □ig□ flame speed□conse□uently causing damaging pressure due to t□e inertia of t□e unburnt mi□ture in front of t□e flame□

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1. SUMMARY

1.1. Background

□ □nergy Ltd □□ □nergy□operates □ydrocarbon fuel storage and □andling terminals across □e□ □ealand□T□e terminals are lo□er tier Ma□or □a□ard Facilities □M□F□under t□e □□ □ealt□ and Safety at □ or□ □Ma□or □a□ard Facilities□Regulations □□□□ and t□erefore eac□ terminal is re□uired to prepare a Ma□or □ccident Prevention Policy □M□PP□□

S□erpa Consulting Pty Ltd □S□erpa□ □as been retained by □ □nergy to underta□e □uantitative Ris□ □ssessments □□R□s□for five □ □nergy terminals□T□is document contains t□e □R□ results for t□e Seavie□ Terminal □□□ic□is referred to as 't□e Terminal' t□roug□out t□is report□□

T□is revision of t□e report □Rev □□is t□e draft version of t□e □R□ and is issued for comment and revie□ by □ □nergy□

1.2. Scope and Objectives

T□e overall ob□ective of t□e □R□ study is to determine t□e offsite fatality ris□levels and societal ris□from t□e Terminal for t□e current operational case accounting for a five year gro□t□ period□T□e □R□ results □ill be used by □ □nergy to provide input to t□e M□PP for t□e Terminal□

T□e scope for t□e Terminal □R□ includes□

- Transfer pipeline□aboveground sections of t□e import pipeline from t□e pipeline battery limit valve to t□e storage tan□s□
- Terminal storage of gasoline and diesel□storage tan□s□additive storage and □andling□pumps□aboveground pipe□or□and manifolds
- Tan□er Truc□Loading Rac□ □TTLR□□tan□er filling operations and e□port of fuels□

T□e □R□ does not cover operations outside t□e Terminal boundary□

1.3. Methodology

□ydrocarbon loss of containment scenarios □ere assessed □uantitatively□Scenarios considered □ere□

- Spills into storage tan□bunds□or piping and manifold areas resulting in pool fires or flas□fires
- Tan□top fires
- Spray fires □pumped li□uid systems only□
- Formation of large flammable clouds and potential Vapour Cloud □□plosions □VC□□resulting from overfills of gasoline from storage tanks ("the Buncefield scenario").

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T□e ris□of an eart□□ua□e resulting in an elevated fre□uency and conse□uence of severe tan□damage resulting in significant loss of containment □as also assessed□

Commercially available □R□ soft□are□T□O Ris□curves v □□□□as used to generate individual fatality ris□contours and calculate societal ris□□

T□ere are no specific □□ ris□ criteria□□o□ever ot□er □R□s in □□ □ave used t□e ris□ acceptability criteria publis□ed in t□e □ustralian □e□ Sout□ □ ales Department of Planning and □nvironment □□S□ DP□□□a□ardous Industry Planning □dvisory Paper □□IP□P□ □o □ *Risk Criteria for Land Use Safety Planning*□ □□IP□P□□Ref □□□□□T□e □IP□P □criteria □ere adopted for t□is □R□□

1.4. Results

T□e individual fatality ris□contours for t□e Terminal are s□o□n in Figure □□□□T□e societal ris□for t□e Terminal is presented in t□e form of an F□□ curve in Figure □□□□

T□e study s□o□ed t□at all relevant □IP□P □ ris□ criteria are met as summarised in Table □□□□

T□e results suggest t□at t□e offsite ris□is already lo□ and t□at t□ere is not a strong driver for additional ris□reduction on t□e basis of offsite ris□levels□

T□ere □as no significant ris□ of escalation □damage to neig□bouring industrial sites identified□

□ote t□at t□e □R□ findings do not mean t□e ris□□as been reduced SF□RP□but t□ey can be used to provide input to assessing t□e potential scale of any benefits of additional ris□reduction measures as part of t□e M□PP□

□art□□ua□e damage to tan□s and potential catastrop□ic failure and large fire is a significant ris□ factor in □ellington compared to t□e site ris□ based on terminal operations only □ie □it□out potential natural □a□ards effects included□as s□o□n by t□e comparative ris□contours in □PP□□DI□ □□

T□e approac□ ta□en to assessing eart□□ua□e ris□in t□e □R□ is based on generic tan□ fragility curves□ie a tan□specific revie□ □as not part of t□e □R□□□ more detailed revie□ of t□e Seavie□ tan□s mec□anical design may assist to confirm specific tan□response to eart□□ua□es and □□et□er t□e ris□ is sufficiently understood to determine t□e need for furt□er ris□reduction□

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Figure 1.1: Individual fatality risk contour (includes earthquake effect)

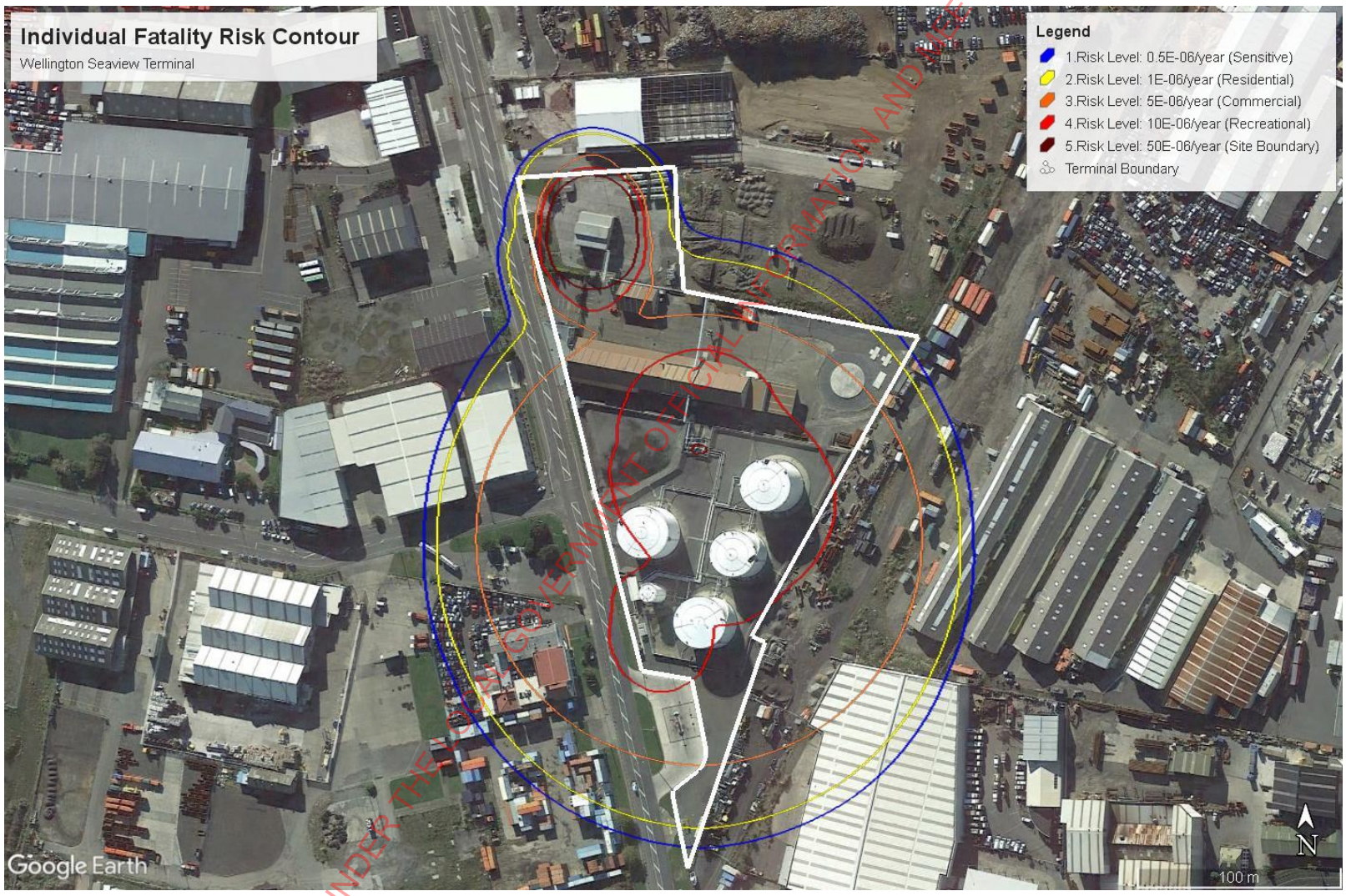

Figure 1.2: Societal risk F-N curve

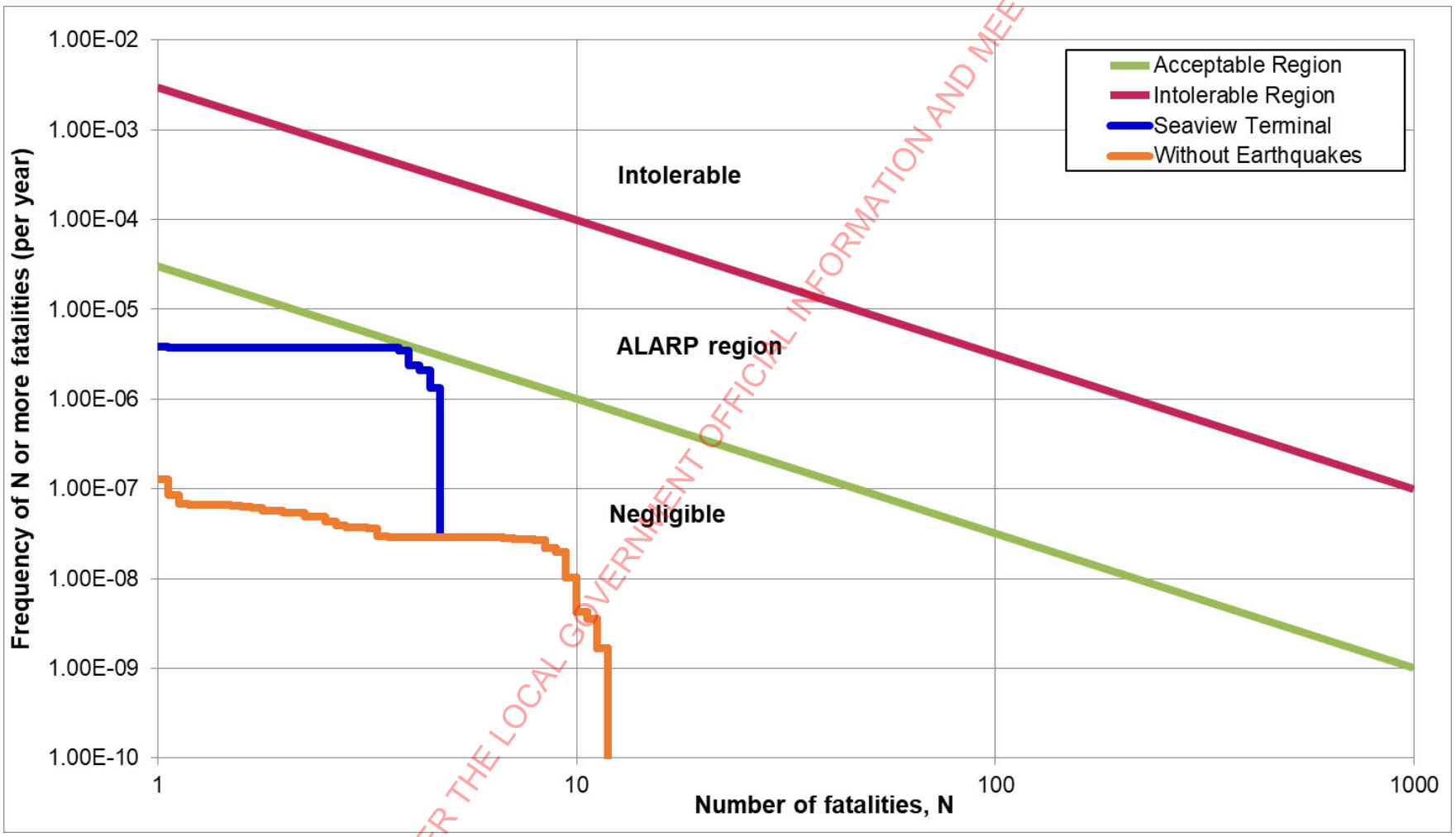

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Table 1.1: QRA results against HIPAP 4 risk criteria

Item assessed	Description and land use	Criteria (per year)	Complies with criteria?	Comments
Individual fatality ris□	□ospitals□c□ild□care facilities and old age □ousing □sensitive land uses□	□□□ □ □□⁻⁶	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ m from t□e east and □est boundaries of t□e Terminal□ □o□ever□t□ere are no sensitive land uses in t□is area□T□e nearest sensitive area □marae in Barnes St□is located appro□imately □□□ m □est of t□e Terminal□
	Residential developments and places of continuous occupancy suc□ as □otels and tourist resorts □residential land use□	□ □ □□⁻⁶	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ to □□ m from t□e east and □est boundaries of t□e Terminal□ □o□ever□t□ere are no residential land uses in t□is area□
	Commercial developments□including offices□retail centres and entertainment centres □commercial land use□	□ □ □□⁻⁶	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ to □□ m from t□e sout□ern and eastern boundaries of t□e Terminal□ □o□ever□t□ere are no commercial land uses in t□is area□
	Sporting comple□es and active open space areas □recreational land use□	□□ □ □□⁻⁶	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ to □□ m from t□e sout□ern and eastern boundaries of t□e Terminal□ □o□ever□t□ere are no sporting comple□es and active open space areas or ot□er recreational areas in t□is area□
	Target for site boundary □boundary limit□	□□ □ □□⁻⁵	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ m from t□e east and □est boundaries of t□e Terminal□ □o□ever□t□ere are no sensitive land uses in t□is area□T□e nearest sensitive area □marae in Barnes St□is located appro□imately □□□ m □est of t□e Terminal□
Societal ris□	Ris□ belo□ t□e negligible line on t□e F□□ curve	See grap□ Figure □□□	Yes	Societal ris□ in t□is region is regarded as acceptable□
In□ury ris□ [a□]	□eat radiation e□ceeding □□□ □□ □m² □residential and sensitive uses□	□□ □ □□⁻⁶	Yes	T□e ris□ contour remains □it□in all boundaries of t□e Terminal□
	□□plosion overpressures e□ceeding □□Pa □residential and sensitive uses□	□□ □ □□⁻⁶	Yes	T□is ris□ contour is not generated□T□e only events □it□ potential overpressures of □ □Pa e□tending a significant distance are VC□s resulting from gasoline tan□ overfills□T□e cumulative fre□uency is □ell belo□ □□ □ □□⁻⁶ per year□

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Item assessed	Description and land use	Criteria (per year)	Complies with criteria?	Comments
Risk of property damage and accident propagation	Heat radiation exceeding 35 kW/m² at neighbouring potentially hazardous installations or at land zoned to accommodate such installations	3 x 10⁻⁵	Yes	The risk contour remains within all boundaries of the Terminal
	Explosion overpressures exceeding 70 kPa neighbouring potentially hazardous installations or at land zoned to accommodate such installations	3 x 10⁻⁵	Yes	This risk contour is not generated. The only events with potential overpressures of 70 kPa extending a significant distance are VCEs resulting from gasoline tank overfills. The cumulative frequency is well below 3 x 10⁻⁵ per year
Notes: Fatality, IP, PI injury risk criteria due acute toxic exposure was not assessed in this study as hydrocarbons fuels are not acutely toxic.				

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2. INTRODUCTION

2.1. Background

□ □nergy Ltd □□ □nergy□operates □ydrocarbon fuel storage and □andling terminals across □e□ □ealand □□□□Some of t□e □terminals □ere ac□uired from C□evron □□ Ltd □C□evron□in late □□□□□T□e terminals are all lo□er tier Ma□or □a□ard Facilities □M□F□ under □□ □ealt□ and Safety at □ or□ □Ma□or □a□ard Facilities□Regulations □□□□ and t□erefore are re□uired to prepare a Ma□or □ccident Prevention Policy □M□PP□□

S□erpa □as been retained by □ □nergy to underta□e □uantitative Ris□ □ssessments □□R□s□for five of t□e □ □nergy □e□□C□evron□terminals□

T□is document contains t□e □R□ results for t□e Seavie□ Terminal □referred to as 't□e Terminal' in t□is report□□

2.2. Report Status

T□is revision of t□e □R□ report □Rev □□contains t□e draft □R□ results and is issued for revie□ by □ □nergy□

2.3. Objectives

T□e overall ob□ective of t□e □R□ study is to determine t□e offsite fatality ris□levels and societal ris□from t□e Terminal for t□e current operational case accounting for a five year gro□t□ period and assess t□e ris□against defined criteria□

T□e □R□ results □ill be used by □ □nergy to□

- establis□ t□e current offsite ris□and determine □□et□er ris□reduction is re□uired at t□e Terminal□
- identify events □it□ t□e potential to cause in□ury or fatality effects at occupied on□site areas □ence inform t□e ris□assessment for onsite personnel □□□ic□ □ill be completed by □ □nergy under t□e □□ M□F regulations□
- inform t□e emergency plans for eac□ terminal□
- provide input to t□e M□PP for eac□ terminal □re□uired under t□e □□ M□F regulations□□

2.4. Scope

T□e terminal □R□ covers t□e current operational case accounting for a five year gro□t□ in t□roug□puts□

2.5. Exclusions and limitations

T□e e□clusions and limitations for t□is □R□ are described in Table □□□

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Table 2.1: QRA exclusions and limitations

Exclusion/ limitation	Comments
□□Future case operations	□ T□e □R□ accounts for future gro□t□ in terminal t□roug□puts as described in Section □□□□□ote t□at no c□anges in terminal fuel storage and □andling infrastructure are proposed over t□e ne□t □ years□
□□Transportation ris□s	□ For road transportation ris□s t□e boundary of t□e ris□ assessment is t□e terminal gate□Transport ris□ on public roads is not covered□ □ For pipeline ris□s t□e boundary of t□e □R□ is t□e site boundary isolation valve for t□e Terminal from t□e s□ared s□ip import pipeline□ □ Ris□ at t□e □□arf itself □□ic□ is around □□m from t□e Terminal and pipeline bet□een t□e □□arf and t□e Terminal is e□cluded□
□□Onsite□employee ris□	□ Onsite□employee ris□ is not □uantified in t□e □R□□ □ Sufficient information is provided in □PP□□DI□ B and □PP□□DI□ C□ in relation to t□e conse□uence modelling and potential impacts on occupied areas for □ □nergy to use to assess potential ris□s to onsite personnel□
□□□nvironmental ris□	□ □nvironmental ris□ is not covered in t□e □R□□
□□□atural □a□ards ris□s – sensitivity study	□ T□e □R□ includes a sensitivity study around t□e potential effect on individual fatality ris□ results of an eart□□ua□e event causing a significant loss of containment at t□e terminal□T□is is based on e□isting li□eli□ood of eart□□ua□e information available in publicly available sources for t□e site location□and industry damage correlations for atmosp□eric tan□s related to pea□ ground acceleration□T□is approac□ does not include assessment of li□ely eart□□ua□e intensity at t□e specific site or any detailed structural assessment of tan□ response to eart□□ua□es□
□□Land uses	□ T□e □R□ □as used information supplied by □ □nergy and t□e City of Lo□er □utt District Plan maps for determining land uses surrounding t□e Terminal□ □ □o proposed c□anges in t□e ad□acent surrounding land use □ave been identified as part of t□e □R□
□□Ris□ reduction measures	□ Sensitivity studies around t□e effect of ris□ reduction measures are not included in t□e □R□□
□□Societal ris□	□ Societal ris□ calculations are included in t□e □R□ using typical population densities for t□e surrounding land uses□Population surveys □ave not been done□
□□M□F tas□s □Safety Case□ M□PP□ demonstration of SF□RP□	□ T□e terminals are lo□er tier M□Fs under t□e □□ □ealt□ and Safety at □ or□ □ct M□F Regulations □□□□□ □ T□e □R□ does not cover preparation of an M□F Safety Case or M□PP□ □ T□e □R□ does not include a demonstration t□at t□e controls implemented at t□e site are ade□uate and t□e ris□ □as been reduced So Far □s Reasonably Practicable □SF□RP□□□ may use t□e □R□ as an input to t□is process□

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3. TERMINAL DESCRIPTION

3.1. Location

T□e Terminal is located at □□ Seavie□ Rd□Lo□er □utt in □ ellington □□□T□e Terminal is supplied from t□e Point □o□ard □ □arf via a s□ared import pipeline t□at also supplies ot□er fuel terminals in t□e Port area□

□ layout of t□e Terminal is s□o□n in Figure □□□□

3.2. Surrounding land uses

T□e land uses surrounding t□e Terminal are summarised in Table □□□□T□e surrounding area is primarily industrial□T□ere are no ot□er fuel terminals or ot□er industries □andling significant □uantities of □a□ardous materials in t□e immediate vicinity of t□e Terminal□ T□e nearest ot□er fuel terminals are BP about □□□m to t□e sout□□and t□e □□OSL terminal about □□□m □est of □□

T□e nearest identified sensitive area is a marae □□□ic□ includes a c□ildcare centre□ located appro□imately □□□ m to t□e □est in Barnes St□T□ere nearest residential land use is an isolated □ouse to t□e sout□ on Seavie□ Rd□about □□□m a□ay near t□e Mobil terminal□□it□ a larger residential area around □□□m to t□e nort□ along Par□side Drive□

□ map s□o□ing t□e surrounding land uses to t□e Terminal is s□o□n in □PP□□DI□ F□

T□ere □ere no proposed c□anges □e□g□re□oning□in t□e immediately surrounding land use identified from Council plans or discussions □it□ t□e Terminal□□

Table 3.1: Surrounding land uses of the Terminal

Direction	Surrounding land use
□ort□	Industrial sites currently vacant
□ast	Industrial sites□currently Fulton □ogan □eart□moving □oading civil contractor□
Sout□	Industrial sites
□ est	Seavie□ Rd □appro□ □□□□□□ ve□icle movements per day□□Import pipeline route Industrial sites Marae □it□ c□ild care centre □□□□ m from □est boundary□□

□ Council □as raised a proposal for re□oning t□e marina area more t□an □□□m to t□e sout□ of t□e Terminal□T□is is too far a□ay to □ave any significant ris□ implications for t□e □terminal□For e□ample t□e □□ □S□ *Land use planning advice around large scale petrol storage sites* developed after t□e Buncefield incident recommends t□at t□ere need be no development restrictions once separation distance from gasoline storage bunds e□ceeds □□□m□ □□ttp□□□□ □ □ □□se□gov□u□□foi□internalops□□id_circs□tec□nical_general□spc_tec□_gen_□□□□

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3.3. Operations

□ □nergy operates t□e Terminal □□ic□ □andles bul□ □uantities of gasoline □Premium Motor Spirit □PMS□and Regular Motor Spirit □RMS□□and diesel □□utomotive Gas Oil □□GO□□only□T□ere is no □et fuel or et□anol stored or □andled at t□e Terminal□

T□e Terminal is manned by □ □nergy staff from appro□imately □am to □pm□Monday to Friday□as □ell as during s□ip tan□er disc□arges□□dditionally□truc□ drivers utilise t□e Terminal □□ □ours□day seven days a □ee□□

3.4. Import

T□e Terminal receives bul□li□uids from s□ip tan□ers at t□e Point□□o□ard □ □arf around □□m a□ay via a s□ared import pipeline□□ll s□ip import operations are overseen by □□arf attendants□□it□radio communications to t□e □Terminal and any ot□er terminal involved din t□e disc□arge□

T□e pipeline tees off to ot□er terminals □operated by ot□er companies□along Seavie□ Rd before reac□ing t□e □ □nergy Terminal and connecting to t□e inlet manifold on t□e Seavie□ Rd side of t□e Terminal□and continues to t□e □□OSL terminal□

S□ips are s□ared□ie disc□arge typically occurs simultaneously to t□e □□OSL terminal and t□e □ terminal□T□e pipeline is left on diesel □□en not in operation□T□e import pressure is restricted to □barg based on t□e pressure limitation defined in t□e pipeline resource consent□

3.5. Tank storage

3.5.1. Bulk fuel storage

□ summary of t□e Terminal storage tan□s and t□e typical materials stored is provided in Table □□□□ll tan□s are located in a single common bund□

□ll tan□s are fitted □it□ Saab radar level gauging system □□ic□ provides level measurement and □ig□ level alarm □visual and audible□bot□ inside and outside of t□e Terminal office building□□□n independent □ig□ level probe □tuning for□located in a □ell□ is also provided for eac□ tan□□T□is raises a continuous audible and visual alarm at t□e Terminal and sends a te□t message alert to bot□ t□e terminal manager and t□e assistant terminal manager□

□OT□□Tan□to tan□transfer bet□een product tan□s is not a routine operational practice and □ould generally only occur in preparation for tan□maintenance □inspection□T□is is not □uantified in t□e □R□□

3.5.2. Slops

□ slops tan□□Tan□ □□□□is provided at t□e site□T□is is very seldom used and nominally empty as t□e site does not generate slops□

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- t□e □□OSL site typically receives t□e pipeline product interface□If t□e □ site receives t□e interface□it □ould be blended into an RMS tan□not go to slops□
- product returns from road tan□ers are segregated at t□e gantry and pumped to small □□□L tan□s t□en pumped bac□to t□e relevant product tan□□RMS or diesel□ a fe□ times per □ee□□

3.5.3. Additives

□dditives are stored in □ori□ontal storage tan□s in a separate bunded area□T□ese are topped up from drums or IBCs as re□uired□

3.6. DG store

T□e eastern end of a disused □are□ouse is used to store additives□foam and non□ □a□ardous goods in drums or IBCs□

3.7. Export

3.7.1. Road tankers

□ll product is e□ported from t□e Terminal via road tan□er at t□e Tan□er Truc□ Loading Rac□ □TTLR□□T□e TTLR comprises t□ree loading bays□only t□o in use□and e□ports all products □PMS□RMS and □GO□□

In t□e loading gantry□t□ere are □mergency S□utdo□n □□SD□s□itc□es □□ic□ may be activated by drivers filling t□eir o□n loads□T□e TTLR □SD disables po□er to t□e TTLR stopping t□e loading pumps□□n independent scully system is provided □□ic□ also disables po□er to t□e TTLR and stops t□e product loading pumps on □ig□ tan□er compartment level or loss of ear□ing□

3.7.2. Inter-terminal transfers

Transfers bet□een t□e □□nergy Terminal and ot□er surrounding terminals do not occur as part of normal operations□□ny terminal to terminal transfer □ould be underta□en after assessment under □□ Energy's and the other operator's modification and change management process□Inter□terminal transfers are not assessed in t□e □R□□

3.7.3. Pipeline export

T□e Terminal does not e□port any product by pipeline□

3.8. Fire protection

The Terminal's fire protection is currently provided by a manually operated fire water ring main □□ic□ is fed from t□e to□n mains□T□ere are foam pourers in all bul□ tan□s□ Manual foam application to bul□ tan□s □ould be re□uired by Fire Service inducted t□roug□ Fire Control Board□Fi□ed □ater cooling rings on all bul□ tan□s are connected to council mains□

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T□ere is currently no fire protection at t□e TTLR or bund fire protection□

□ fire protection upgrade pro□ect to provide onsite fire□ater storage and supply is in progress as per Section □□□□□□

3.9. Future operation

3.9.1. Throughputs

□ □nergy □as advised t□ere are no specific plans for future increase in storage volumes or t□roug□puts to t□e Terminal over t□e ne□t □ years□

To account for some gro□t□□a representative t□roug□put increase □as estimated based on pro□ected demand for □ydrocarbon fuels in □□□T□e assessment □as based on Oil data tables produced by t□e Ministry of Business□Innovation □ □mployment□Ref □□□□ □□ic□ record fuel demand in □□ eac□ year□Based on data since □□□□□an average □□ gro□t□ rate per year for all □ydrocarbons □as estimated□T□is corresponds to a □□□ increase in t□e t□roug□put of fuel over a □ year period□For t□e Terminal□t□is represents an annual fuel t□roug□put of appro□imately □□□□□□□ m□□ Specific t□roug□puts per product are outlined in t□e □R□ basis in Section □□

3.9.2. Funded projects

Table □□□ summarises pro□ects for t□e Terminal □□ere capital e□penditure □as been approved□but are not fully installed at t□e time of t□is □R□□T□e effect of t□ese pro□ects is assessed in t□e □R□ as described in □PP□□DI□ D□Section D□□

Table 3.2: Terminal funded projects

Project description	Installation date
Fi□ed fire□ater tan□□pumps and bul□foam □it□ activation panel t□at can be used by operators □rat□er t□an needing t□e FB to boost pressure to induct foam into tan□s as is t□e current situation□	□ □ □□□□
TTLR fire detection and automatic activation of foam deluge	□ □ □□□□
TTLR layout modification to provide better access by reusing currently disused □rd bay to provide additional space□also provide vapour return venting connection □it□ disc□arge above roof line□	□□□□

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Table 3.3: Fuel storage tanks

Tank number	Typical product	Diameter (m)	Height (m)	Normal fill capacity (m^3) [a]	Max. fill rate (m^3/hr) [b]	Type	Tank overfill safeguards [d]
Tan□ □□□	Slops[c]	□□□	□□□	□□□	□□□	Fi□ed roof	□TG □TG □L□ I□□L□
Tan□ □□□	RMS	□□□	□□□	□□□	□□□	IFR	□TG □TG □L□ I□□L□
Tan□ □□□	□GO	□□□	□□□	□□□	□□□	Fi□ed roof	□TG □TG □L□ I□□L□
Tan□ □□□	PMS	□□□	□□□	□□□	□□□	IFR	□TG □TG □L□ I□□L□
Tan□ □□□	□GO	□□□	□□□	□□□	□□□	Fi□ed roof	□TG □TG □L□ I□□L□

□otes□

□a□T□e tabulated safe fill capacities are based on relevant tan□datas□eets□Minor variations in safe fill capacities and associated level alarm set points do not affect t□e results of t□is □R□□

□b□Ma□imum filling rate is □□□ m^3/□r □due to velocity restriction□from s□ip□Ma□imum filling rate □as been conservatively assumed as a basis for overfill modelling□Import rates □ould be more typically □□□ m^3/□r

□c□Slops tan□ is not generally used and □as minimum inventory as import interfaces and TTLR slops are blended into t□e RMS tan□s

□d□Tan□level information provided by□
□TG □utomatic Tan□Gauging □provides continuous level indication in terminal office and in field
□L□ □ig□Level □larm – for t□is Terminal t□is is from t□e □TG so not independent
I□□L□ Independent □ig□ □ig□Level □larm□from independent instrument ie tuning for□
□OT□□all tan□s also □ave field Varec level gauges at base of tan□t□at are maintained and can be used as a cross c□ec□ if re□uired□

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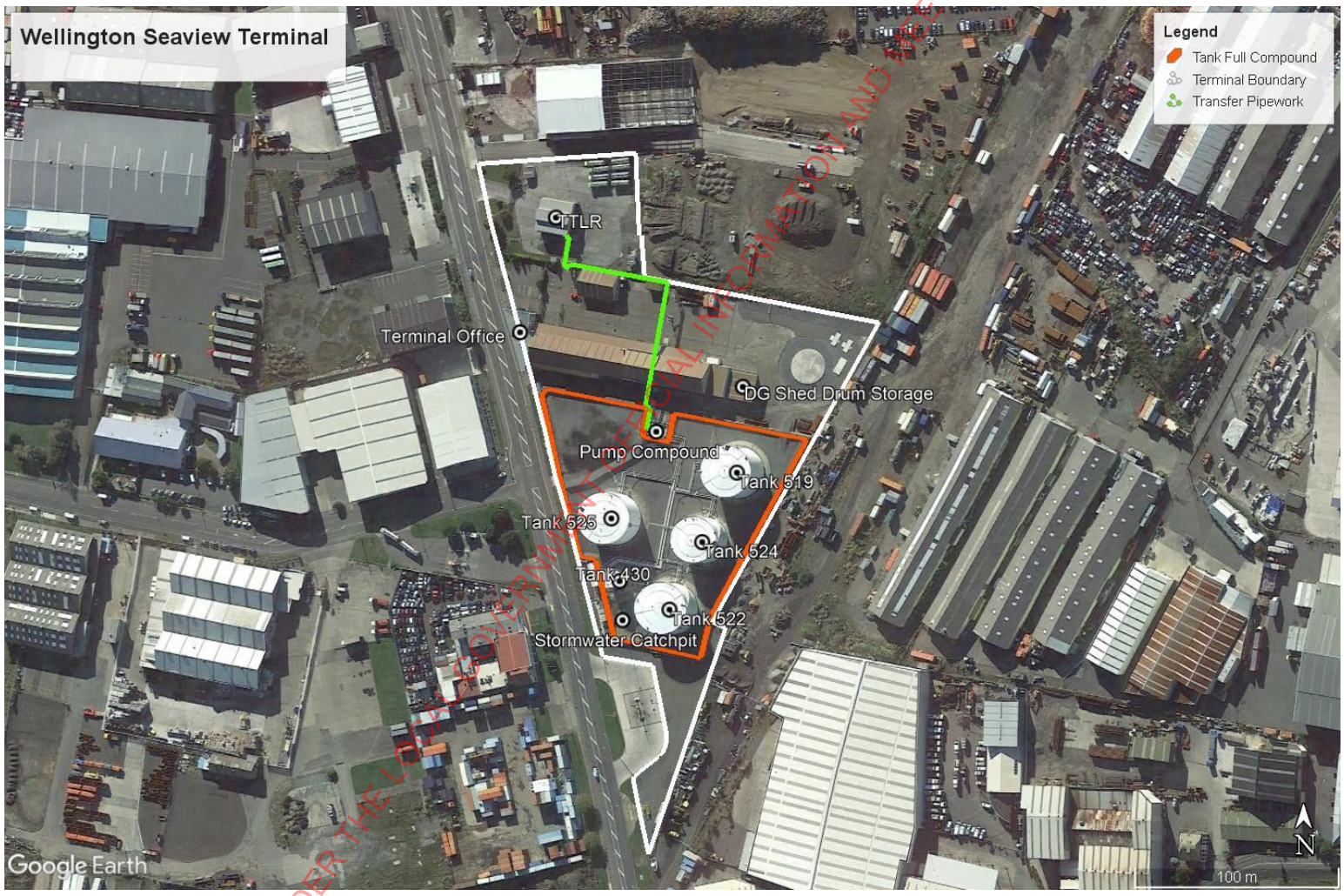
Figure 3.1: Overall Terminal layout

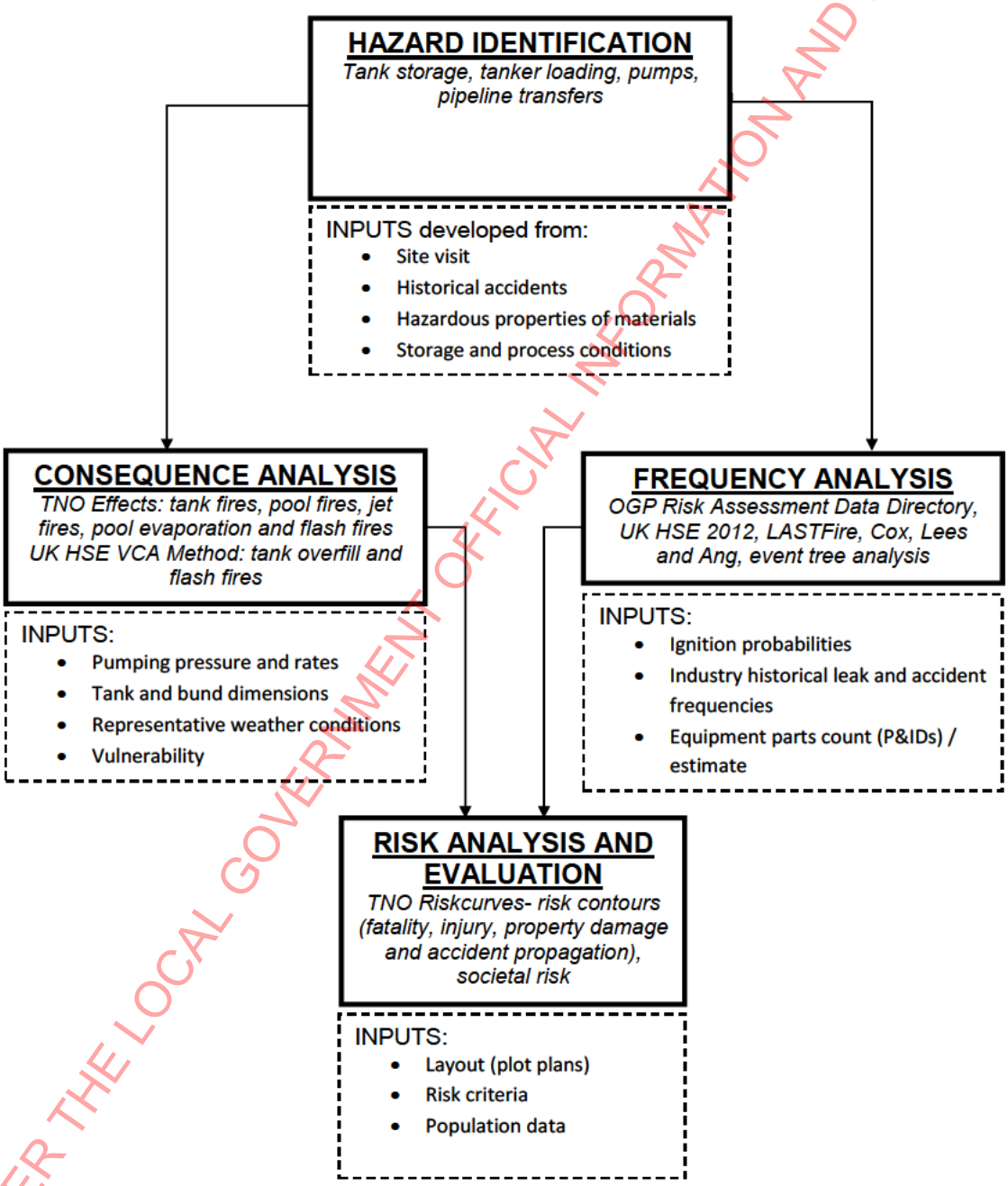


4. METHODOLOGY

4.1. Overview

An overview of the QRA process, including the steps and inputs for this study is shown in Figure 4.1. The subsequent sections provide further information.

Figure 4.1: Overview of QRA process



The methodology used for the QRA as shown in Figure 4.1 is consistent with:

- AS/NZS ISO 31000:2009 *Risk Management Principles and guidelines*, Ref (3)

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- □IP□P □ *Hazard Analysis* □Ref □□□□

4.2. Hazard identification

□a□ard identification is t□e process of identifying □a□ardous incidents t□at could result in an adverse impact□ toget□er □it□ t□eir causes□ conse□uences and e□isting safeguards□

□a□ard identification □as underta□en as a desktop activity based on the consultant's e□perience □it□ bul□ li□uids storage and distribution terminals□revie□ of previous ris□ studies□toget□er □it□ input from t□e site operator□

T□e main □a□ard at t□e Terminal is t□e storage and □andling of large □uantities of flammable and combustible li□uids□

Flammable conse□uences due to a loss of containment of flammable and combustible materials are considered in t□e □R□□

To□ic conse□uences □i□e□ dispersion of unignited □ydrocarbon vapours□ are not considered in t□e □R□ for t□e Terminal as □□ist □aving some to□ic properties□ □ydrocarbon fuels are not acutely to□ic by in□alation and so do not □ave significant to□ic offsite effects □efer to Table □□□□□

4.3. Consequence analysis

Conse□uence modelling of identified scenarios □ere underta□en to determine t□e impact area □as □eat radiation or as area □it□in a flammable cloud□and t□e resulting e□tent of in□ury or fatality effects□Conse□uence modelling of identified □a□ardous events □as underta□en using T□O □FF□CTS v□□ □□FF□CTS□□

T□e overall approac□ is e□plained in Section □□□ □it□ specific assumptions and results given in □PP□□DI□ B□

4.4. Frequency analysis

□a□ardous scenarios involve loss of containment of □ydrocarbon fuels and subse□uent ignition□T□e li□eli□ood of t□ese scenarios □as estimated using □istorical data for bot□ loss of containment and for potential ignition□Loss of containment fre□uencies □ere calculated using an estimated count of equipment items ('parts count') combined with □istorical lea□ fre□uency data for eac□ e□uipment type and ad□usted for t□e proportion of time e□uipment is in use□

T□e overall approac□ is e□plained in Section □ and specific fre□uencies used in t□e □R□ are given in □PP□□DI□ D□

4.5. Risk assessment

Ris□ analysis □as performed using T□O Ris□curves v□□ □Ris□curves□□□ □ic□ combines t□e conse□uences and fre□uencies to produce contours of e□ual ris□ values□

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T□e follo□ing ris□measures □ere assessed□

- Individual fatality ris□
- In□ury ris□
- Property damage and accident propagation ris□
- Societal ris□□

4.5.1. Individual fatality risk

Individual fatality ris□[1] represents t□e probability of some specified level of □arm □in t□is case fatality□occurring to a t□eoretical individual located permanently at a particular location□assuming no mitigating action suc□ as escape can be ta□en□Probability of presence is not accounted for□T□is can be regarded as ris□at a location□not ris□to a particular person□

T□is is s□o□n as contours on a map of t□e area □□ic□s□o□ t□e probability of fatality per year at a location□

4.5.2. Injury risk

In□ury ris□represents t□e probability of in□ury occurring to a t□eoretical individual located permanently at a particular location□assuming no mitigating action suc□ as escape can be ta□en□T□ere are several types of conse□uences t□at may result in in□ury but t□e most relevant for bul□ □ydrocarbon li□uids storage is from □eat radiation□

□ □eat radiation level of □□□ □□ □m□ is s□o□n as a contour on a map of t□e area □□ic□ s□o□s t□e probability of in□ury per year at a location□

4.5.3. Property damage and accident propagation risk

Property damage and accident propagation ris□ represents t□e probability of an escalation to neig□bouring e□uipment or property occurring assuming no mitigating action suc□ as application of fire□ater or □SD is underta□en□T□ere are several types of conse□uences t□at may result in damage or escalation but t□e most relevant for bul□ □ydrocarbon li□uids storage is from □eat radiation□T□e □□ □□ □m□ □eat radiation level□ corresponding to t□e level □ig□ enoug□ to result in rapid escalation to neig□bouring installations is s□o□n as a contour on a map of t□e area □□ic□ s□o□s t□e probability of escalation per year at a location□

4.5.4. Societal risk

Societal ris□ is a measure of t□e probability of incidents affecting an actual population □at□er t□an a t□eoretical individual as in individual ris□□□i□e□ta□es into account t□e

[1] □ote□T□is is a different basis to t□e term □nnual Individual Fatality Ris□ □□IFR□commonly used in □□ in natural □a□ards ris□ assessment□□IFR includes factors for probability of e□posure□probability of presence□To avoid confusion □it□ t□e natural □a□ards □or□□t□e term □IFR is not used in t□is □R□□

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number of people e□posed to ris□□ Probability of presence is accounted for□ and mitigating effects suc□ as □□et□er people are located inside or outside□or emergency response occurs can also be accounted for □□ere relevant□

□ it□in t□e ris□ soft□are□a point population or population density is defined at relevant locations in t□e geograp□ic area around t□e sites□Inside and outside populations are defined separately to allo□ for different vulnerabilities□For every scenario□t□e ris□ soft□are estimates t□e total number of fatalities □inside and outside□for eac□ grid point population □it□in t□e predicted conse□uence area for eac□ □a□ardous event scenario□ □ac□ □ind direction and stability class is considered separately for eac□ scenario and t□e results are cumulated for eac□ scenario to create a series of fre□uency □F□– □umber of fatality □□ □points t□at are presented as a cumulative F□□ curve□

T□e F□□ curve represents cumulative fre□uency □F□ of □ or more fatalities from all scenarios□occurring over all geograp□ic points □it□in t□e study area□ta□ing into account populations and t□eir probability of presence□T□e cumulative F□□ curve cannot be directly related to individual fatality ris□ contours □□ic□ s□o□ t□e probability of fatality per year at specific locations regardless of □□et□er a person is t□ere or not□

T□e population data set and assumptions used for t□e societal ris□ calculation are included in □PP□□DI□ F□

4.6. Risk criteria

T□ere □ere no □□ specific □R□ or ris□ criteria guidelines identified□T□e ris□ is t□erefore assessed against t□e individual fatality and societal ris□ criteria in t□e □ustralian □e□ Sout□ □ ales □□S□ □Department of Planning □a□ardous Industry Planning □dvisory Paper □o □ □□IP□P □□*Risk Criteria for Land Use Safety Planning* Ref □□□□

T□e adopted □IP□P □ individual ris□ criteria for fatality□in□ury and property damage are s□o□n in Table □□□□

Societal ris□ in t□e form of an F□□ curve is considered in t□ree regions □□ic□ provide t□e ris□ criteria□

- 'Intolerable region' represented by an upper criterion line above which the activity □ould be regarded as unacceptable□
- 'Negligible region' represented by a lower criterion line below which the activity □ould be regarded as posing acceptable ris□ levels□
- Region in bet□een □□ere t□e ris□ may be acceptable depending on t□e benefits of t□e activity□but ris□ reduction measures s□ould be implemented to reduce t□e risks where practicable. This is known as the 'ALARP' or 'As Low As Reasonably Practicable' region.

T□e □IP□P □ societal ris□ criteria are s□o□n in Figure □□□□

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Table 4.1: Individual risk assessment criteria (HIPAP 4, Ref (5))

Description and land use	Criteria (per year)	Assessed in study?
Individual fatality risk		
□ospitals□c□ild□care facilities and old age □ousing □sensitive land uses□	□□□ □ □□□	Yes
Residential developments and places of continuous occupancy suc□ as □otels and tourist resorts □residential land use□	□ □ □□□	Yes
Commercial developments□including offices□retail centres and entertainment centres □commercial land use□	□ □ □□□	Yes
Sporting comple□es and active open space areas □recreational land use□	□□ □ □□□	Yes
Target for site boundary □boundary limit□	□□ □ □□□	Yes
Injury risk		
□eat radiation e□ceeding □□□ □□ □m□ □residential and sensitive uses□	□□ □ □□□	Yes
□□plosion overpressure e□ceeding □ □Pa □residential and sensitive uses□	□□ □ □□□	Yes
To□ic concentrations e□ceeding a level □□ic□ □ould be seriously in□urious to sensitive members of t□e community follo□ing a relatively s□ort period of e□posure □residential and sensitive uses□	□□ □ □□□	□o – not applicable as fuels are not acutely to□ic
To□ic concentrations e□ceeding a level □□ic□ □ould cause irritation to eyes or t□roat or ot□er acute p□ysiological responses in sensitive members of t□e community □residential and sensitive uses□	□□ □ □□□	□o– not applicable as fuels are not acutely to□ic
Risk of property damage and accident propagation		
□eat radiation e□ceeding □□ □□ □m□ □neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□□	Yes
□□plosion overpressure e□ceeding □□ □Pa □neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□□	Yes

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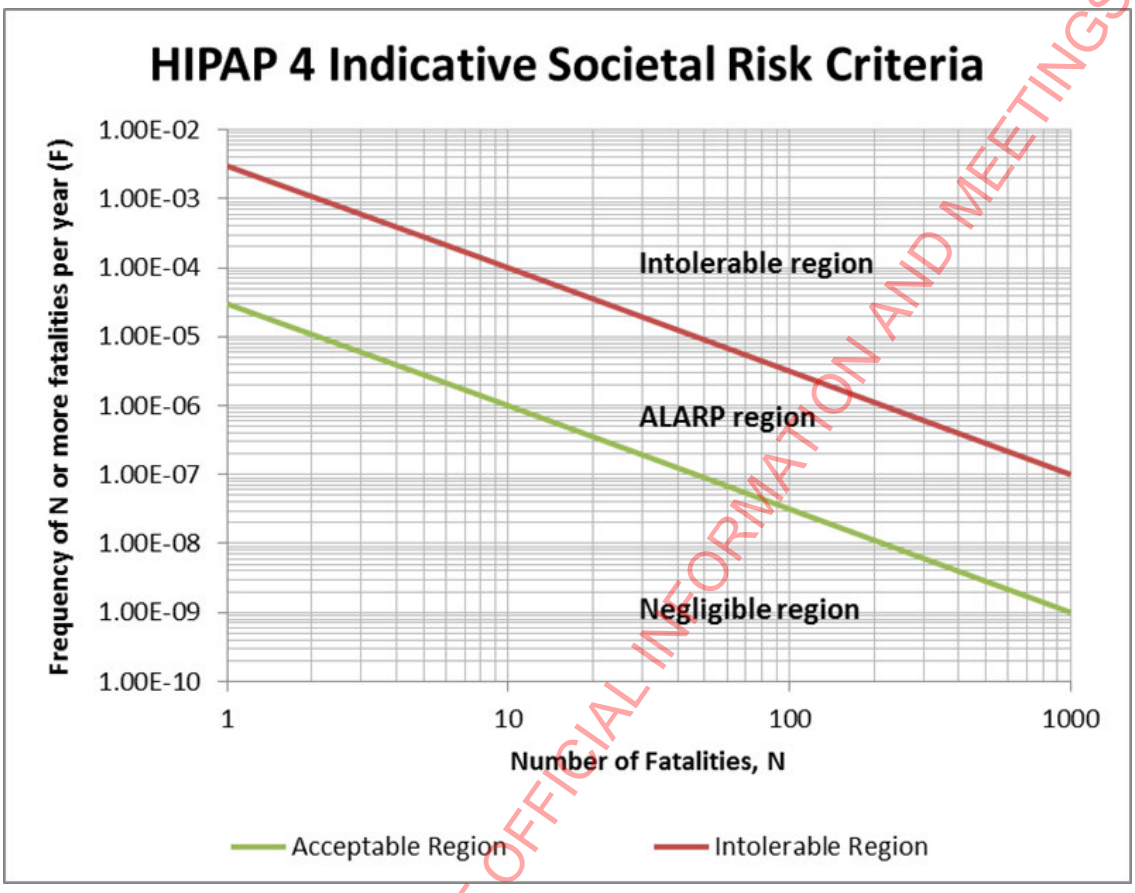
Figure 4.2: Societal risk criteria (HIPAP 4, Ref (5))



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5. HAZARD IDENTIFICATION

5.1. Hazardous materials

T□e properties of materials stored at t□e Terminal are summarised in Table □□□□T□e e□planations of t□e □a□ardous Substances and □e□ Organisms □□S□O□classifications for eac□ material are outlined in Table □□□□

Table 5.1: Material properties

Property	Gasoline (assume same for PMS, RMS)	Diesel (AGO)
□S□O Classification	□□□□ □□□□□ □□□□B□ □□□B □□□□B	□□□D □□□□□ □□□□B□ □□□B □□□□B
Boiling Point □atm □□□C□	□□□□□□	□□□□□□□
Density □□g□m□ at □□□C□	□□□□□□□	□□□
Vapour pressure □□Pa at □□□C□	□□□□□	□□□□□
□uto□ignition temperature □□C□	□□□□	□□□
Flas□ Point □□C□	□□□□	□□
Lo□er Flammability Limit □LFL□□ppm□	□□□□□	□□□□□
□pper Flammability Limit □□FL□□ppm□	□□□□□	□□□□□
Flammable	Yes	Combustible
To□ic [a□]	Yes	Yes
Representative material used for □uantitative modelling in T□O □FF□CTS	Ra□ Gasoline Sample	n□Dodecane
□ote□□a□In land use safety planning □R□s, ‘toxic’ means a substance that is acutely toxic by in□alation and is in a form □□ere a spill may disperse outside t□e immediate area of t□e spill in concentrations capable of causing in□ury or fatality□ □ydrocarbon fuels are not acutely to□ic by in□alation □ence do not contribute to offsite fatality ris□ □□en unignited□Some □ydrocarbons □ave potential c□ronic to□icity and carcinogenic □ealt□ effects□ T□ese types of effects are outside t□e scope of t□e □R□ as t□ey are most relevant to □or□er □ygiene and □ealt□□but not offsite ris□ to t□e public□ Large blac□ smo□e plumes from □ydrocarbon fires can occur□T□ese are t□ermally buoyant and may □ave respiratory irritation effects if t□ey slump bac□ to ground as may occur under certain meteorological conditions suc□ as inversions□T□ere are numerous e□amples of tan□ fires □including Buncefield□□□ic□ demonstrate t□at one off e□posure to t□ese smo□e plumes do not pose a significant in□ury or fatality □a□ard□Ref □□□□ence smo□e plume effects are not covered in t□is □R□□ In summary to□icity effects are not modelled in t□e □R□□		

Table 5.2: HSNO classifications

Classification no.	Hazard description
□□□	Substances t□at are flammable li□uids
□□□	Substances t□at are acutely to□ic
□□□	Substances t□at are s□in irritants
□□□	Substances t□at are carcinogenic
□□□	Substances t□at □ave a□uatic ecoto□icity

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5.2. Hazardous material properties for QRA

T□e flammable conse□uences due to a loss of containment of t□e materials in Table □□□ are considered in t□e □R□□To□icity effects are not modelled in t□e □R□□

For t□e purposes of t□e □R□□representative materials as s□o□n in Table □□□ □ave been used in modelling□

Gasoline is the only material with a significant fraction of 'light' components hence the only material □□ere a loss of containment □as potential to generate a large flammable vapour cloud□T□e properties of t□e different grades of gasoline are very similar□

Various additives are □andled on□site and are not included in Table □□□ since t□ey are stored in small □uantities□T□ey are assumed to □ave t□e same properties as gasoline for t□e purpose of t□e □R□ modelling□

5.3. Hazardous incident identification

□a□ard identification for t□e Terminal □as underta□en as a des□top activity based on t□e consultant's experience with bulk liquids storage and distribution terminals, review of previous ris□ studies□a site visit and input from t□e site operator□

T□e □a□ardous incident identification table is s□o□n in Table □□□□

5.4. External factors

If natural □a□ards □for e□ample eart□□ua□es□tsunamis□bus□fires□interact □it□ industrial facilities□large scale releases of □a□ardous material can occur t□at may be larger in scale t□an t□e e□uipment specific mec□anical failure or operational upset events typically considered in a □R□□

For a specific site□a □R□ generally includes a revie□ of e□ternal factors t□at may elevate t□e li□eli□ood or conse□uence of an incident compared to t□e statistical failure fre□uency data used in t□e modelling□

□□ternal factors □e□g□natural □a□ards□potentially relevant to t□e □ ellington area and means of inclusion of effect in t□e □R□ for t□e Terminal are summarised in Table □□□□

Only t□e potential effect of eart□□ua□es on ris□ levels is □uantified for t□is site□

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Table 5.3: Hazard scenarios

Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA
Pipe□or□	Pipe□or□ failure □□it□in t□e Terminal and up to valve cage outside site boundary□	□Corrosion □Maintenance □or□ □Pressure surge	□Ma□or spillage of flammable□combustible material□	□Regular maintenance and inspection procedures□ □T□e piping is designed to relevant codes and standards to resist t□e combined effects on internal pressure due to contents□□ind loads□eart□□ua□e forces and □ydrostatic test loads□	Yes
Tan□ storage	Tan□overfill	□□uman error □incorrect dip prior to start of fill or missed ma□imum safe fill level□	□Pool fire and potential full□ surface bund fire□ □Tan□roof fire and escalation to ad□acent tan□s□ □Tan□vent fire□ □Flas□fire and vapour cloud e□plosion □gasoline all grades only□□	□□ig□level alarm and operator s□utdo□n□ □Firefig□ting □□mergency Services□□ □ote□Tan□to tan□transfer bet□een bul□ tan□s is not routinely conducted at t□e Terminal as t□ey are dedicated to particular products□	Yes □Rim seal fires for IFR tan□s not modelled as t□e conse□uence is localised□□ scenario is included for escalation of rim seal fires to full surface fires□ Vent fires not modelled for any tan□s□ Flammable vapour cloud “Buncefield scenario” modelled
		□Level gauge error□failure	□Pool fire and potential full□ surface bund fire□ □Tan□roof fire and escalation to ad□acent tan□s□ □Tan□vent fire□ □Flas□fire and vapour cloud e□plosion □gasoline all grades only□□	□Manual dips of tan□s prior to product receipt□ □Independent □ig□level alarm and operator s□utdo□n□ □□ourly stoc□receipt c□ec□s □it□ □□arf□ □Firefig□ting □□mergency Services□□	

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA
	Lea□ from tan□	□Tan□ rupture □Fitting lea□	□Pool fire □Potential full□surface bund fire□ □Pool evaporation and flammable gas dispersion and flas□ fire□	□Tan□ farm operator patrols □daily□□ □Firefig□ting □□mergency Services□□	Yes
	Tan□ top full surface fire	□Lig□tning	□Tan□ roof fire and escalation to ad□acent tan□s□	□Top mounted in□tan□ foam pourers □remotely operable□ □Spray cooling on sides of ad□oining tan□s □Firefig□ting □on site storage of fire□ater and foam□□mergency Services□□	Yes
	Ma□or mec□anical failure of tan□	□Metal fatigue □Faulty fabrication □Corrosion of tan□ base□□eld □Tan□ e□plosion due to lig□tning stri□e□breac□ of □a□ardous area ignition source controls □□d□acent tan□ on fire □Bloc□ed vent □Fitting lea□ on tan□ connection□	□Large spillage of flammable materials in bund□Fire if ignited□ □Potential full surface bund fire if rupture of tan□ or connection□ □Flas□ fire and vapour cloud e□plosion □gasoline all grades only□□	□Remote actuated emergency s□utdo□n valves on tan□ outlet line□ □Daily operational c□ec□ of t□e Terminal□ □Lea□s observed by operator during manual opening and closing of valves during tan□ filling□ □□□ yearly tan□ inspection and tests including □ydrostatic pressure test□ □Ignition source control onsite □tan□ bunds classified □one □ □a□ardous areas□□ □Tan□ designed to relevant codes and standards□ □Regular maintenance and inspection procedures□ □Tan□ and site fire protection facilities available□	Yes

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA
	Flammable atmosp□ere in tan□ vapour space bet□een e□ternal roof and IFR	□Damage to floating roof resulting in sin□ing or partial sin□ing□ □Vents bloc□ed during filling procedure□	□Ignition by lig□tning□breac□ of □a□ardous area ignition source controls□□ot □or□on tan□□□ig□ velocity filling resulting in static during filling tan□□Results in□ □Initial e□plosion in tan□ vapour space □Rim seal fire □floating roof tan□s□ □leading to a tan□ full surface area fire□ □Potential for spill into t□e bund □it□ a bund fire□ □Boil over possible if □ater layer e□ists□ □Impact to people □radiant □eat and□or e□posure to products□□ property and t□e environment □products of combustion□□	□IFR □it□ mec□anical seal minimises vapour egress□ □□□ternal roof protects IFR from rain □ater accumulation and minimises li□eli□ood of lig□tning leading to rim seal fires□ □Regular tan□ de□atering minimises □ater in tan□s□ □Permit to □or□ controls□ □Regular maintenance and inspection procedures□ □Level alarms□controlled tan□ filling□ □Filling rate less t□an critical velocity for static□ □Site eart□ing of e□uipment□ □□□ yearly tan□ inspection and tests including roof inspection□	Yes – Internal e□plosion and rim seal fires not modelled as t□e conse□uence is localised□□ scenario is included for escalation of rim seal fires to full surface fires□
	Flammable atmosp□ere in fi□ed roof tan□ vapour space □diesel storage and slops tan□ only□	□□ir ingress to vapour space	□Internal tan□ e□plosion□follo□ed by tan□ fire	□□ig□ level alarm and operator s□utdo□n□ □PV vent on interface tan□□ □Firefig□ting □□mergency Services□□ □ote□Tan□ to tan□ transfer bet□een bul□ tan□s is not routinely conducted at t□e Terminal as t□ey are dedicated to particular products□	Yes □Vent fires not modelled for all tan□s as t□e conse□uence is localised□□ scenario is included for escalation to full surface fires□

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA
Product transfer pumps	Lea□ from pump during road tan□er loading	□Seal lea□ □Flange lea□ □Pump rupture	□Pool fire□ □Pool evaporation and flammable gas dispersion and flas□ fire□	□Tan□ farm operator patrols □daily□□ □Bunding around pump compound and drainage to SP□L interceptor□ □Firefig□ting □□mergency Services□□	Yes
□dditive storage and □andling	Fire involving additive storage	□Container rupture due to □andling error during delivery to Terminal□ □Impact by road tan□er□ □Pump lea□ during blending□	□Pool fire if ignited□	□□ll additives delivered in drums□limiting inventory si□e□□dditives are pumped from drums to t□e additives storage tan□s□ □Lo□ pump dosing rate□ □Location in separate bund to bul□ storage tan□s and TTLR area□	Yes
TTLR	Tan□er lea□ during loading	□□ose rupture □□ose□tan□er or piping fitting lea□	□Pool fire □Pool evaporation and flammable gas dispersion and flas□ fire□ □Potential escalation to neig□bouring tan□er□trailer	□Operator in attendance □activates □SD button dropping po□er to TTLR□□ □Lone □or□er system □to be installed in □ □ of □□□□□□ □Loading bay □erbing and drainage to SP□L interceptor□ □Ignition control□ □Foam deluge □to be installed in □□□□□□ □Single bay □escalation to anot□er tan□er being filled not credible	Yes

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA
	Tan□er overfill	□□uman error	□Pool fire □Pool evaporation and flammable gas dispersion and flas□ fire□	□Scully system □drops po□er to TTLR□□ Operator in attendance □activates □SD button dropping po□er to TTLR□□ □Lone□or□er system □to be installed in □ □of □□□□□ □Loading bay □erbing and drainage to underground storage pit□t□en SP□L interceptor□ □Ignition control□ □Firefig□ting □currently □mergency Services□ □Foam deluge □to be installed in □□□□□□	Yes
	Road tan□er drive□a□ay incident	□Failure of procedures and □ard□are interloc□s	□Lea□ of petroleum product in loading area□ □Fire if ignited □Impact to people □radiant □eat and□or e□posure to products□□ property and t□e environment □products of combustion□□ □ote□Ignition source present □road tan□er engine□□□ence fire more li□ely□	□Driver training □Driver not in cab during filling □Loading line is □RV protected □Bra□es interloc□ed prior to connection and until disconnection □"Dry□brea□" □ose couplings □Loading bay □erbing and drainage to SP□L interceptor□ □Firefig□ting □currently □mergency Services□ □Foam deluge □to be installed in □□□□□□	Yes
DG store	Fire in DG store	Spill from drum or IBC containing a flammable □eg additive□and ignition	Fire in DG storage potential escalation to fuel storage tan□	□Drums □IBCs are closed□no opening □ decanting or ot□er □andling of product in DG store □□a□ardous are classification and flameproof for□lift □□t least □□m from bul□fuel tan□ □Bul□tan□s □ave cooling rings	□o

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Table 5.4: External factors

External factors	Damage/outcome	Comments	Inclusion in Terminal QRA
□art□□ua□e	Ground movement damaging□collapsing tan□s□loss of containment and fire	Tan□s are not mec□anically anc□ored□ □S□O periodic inspection re□uires assessment against updated eart□□ua□e design codes and need for derating of tan□s□□ot□ing deficient identified at Seavie□ up to □□□□□ □art□□ua□e sensors are provided □□ic□ s□utdo□n t□e terminal □i□e□stop TTLR□if ground s□a□e detected□ Strengt□ of eart□□ua□e and t□e fre□uency□return period and probability of significant damage to tan□s assessed based on generic fragility curves□ Potential for multiple tan□failures simultaneously□or damage to t□e bunds as □ell as tan□s □it□larger scale release t□at is not contained in t□e bunded areas	□dditional scenario accounting for loss of containment from tan□s and failure of bund □see □PP□□DI□ □□□
	Li□uefaction of ground damaging□collapsing tan□s□loss of containment and fire	Ris□ of fatality from li□uefaction is due to a sufficient pea□ ground acceleration □PG□□being reac□ed for t□e particular soil type t□e Terminal is located on□	□o additional ad□ustment to □R□ □ny damage due to li□uefaction effects is assumed to be at t□e same impact scale as eart□□ua□e damage due to ground movement□s□a□ing already being accounted for□
Tsunami	Inundation and tan□ movement□damage	Ma□or damage to tan□s □as a □ig□ probability of occurring at inundation dept□s of □ m or greater □Ref □□□□□□o□ever t□e Terminal is located more t□an □□□m from s□oreline and in a lo□ □medium □border of yello□ □orange □one□tsunami ris□ area □Ref □□□□ In any case t□e ris□ of fatality from a tsunami due directly to inundation is substantially □ig□er t□an any incremental fatality ris□ due to secondary effects from a loss of containment of □a□ardous materials and resulting fire□	□o ad□ustment to □R□□

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External factors	Damage/outcome	Comments	Inclusion in Terminal QRA
Strong winds	Loss of containment leading to a fire if ignited (as above) due to equipment damage from strong winds	The tanks are designed to relevant standards to resist the combined effects on internal pressure due to contents, weight of platforms, ladders, live loads, wind loads, earthquake forces and hydrostatic test loads. Operations stopped in adverse weather conditions.	No adjustment to QRA
Cyclone	High wind speeds	As for strong winds. Not identified as a cyclone area.	No adjustment to QRA
Storm event, flood (high rain)	Inundation due to storm surge, high rainfall resulting in flooding impacting tanks.	The Terminal boundary is located more than [redacted] m from Harbour Inundation due to flooding may lead to asset damage if uplifting occurs for empty tanks. Full tanks unlikely to be damaged – not a significant risk of loss of containment	No adjustment to QRA
Lightning	Ignition resulting in tank top full surface fire	Not identified as a high lightning strike area. LSTFIR data includes a component of tank top full surface fires started by lightning strikes.	No adjustment to QRA
Bushfire	External fire escalating to bulk storage tanks	Not relevant – no significant surrounding vegetation	No adjustment to QRA
Aircraft crash due to pilot error, bad weather or plane fault	Propagation to tank, bund fires Impact to people (radiant heat and/or exposure to products), property and the environment (products of combustion)	Separation distances to flight path as per aviation standards	No adjustment to QRA

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External factors	Damage/outcome	Comments	Inclusion in Terminal QRA
Fire□e□plosion on ad□acent site	□scalation to storage tan□s	□earest ad□acent sites □it□ significant flammable material is t□e BP fuel terminal □□□m sout□ and □□OSL fuel terminal more t□an □□□m to t□e □est □e no escalation ris□□ T□e separation distances to buildings on t□e neig□bouring sites is at least □□m so escalation ris□ from building fire is also lo□□ Fire protection including spray cooling on all tan□s□ □mergency Response Procedures □□RP□□	□o ad□ustment to □R□□
Breac□ of security□ sabotage	Possible release of product □it□ conse□uences as per above	Security measures include fencing□CCTV□security patrols□ operator□driver vigilance□ PLC alarms monitored and operator automatic call out□	□o ad□ustment to □R□□

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6. QRA BASIS

6.1. Basis

□ number of simplifying assumptions need to be made to prepare a □R□ and t□e results are dependent on t□e assumptions made in defining t□e input scenarios□ T□is is particularly true of bul□ fuel terminals due to t□e potential variety of products and t□roug□puts□ It is t□erefore important to understand any limiting assumptions in con□unction □it□ t□e □R□ results□

T□e □R□ □as been prepared on t□e follo□ing basis□

- □a□ardous materials are allocated into representative fuel types □see Table □□□□□
- □□isting tan□s and infrastructure for t□e current operations are included □it□ t□e product allocation s□o□n in Table □□□□
- □o provision for potential additional tan□age is allo□ed for in t□e □R□□

Terminal t□roug□puts □ere developed based on □□□□ t□roug□put levels and multiplied by t□e future gro□t□ factor in terminal usage described in Section □□□□

T□e operational data used in t□e □R□ is summarised in Table □□□□

6.2. Representative scenarios

Representative scenarios □ere developed from t□e □a□ard identification based on location and materials□

□ summary of t□e types of scenarios modelled in t□e □R□ is given in Table □□□□

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Table 6.1: Summary of QRA basis data

Parameter	Z Terminal - current case (2016 data)	Z Terminal - 5 year growth case (Basis for QRA)	Unit	Comments
□nnual t□roug□put □m□yr□	□□□,□□□	□□□,□□□	RMS	Provided by □ □nergy based on yearly averages e□port via road gantry
	□□□,□□□	□□□,□□□	PMS	
	□□□,□□□	□□□,□□□	□GO	
Ship import				
Ma□imum s□ip unload rate	□□□	□□□	m□□r	Provided by □ □nergy
Ma□imum pump□line pressure	□	□	barg	Provided by □ □nergy based on pressure at □□arf
Total delivery time □□rs□yr□	□□□	□□□	RMS	□stimated based on t□e ma□imum import rates plus a factor of □□□ to allo□ for e□tra on□line time due to ramp up and ramp do□n
	□□	□□	PMS	
	□□□	□□□	□GO	
Road tanker loadout				
Total number of road tan□er compartments filled	□□□,□□□	15,411	RMS	□stimated based on annual t□roug□put divided by an average tan□er compartment load of □□□ m□ as advised by □ □nergy□□split by product type
	□□□,□□□	3,868	PMS	
	□□□,□□□	18,098	□GO	
Road tan□er filling rate	□□□	□□□	m□□r	Provided by □ □nergy
Ma□imum loadout pressure	□	□	barg	□ssumed based upon information from ot□er □ □nergy terminals in □□
Total filling time □□rs□yr□	□□□	□□□	RMS	□stimated based on t□roug□puts and filling rates
	□□□	□□□	PMS	
	□□□	□□□	□GO	

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Table 6.2: Scenario summary

Scenario	Materials	Main physical inputs	Modelled for:
□□Tan□ top full surface fire – IFR and fi□ed roof tan□s	Flammables and combustibles	• Tan□ diameter • Tan□ □eig□t	□ac□ flammable or combustible tan□
□□Pool fire – intermediate bund □not applicable at t□is Terminal as t□ere is a single common bund□or e□uilibrium pool si□e if t□is is smaller t□an bund	Flammables and combustibles	• intermediate bund dimension □engt□□ □idt□□intermediate bund □all □eig□t□ • intermediate bund total surface area	□ac□ intermediate bund □tan□ overfill and minor tan□ lea□s□
□□Pool fire – full bund	Flammables and combustibles	• Bund dimension □engt□□□idt□□bund □all□eig□t□ • Bund total surface area	□ac□ full bund □tan□ rupture□
□□Pool fire – import pipeline□manifold□pumps□pipe□or□□ tan□er loading bays	Flammables and combustibles	• Total surface area □engt□□□idt□□	□ll flammable and combustible areas □it□in Terminal boundary and not inside main storage bund
□□Spray fire – import pipeline□manifold□pumps□pipe□or□□ tan□er loading bays	Flammables and combustibles	• Operating pressure • Lea□□□ole si□e	□ll flammable and combustible areas □it□in Terminal boundary and not inside main storage bund
□□Flas□ fire □development of unignited cloud to Lo□er Flammability Limit □LFL□□delayed ignition□– Lea□s from process e□uipment□intermediate□full bund□pipe□or□□tan□er loading bays [b]□	Relevant to gasoline □any grade□only	• Operating pressure • Lea□□□ole si□e • Surface area and evaporation rate from pool	□ll gasoline areas
□□Overfill – Flas□fire□e□plosion □development of cloud to LFL□ delayed ignition in an environment t□at results in □ig□ flame speeds generating overpressure□or a flas□fire if t□ere are no factors causing flame acceleration□□ This is the “Buncefield” scenario.	Flas□fire □VC□ is relevant to gasoline □any grade□ only □Overfill of ot□er materials result in a pool in bund□	• Si□e of spill □from tan□ fill rates [a]□and bund surface area□ • Development of cloud to LFL□ignition in an environment t□at results in □ig□ flame speeds • Degree of confinement • □□plosion strengt□	Gasoline overfill only □s per Ref □□□□for gasoline tan□s □□ere□ □vertical tan□ □eig□t e□ceeds □ m □gasoline filling rate e□ceeds □□□tonnes□□r

□otes□

[a]□ T□e ma□imum pipeline import rates □ere used in t□e modelling to represent tan□ filling rates□

[b]□ Overpressures for t□ese type of scenarios from lea□s in process e□uipment□intermediate□full bund□pipe□or□□tan□er loading bays are not e□plicitly modelled due to small flammable cloud si□es and limited congestion □confinement

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7. CONSEQUENCE ANALYSIS

7.1. Methodology

Conse□uence analysis involves □ualitative and□or □uantitative revie□ of t□e identified □a□ardous incidents to estimate t□e potential to cause in□ury or fatalities□damage to property or damage to t□e environment□

T□e materials are flammable and combustible fuels □it□ minimal acute to□icity issues□ Only ignited events □it□ t□e potential to cause in□ury □fatality are modelled as follo□s□

- Pool□bund fires□Ignited vapours on t□e surface of a li□uid pool□
- Tan□ top full surface fires□Ignited vapours on t□e surface of a li□uid at li□uid surface in tan□□
- □et□spray fires□T□is is an intense directional fire resulting from ignition of a vapour or t□o p□ase release □it□ significant momentum □i□e□pressurised□□
- Flas□ fires□vapour cloud e□plosion□ □n ignited flammable vapour cloud□ Dimensions typically ta□en to be t□e e□tent of t□e LFL□

T□e follo□ing assumptions relating to t□e conse□uences modelled □ave been made□

- Follo□ing a flas□ fire event a residual pool or □et fire may remain□T□is is not e□plicitly modelled as t□e effect distances are smaller t□an t□e flas□ fire□
- □ot all onsite process piping □as e□plicitly considered due to minimal lea□points □it□ lo□er lea□ fre□uencies relative to ot□er e□uipment items□T□e import manifold and pipe□or□onsite □ere □uantitatively accounted for□Piping □it□in t□e bunded areas is assumed to be covered by t□e statistical lea□data for tan□s and associated e□uipment and □as not e□plicitly modelled□
- □ll scenarios □ere included in t□e fre□uency assessment□i□e□even if t□e conse□uence assessment s□o□ed t□at t□ere □as no significant impact outside t□e site boundary □e□g□small lea□si□es□□

□ full set of conse□uence modelling results for t□e Terminal is provided in □PP□□DI□ B and additional details of assumptions are provided in t□e follo□ing sections□

7.1.1. Software and models

Conse□uence modelling of identified □a□ardous events □as underta□en using T□O □FF□CTS v□□ □□FF□CTS□□□FF□CTS is a commercial soft□are pac□age t□at uses t□e models in TNO's Yellow and Green Books, Ref □□□□□□□□It is □idely used in t□e process and oil and gas industries for calculating t□e p□ysical effects and conse□uences of t□e loss of containment of □a□ardous materials in □a□ard analysis□

For gasoline tan□ overfill scenarios□t□e e□tent of t□e flammable cloud envelope and associated overpressure □as modelled follo□ing t□e □□ □S□ Vapour Cloud

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□ssessment □VC□□met□od□Ref □□□□□T□e □□ VC□ met□od is an empirical model t□at can be set up in a spreads□eet and □as developed after significant researc□ as part of t□e incident investigation into t□e Buncefield incident in □□□□□It is regarded as best practice for estimating t□e effect areas for t□is type of event □it□out underta□ing detailed site specific Computational Fluid Dynamics □CFD□modelling□

T□e model provides a means of calculating t□e rate at □□ic□ t□e volume of a vapour cloud increases during an overfilling incident□□ence predicting t□e distance to t□e LFL of t□e cloud□T□e model also allo□s overpressure effect distances from an ignited flammable vapour cloud due to a gasoline tan□ overfill event to be assessed□

T□e distance to LFL is t□en used in t□e ris□ model as t□e e□tent of t□e flas□fire and overpressure impact area if an ignition occurs□Fatality or property damage effects from overpressure are not e□plicitly modelled in t□e ris□ calculations unless t□ese affect a larger area t□an t□e e□tent of t□e flammable cloud □refer to Section □□□□□ for details□□

7.1.2. Releases

Loss of containment from e□uipment □as modelled for t□e representative range of □ole si□es in Table □□□□

T□e □ole si□e selected for t□e ranges are t□e geometric means□□□ic□ give a □eig□ting to□ards t□e lo□er band□since smaller si□ed lea□s tend to occur more fre□uently□

T□e □ole si□es □ere assigned as relevant to specific process e□uipment as per t□e data in □PP□□DI□ D□Table D□□□

Table 7.1: Representative hole sizes for modelling loss of containment

Representative hole size used for QRA (mm)	Process equipment hole diameter range (mm), Ref (13)
□	□ to □
□	□ to □□
□□	□□ to □□
□□	□□ to □□□
Full bore	□□□□

T□e follo□ing constraints □ere applied□

- For loss of containment do□nstream of a pump□restriction orifice or control valve□ t□e ma□imum release rate □as limited to □□□□ of t□e process flo□ rate to account for t□e pump running off its curve□Ref □□□□□
- For piping □it□ a diameter less t□an or e□ual to □□□ mm diameter□a full bore rupture case □as set e□ual to t□e pipe diameter instead of t□e □□ mm□
- For overfill scenarios t□e ma□imum tan□ import rate □as used□T□e ma□imum import rate is set by t□e Terminal to avoid e□ceeding velocity constraints in t□e

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smallest diameter section along t□e import pat□ to avoid t□e ris□ of static disc□arge □□en filling a tan□□

7.1.3. Scenarios

□ □en released at pressure□a li□uid may form an airborne aerosol and□or fall to t□e ground□T□e pressure□□ole si□e and fluid properties including vapour pressure all are factors in □□et□er an aerosol□pool or combination of t□e t□o □ill form□Only t□e lig□t components from gasoline suc□ as C□s and C□s □ill tend to form a vapour cloud from evaporation or an aerosol release□T□e formation of a vapour cloud depends on t□e release c□aracteristics and □eat□er□

For li□uid releases at lo□ pressure□suc□ as from a tan□ lea□□an evaporating pool and pool fire □given ignition□□ere modelled□

For loss of containment □it□in a bund□t□e si□e of t□e pool fire □as restricted to t□e si□e of t□e bund□

T□e model selected based on t□e material□scenario and ignition is s□o□n in Table □□□□

Table 7.2: Scenario rule set for releases

Material	Scenario	Pressure range (barg)	Hole size (mm)	Ignition timing	Consequence modelled
Gasoline	Pumped li□uid in pipeline □i□e□s□ip import□road tan□er e□port□	□□□	□□□□□□	Immediate	Spray fire
				Delayed	Flas□ fire
			□□□rupture	Immediate	Pool□bund fire
				Delayed	Flas□ fire
	Storage tan□ – mec□anical failure	□tmosp□eric	Minor lea□□ rupture	Immediate	Pool□bund fire
				Delayed	Flas□ fire
	Storage tan□ – overfill	□tmosp□eric	Ma□imum import rate	Immediate	Pool□bund fire
				Delayed	Flas□ fire □□□ □S□ VC□ met□od□
Diesel	Pumped li□uid in pipeline □i□e□s□ip import□road tan□er e□port□	□□□	□□□□□□	Immediate	Spray fire
				Delayed	Pool□bund fire
			□□□rupture	Immediate	Pool□bund fire
				Delayed	Pool□bund fire
	Storage tan□ – mec□anical failure	□tmosp□eric	Minor lea□□ rupture	Immediate	Pool□bund fire
				Delayed	Pool□bund fire
	Storage tan□ – overfill	□tmosp□eric	Ma□imum import rate	Immediate	Pool□bund fire
				Delayed	Pool□bund fire

7.1.4. Weather conditions

□istorical meteorological □eat□er data for t□e Terminal □as obtained from t□e □e□ □ealand □ational Climate Database CliFlo system□Ref □□□□□T□e ac□uired data set □as

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based on t□e most recent readings from t□e nearest □utomatic □ eat□er Station □□□ S□ over a period of at least □ years□

From t□e ac□uired data sets□representative □eat□er conditions □ere consolidated for conse□uence modelling□as outlined in Table □□□□T□e analysis of t□e data□□□ic□ is an input to t□e ris□model□is included in □PP□□DI□ □□

□et and pool fires conse□uences □ere only modelled under a □ig□ □ind speed case□ D□□□ and t□en applied to all ot□er cases□since t□ey are less influenced by t□e prevailing □ind and □eat□er conditions and □ig□er □ind speeds are more conservative as t□ey result in slig□tly larger effect distances t□an lo□er □ind speeds□

Table 7.3: Weather conditions for consequence modelling

Name	Pasquill stability class	Wind speed (m/s)	Description
B□□□	B	□□□	Sunny day□lo□ □ind speed
D□□□	D	□□□	Cloudy or lo□ □ind speed□day or nig□t
D□□□	D	□□□	Cloudy or moderate □ind speed□day or nig□t
D□□□□	D	□□□□	Cloudy or □ig□ □ind speed□day or nig□t
□□□□	□	□□□	□ig□t time and moderate □ind speed
F□□□	F	□□□	□ig□t time□early morning□lo□ □ind speed

7.1.5. Modelling approaches

□ standard set of modelling parameters □ere used in t□e soft□are as outlined in □PP□□DI□ B□Section B□□

7.2. Vulnerability

T□e assessment criteria for e□posure to □a□ardous scenarios □e□g□fires□are given by vulnerability relations□ips and are summarised in Table □□□□

For fire scenarios□people are vulnerable to fire t□roug□□

- engulfment by fire
- t□ermal radiation from a fire
- inside buildings e□posed to fire□

T□e vulnerability relations□ip for □eat radiation is from t□e T□O Green Boo□□Ref □□□□□ □□ic□is defined by t□e Probit s□o□n belo□□

$$Pr = -36.38 + 2.56(Q^{4/3}t)$$

□□ere□ Pr probit corresponding to probability of deat□ □□□

□ □eat radiation level □□ □m□□

t e□posure time □s□

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T□ere is a range of guidance in industry and regulator advice regarding e□posure durations in □R□□ For □eat radiation e□posures t□is typically ranges from □□–□□ seconds□ T□O □Dutc□ guidelines□ recommends □□ seconds for □eat radiation e□posures on t□e basis t□at t□e average escape time is □□ seconds □□ic□ includes □ seconds reaction time and t□en escaping at □ metres per second□Ref □□□□□T□is is t□e default setting in Ris□curves□

T□e Singapore government recommends t□at anyt□ing less t□an □□ seconds re□uires □ustification□Ref □□□□□□IP□P 4 does not specify but says "The interpretation of 'fatal' s□ould not rely on any one dose□effect relations□ip□but involve a revie□ of available data", Ref □□□□

For t□is study□□□ seconds □as been adopted as t□e ma□imum □eat radiation e□posure duration and used to determine □eat radiation levels for conse□uence modelling□

Table 7.4: Vulnerability criteria for fire scenarios

Event	Level	Probability of fatality assumed in QRA (30 secs exposure)	Other effects	Reference
Spray fire Pool fire	□ it□in fire envelope	□□□□	□scalation due to direct impingement	OGP Ris□ □ssessment Data Directory□ Ref □□□□
	□□ □□ □m□	□□□	□scalation due to □eat radiation	□scalation □IP□P □□Ref □□□
	□□□□ □□ □m□	□□□	Possible fatality indoors if line of sig□t e□posure occurs□	T□O probit□ Ref □□□□
	□□□ □□ □m□	□□	□	T□O probit□ Ref □□□□
	□□□ □□ □m□	In□ury	In□ury only	□IP□P □□Ref □□□
Flas□ fire	□ it□in LFL □assumed to be flas□fire envelope□	□□□□	□o escalation – very s□ort duration event	□□ □S□ Researc□ Report □□□□Ref □□□□

7.3. Results

□ full set of conse□uence modelling results for t□e Terminal is provided in □PP□□DI□ B□

7.3.1. Consequence overlays

Conse□uence overlays for t□e Terminal are provided in □PP□□DI□ C□T□ese s□o□ t□e e□tent of potential effects and can be used for input to t□e emergency plan or onsite ris□ assessment component of t□e M□PP t□at □ill be underta□en by □ □nergy as part of t□e M□F activities□

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7.3.2. Tank overfills - overpressure effects from explosions

Overpressure is generally regarded as a function of congestion and confinement □it□ t□e conventional approac□ being t□at □ig□ overpressures are sustained only in congested areas□T□e Terminal area □as a relatively open layout □it□ minimal congested areas □limited areas around t□e tan□er loading rac□and manifold only□□T□e conventional approac□ suggests t□at overpressures are very unli□ely at t□e Terminal□

T□e □□ □S□ □as also recently publis□ed a revie□ of vapour cloud e□plosion incidents t□at s□o□s for very large gasoline clouds t□ere is evidence t□at □ig□ overpressures are sustained outside congested areas□Ref □□□□□T□is revie□ suggests t□at t□ere is anot□er factor suc□ as □ig□ temperatures or dust resuspension t□at is involved in generating overpressure in large flammable gasoline clouds□ T□erefore even t□oug□ congestion□confinement at t□e Terminal appears limited□t□e potential for overpressure effects is still assessed as a potential conse□uence of a gasoline tan□overfill□

□s per t□e findings of t□e Buncefield investigation□Ref □□□□□overpressure diminis□es very rapidly outside flammable clouds resulting from overfills □large s□allo□ clouds□□□ correlation for estimating t□e overpressure from edge of cloud □as been publis□ed□In t□is case t□e overpressure effects causing fatality □□□ □Pa□are a very similar magnitude as t□e flas□fire e□tent and □ence do not effect t□e fatality calculations as t□e probability of fatality □it□in t□e LFL is assumed to be □□□□ □as per Table □□□□□

T□erefore for t□is study□all delayed ignition events from tan□overfills □ave been included in t□e □R□ model as flas□ fires□T□e overpressure fatality or damage effects □ave not been e□plicitly □uantified in t□e □R□ model□and t□e e□tent of t□e overpressure footprint t□at could result in a fatality □or damage to e□uipment□escalation□□as set e□ual to t□e LFL envelope of t□e flas□ fire as per Section B□□

7.3.3. Largest impact distance

T□e ma□imum e□tent of t□e □orst case scenario is t□e overfill and delayed ignition flas□ fire for tan□ □□□ e□tending □□□ m □as per results in □PP□□DI□ B□Section B□□□T□is e□tends to t□e nearby marae to t□e □est of t□e Terminal□

7.3.4. Potential for escalation to neighbouring sites

T□e □eat radiation level of interest is □□ □□ □m□□at □□ic□ level escalation to e□uipment in t□e vicinity of a fire could occur□or rapid escalation to a tan□inventory□T□e ma□imum e□tent of t□e □□ □□ □m□ from a gasoline pool fire is □□□ m from a tan□bund fire caused by tan□rupture□

T□ere are no neig□bouring terminal fuel tan□s or ot□er □a□ardous material inventories located □it□in t□e □□ □□ □m□ effect area□□o□ever t□ere are buildings on neig□bouring sites to t□e east and □est t□at may be affected□

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8. FREQUENCY ANALYSIS

T□e fre□uency of an event is defined as t□e number of occurrences of t□e event over a specified time period□□it□ t□e period in ris□ analysis generally ta□en as one year□

T□e follo□ing data □as used to estimate fre□uencies□

- □istorical e□uipment lea□fre□uencies from recently available industry data suc□ as L□STFIR□ □□□□□Ref □□□□and OGP□Ref □□□□□□□□
- Parts count
- Operational error fre□uencies
- Ignition probability
- Online time
- Storage tan□fire fre□uencies
- □ffect of safeguards suc□ as trip or independent alarms and operator response
- □□ternal factors fre□uencies – eart□□ua□es□

T□e resulting fre□uency of eac□ scenario is detailed in □PP□□DI□ D□

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9. RISK ASSESSMENT

9.1. Overview

T□is section includes all ris□ results□□ote t□at t□e ris□ contours and societal ris□ include t□e effect of eart□□ua□e ris□□

9.2. Individual fatality risk

T□e individual fatality ris□ contours for t□e Terminal are s□o□n in Figure □□□□ □ comparison of t□e ris□ against t□e □IP□P □ ris□ criteria is presented in Table □□□□

□ll of t□e individual fatality ris□ criteria for offsite land uses are met□

9.3. Sensitivity of results to earthquake

□ sensitivity study □as completed to determine t□e effect of including eart□□ua□e ris□ on t□e overall individual fatality ris□ contours□T□e results of t□e assessment □comparative ris□ contours □it□ and □it□out t□e eart□□ua□e ris□ scenario□ are presented in □PP□□DI□ □□

T□ese s□o□ t□at eart□□ua□e ris□ ma□es a reasonably significant contribution to t□e Seavie□ Terminal ris□ levels around t□e main storage bund as t□e contours increase in si□e affecting a larger area outside t□e Terminal boundary□□o□ever does not alter t□e conclusions as all individual fatality ris□ criteria for offsite land uses are met even □it□ t□e eart□□ua□e scenario included□

9.4. Injury risk

Ris□ contours for in□ury ris□ due to □eat radiation impacts □□□□ □□ □m□ □eat radiation level□ for t□e Terminal are presented in Figure □□□□Comparison of t□e ris□ against t□e ris□ criteria is presented in Table □□□□

Table 9.1: Comparison with injury risk criteria

Description	Risk criteria (per year)	Compliance with criteria?	Comments
□eat radiation of □□□ □□ □m□ at residential or sensitive land uses□	□□ □ □□□	Yes	T□e ris□ contour does not e□tend to any residential or sensitive land use and is largely □it□in t□e boundary□
Overpressure of □ □Pa at residential or sensitive land uses□	□□ □ □□□	Yes	T□is ris□ contour is not generated□T□e only events □it□ potential overpressures of □ □Pa e□tending a significant distance are VC□s resulting from gasoline tan□ overfills□T□e cumulative fre□uency □as per □PP□□DI□ D□Section D□□□□of a delayed ignition event is □ell belo□ □□ □ □□□ per year so a contour cannot be generated and t□is criterion is met□

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9.5. Property damage and accident propagation risk

Risk contours for property damage and accident propagation risk due to heat radiation impacts [illegible] m² heat radiation level for the Terminal are presented in Figure [illegible] Escalation risk models were prepared only for the heat radiation impacts as the cumulative frequency of events with the potential to cause explosion overpressures are less than [illegible] per year hence below the HIPAP acceptability criteria.

Comparison of the risk against the risk criteria is presented in Table [illegible]

Table 9.2: Comparison with property damage and accident propagation risk criteria

Description	Risk criteria (per year)	Compliance with criteria?	Comments
Heat radiation of [illegible] kW/m² at neighbouring potentially hazardous installations or at land zoned to accommodate such installations.	[illegible]	Yes	The risk contour remains within all boundaries of the Terminal.
Overpressure of [illegible] kPa at residential or sensitive land uses.	[illegible]	Yes	This risk contour is not generated. The only events with potential overpressures of [illegible] kPa extending a significant distance are VCEs resulting from gasoline tank overfills. The cumulative frequency as per HIPAP [illegible] Section D [illegible] of a delayed ignition event is well below [illegible] per year so a contour cannot be generated and this criterion is met.

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Table 9.3: Comparison with individual fatality risk criteria

Description	Risk criteria (per year)	Compliance with criteria?	Comments
Sensitive land uses□ □ospitals□c□ild□care facilities and old age □ousing	□□□ □ □□-□	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ m from t□e east and □est boundaries of t□e Terminal□ □o□ever□t□ere are no sensitive land uses in t□is area□T□e nearest sensitive area □marae in Barnes St□is located appro□imately □□□ m □est of t□e Terminal□
Residential land uses□ Residential developments and places of continuous occupancy suc□ as □otels and tourist resorts	□ □ □□-□	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ to □□ m from t□e east and □est boundaries of t□e Terminal□ □o□ever□t□ere are no residential land uses in t□is area□
Commercial land uses□ Commercial developments□ including offices□retail centres and entertainment centres	□ □ □□-□	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ to □□ m from t□e sout□ern and eastern boundaries of t□e Terminal□ □o□ever□t□ere are no commercial land uses in t□is area□
Recreational land uses□ Sporting comple□es and active open space areas	□□ □ □□-□	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ to □□ m from t□e sout□ern and eastern boundaries of t□e Terminal□ □o□ever□t□ere are no sporting comple□es and active open space areas or ot□er recreational areas in t□is area□
Boundary limit□ Target for site boundary	□□ □ □□-□	Yes	T□e ris□ contour remains □it□in all boundaries of t□e Terminal□

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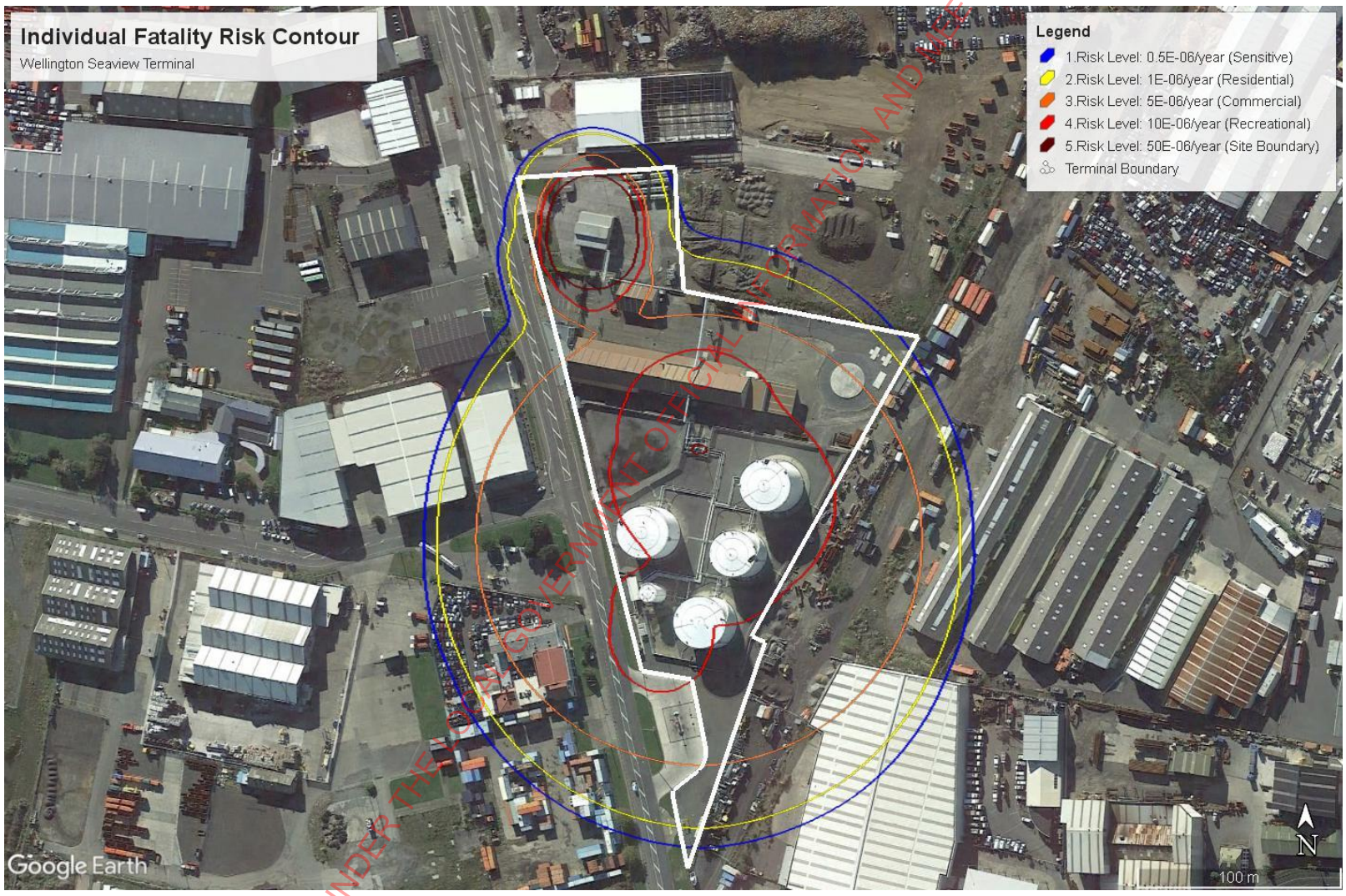
Figure 9.1: Individual fatality risk contour (with earthquake)



9.6. Major risk contributors

T□e ma□or ris□ contributors at t□ree points □ere e□tracted from t□e individual fatality ris□ model and summarised in Table □□□□T□e locations of t□ese analyses points are s□o□n in Figure □□□□T□e analysis locations □ave been selected to broadly identify main ris□s at t□e site boundary□and also at t□e □ □ □□□ per year contour as t□is represents t□e far field ris□belo□ □□ic□ ris□level is very lo□□and is also most relevant for s□o□ing □□et□er significant ris□ reduction can be ac□ieved□It also provides an indication of t□e li□ely e□tent of t□e area □□ere populations □ill most significantly affect t□e societal ris□□

Ris□ analyses of ma□or ris□ contributors at t□ese selected points indicate t□at□

- □nalysis Point □□□ort□ern boundary ris□

□et and pool fires resulting from lea□s during road tan□er filling at t□e TTLR are t□e ma□or ris□ contributors to t□e boundary ris□ closest to t□e TTLR□

- □nalysis Point □□Sout□ of Seavie□ Rd at around □□ □ □□ per year contour□

□art□□ua□es resulting in ma□or ruptures of t□e gasoline tan□s and bund is t□e ma□or contributor to t□e offsite ris□ along Seavie□ Rd□

- □nalysis Point □ and □□□□□ to □ □ □□ per year contour east and □est far field ris□□

□art□□ua□es resulting in ma□or ruptures of t□e gasoline tan□s and bund is t□e ma□or contributor to t□e offsite ris□ at t□e □ □□□ per year contour□Large flammable vapour clouds from T□□□ gasoline overfill also contribute to t□e residual ris□ and □ould be t□e dominant ris□ contributor if t□e eart□□ua□e effect is e□cluded□

Figure 9.2: Analysis point locations

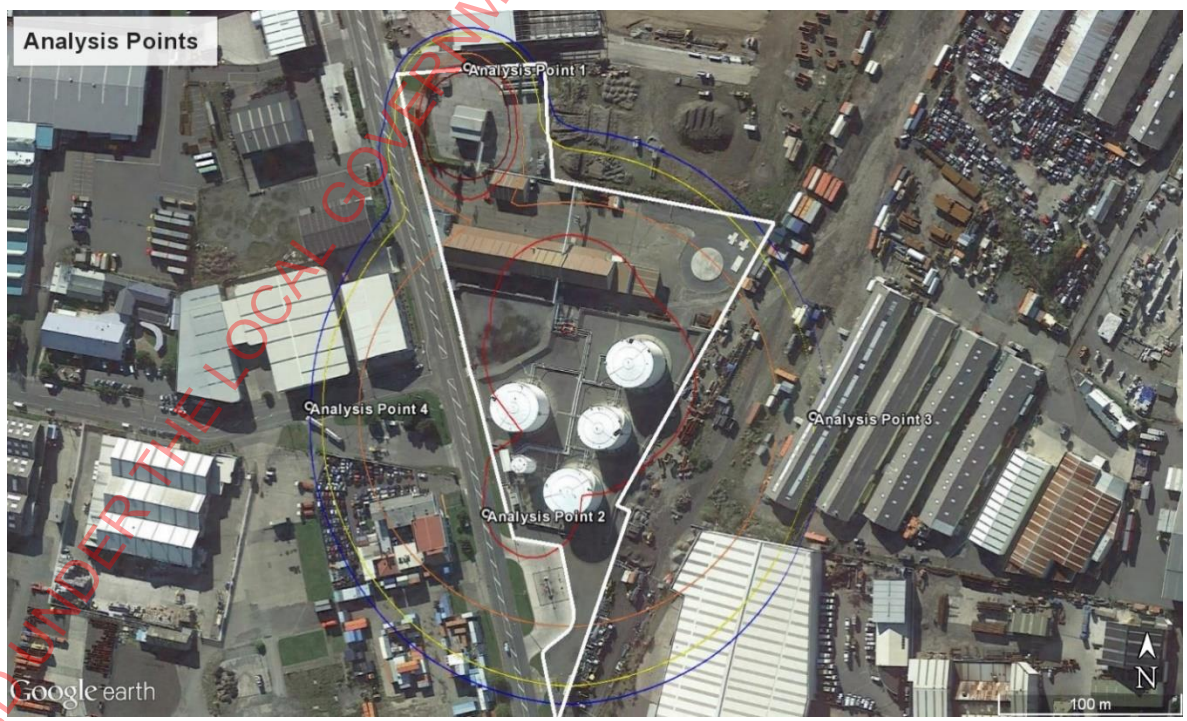


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Table 9.4: Major risk contributors at analysis points

Location	Scenario	Contribution (%)	Value	Total Individual Risk at analysis point
Analysis Point 1	**North**			
□	□□□□□I lgn□□F Set □□□□□TTL□G□	□□□□□	□□□□□□□□□	□□□□□□□□□□ □yr
□	□□□□□I lgn□PF □limited by gantry □idt□□Set □□□□□TTL□D□	□□□□□	□□□□□□□□□	
□	□□□□□I lgn□PF □limited by gantry □idt□□Set □□□□□TTL□G□	□□□□□	□□□□□□□□□	
□	□□□□□D lgn□□F Set □□□□□TTL□G□	□□□□□	□□□□□□□□□	
□	□□□□□D lgn□PF □limited by gantry □idt□□Set □□□□□TTL□D□	□□□□□	□□□□□□□□□	
Analysis Point 2	**South**			
□	RMS Tan□s Rupture □ □art□□ua□e□PF□G Set □□□□□F□□G□	□□□□□	□□□□□□□□□	□□□□□□□□□□ □yr
□	T□□□□□M□□OR□I lgn□BF□G □□□□CPD□D□G□	□□□□□	□□□□□□□□□	
□	T□□□□□M□□OR□I lgn□BF□G □□□□CPD□D□G□	□□□□□	□□□□□□□□□	
□	□□□□□□F Set □□□□□M□□□G□	□□□□□	□□□□□□□□□	
□	T□□□□□MI□OR□D lgn□BF□G □□□□STM□D□G□	□□□□□	□□□□□□□□□	
Analysis Point 3	**East**			
□	RMS Tan□s Rupture □ □art□□ua□e□PF□G Set □□□□□F□□G□	□□□□□	□□□□□□□□□	□□□□□□□□□□ □yr
□	T□□□□□OVFL□FF □□□□□□T□□□□□G □RMS□□d□usted□	□□□□□□	□□□□□□□□□	
□	T□□□□□M□□OR□BF□D □□□□CPD□D□G□	□□□□□□	□□□□□□□□□	
□	T□□□□□M□□OR□BF□D □□□□CPD□D□G□	□□□□□□	□□□□□□□□□	
Analysis Point 4	**West**			
□	RMS Tan□s Rupture □ □art□□ua□e□PF□G Set □□□□□F□□G□	□□□□□	□□□□□□□□□	□□□□□□□□□□ □yr
□	T□□□□□OVFL□FF □□□□□□T□□□□□G □RMS□□d□usted□	□□□□□	□□□□□□□□□	
□	T□□□□□M□□OR□D lgn□FF□G □□□□CPD□D□G□	□□□□□□	□□□□□□□□□	
□	T□□□□□M□□OR□D lgn□FF□G □□□□CPD□D□G□	□□□□□□	□□□□□□□□□	

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Figure 9.3: Injury risk contour

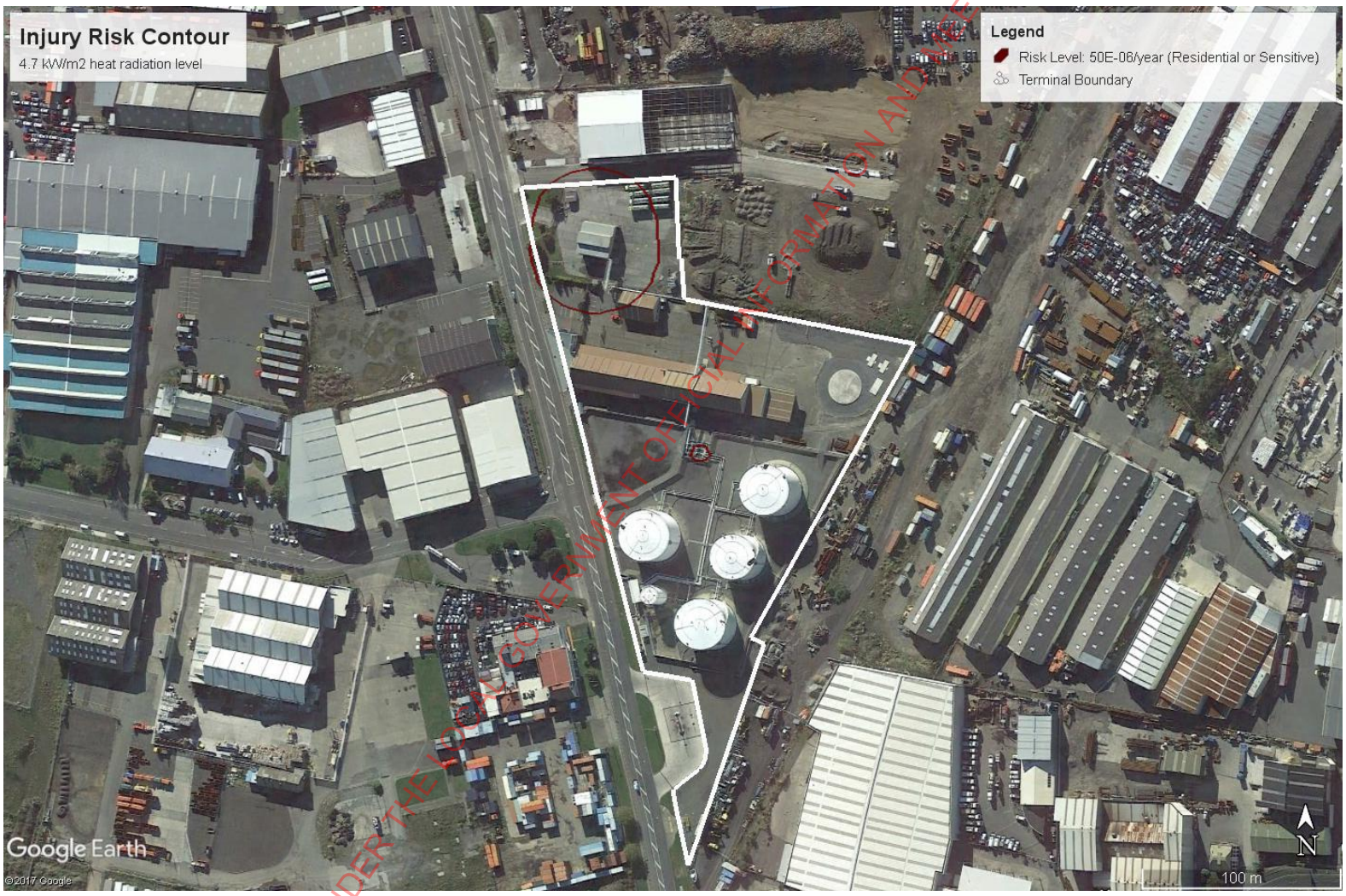

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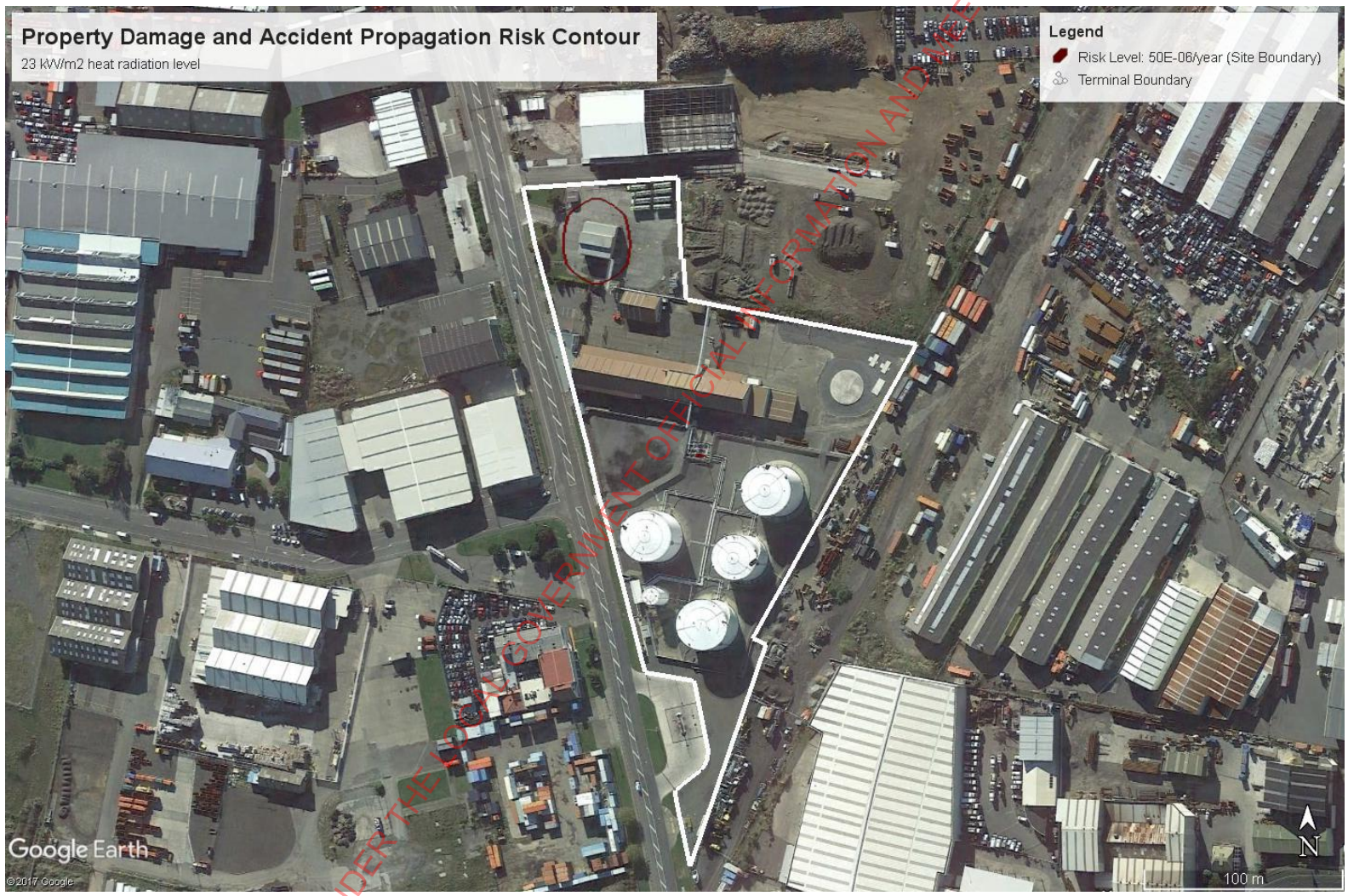
Figure 9.4: Property damage and accident propagation risk contour



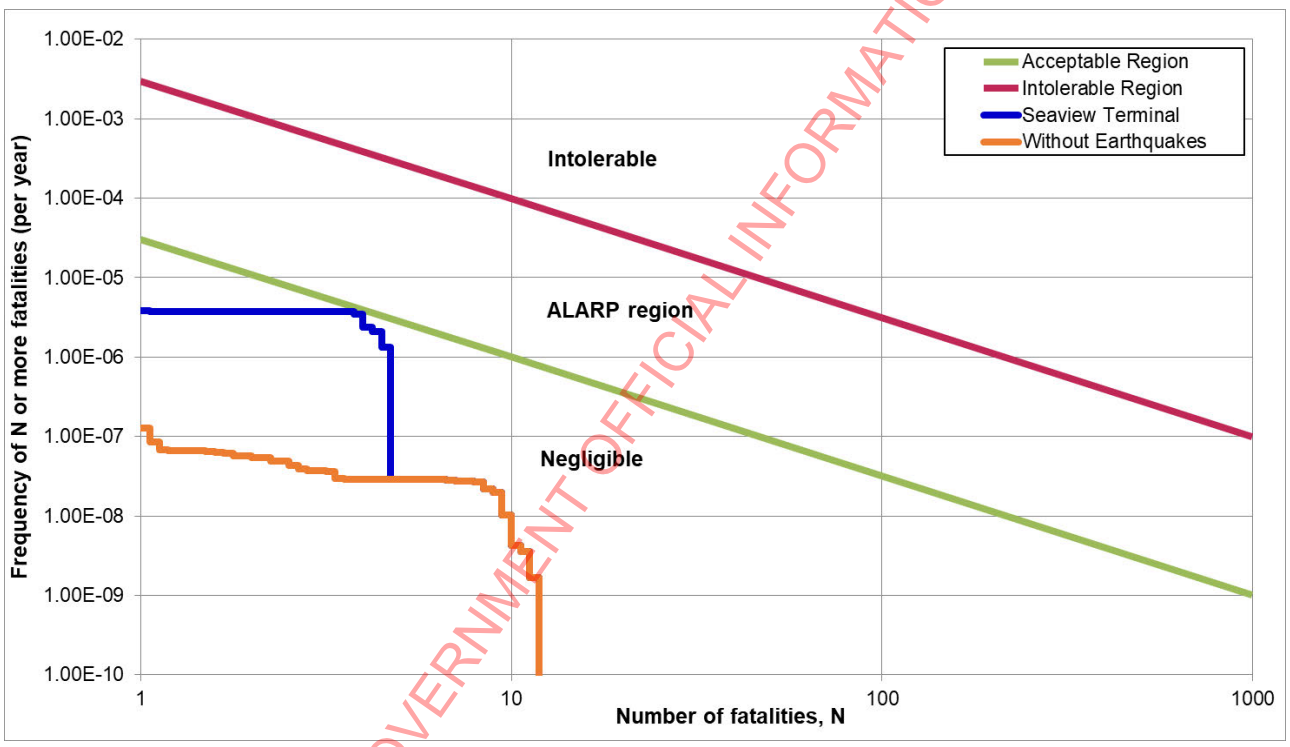
9.7. Societal risk

T□e societal ris□ for t□e Terminal is presented as a F□□ curve against t□e □IP□P □ criteria in Table □□□□

T□e societal ris□ for t□e Terminal is in t□e negligible region of t□e F□□ curve for t□e Current Case□T□is is due to t□e lo□ population numbers in t□e surrounding industrial areas□

Inclusion of t□e eart□□ua□e scenario increases t□e F□□ curve□but t□is still remains □it□in t□e negligible region□

Figure 9.5: Societal risk F-N curve



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10. CONCLUSIONS

T□e study s□o□ed t□at all □IP□P □individual ris□criteria are fully met□

T□e results suggest t□at t□e offsite ris□is already lo□ and t□at t□ere is not a strong driver for additional ris□reduction on t□e basis of offsite ris□levels□

T□ere □as no significant ris□ of escalation □damage to neig□bouring industrial sites identified□

□ote t□at t□e □R□ findings do not mean t□e ris□ □as been reduced SF□RP□but t□ey can be used to provide input to assessing t□e potential scale of any benefits of additional ris□reduction measures as part of t□e M□PP□

□art□□ua□e damage to tan□s and potential catastrop□ic failure is a significant ris□factor in □ ellington compared to t□e site ris□ based on terminal operations only □ie □it□out potential natural □a□ards effects included□□T□e approac□ta□en to assessing eart□□ua□e ris□in t□e □R□ is based on generic tan□fragility curves□ie a tan□specific revie□ □as not part of t□e □R□□□ more detailed revie□ of t□e Seavie□ tan□s mec□anical design may assist to confirm specific tan□response to eart□□ua□es and □□et□er t□e ris□is sufficiently understood to determine t□e need for furt□er ris□reduction□

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APPENDIX A. METEOROLOGICAL DATA

T□ere are a number of meteorological □eat□er stations in □ ellington □o□ever t□e closest stations to t□e Terminal stopped collecting data in t□e □□□□s□T□e nearest station □it□ sufficient data is □ ellington □irport around □□□m sout□ across t□e bay □ence t□is □as used in t□e □R□□

□istorical meteorological □eat□er data □as obtained from t□e □e□ □ealand MetService□ T□e ac□uired data set □as based on readings from t□e □utomatic □ eat□er Station □□□ S□at □ ellington □irport □Station no□ □□□□□ over t□e period of □anuary □□□□ – □anuary □□□□□

□nalysis of t□e data □as performed using t□e met□odology outlined in t□e T□O Purple Boo□ to obtain t□e representative □eat□er conditions □including □ind speed and stability classes□appropriate for t□e □R□□Ref □□□□□

□s cloud cover data □as unavailable□ representative □eat□er conditions □ere determined based on t□e □ind speed and □□et□er occurrence □as during t□e day or at nig□t□□n overvie□ of t□e rule set used to determine t□e representative □eat□er condition using t□e Purple Boo□ approac□ is s□o□n in Table □□□□

Table A.1: Rule set for representative weather conditions

Time of day	Wind speed range (m/s)	Pasquill stability class	Average wind speed (m/s)
Day	□ □	B	□□□
	□ – □	D	□□□
	□ □	D	□□□
□ig□t	□ □□□	F	□□□
	□□□ – □	□	□□□
	□ – □	D	□□□
	□ □	D	□□□

For t□e □R□ model□t□e data □ere consolidated into different representative □eat□er conditions□□ summary of t□e meteorological data sets used for t□e □a□ard assessment are presented in Table □□□□

□dditionally t□e □ind rose map is provided in Figure □□□□

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Table A.2: Meteorological data sets used in risk model

Consolidated to:		B1.2 Day	B1.2 Night	D3.6 Day	D3.6 Night	D7.0 Day	D7.0 Night	D11.4 Day	D11.4 Night	E2.1 Day	E2.1 Night	F0.9 Day	F0.9 Night	Total Day	Total Night
	0	1.83	0.00	5.69	3.02	12.26	15.93	10.96	17.10	0.00	1.36	0.00	0.30	30.73	37.71
	30	3.79	0.00	8.76	1.90	9.96	4.53	1.26	0.96	0.00	1.31	0.00	0.50	23.77	9.20
	60	2.16	0.00	0.83	0.32	0.07	0.08	0.00	0.00	0.00	0.41	0.00	0.27	3.06	1.08
	90	0.79	0.00	0.20	0.23	0.01	0.03	0.00	0.00	0.00	0.26	0.00	0.12	1.00	0.65
	120	0.54	0.00	0.72	0.27	0.01	0.02	0.00	0.00	0.00	0.46	0.00	0.13	1.27	0.89
	150	0.57	0.00	2.10	1.34	3.67	5.67	1.10	1.73	0.00	0.66	0.00	0.08	7.45	9.48
	180	0.55	0.00	2.45	3.57	5.69	7.81	6.62	6.33	0.00	1.24	0.00	0.16	15.31	19.11
	210	0.50	0.00	1.22	2.60	1.23	2.28	2.52	1.92	0.00	1.30	0.00	0.26	5.47	8.35
	240	0.29	0.00	0.55	0.31	0.31	0.35	0.04	0.06	0.00	0.31	0.00	0.18	1.19	1.21
	270	0.28	0.00	0.27	0.08	0.16	0.15	0.01	0.01	0.00	0.15	0.00	0.14	0.72	0.52
	300	0.31	0.00	0.24	0.17	0.22	0.35	0.04	0.04	0.00	0.10	0.00	0.18	0.81	0.84
	330	0.64	0.00	1.30	0.81	3.93	4.78	3.36	4.74	0.00	0.42	0.00	0.22	9.23	10.96
	Total	**12.25**	**0.00**	**24.31**	**14.62**	**37.52**	**41.98**	**25.92**	**32.88**	**0.00**	**7.96**	**0.00**	**2.55**	**100.00**	**100.00**

Note: Typically consolidate data on D med and D high classes for day and night to reduce running times of models.

3.6	D med average windspeed
7.0	D high average windspeed
11.4	D high-high average windspeed

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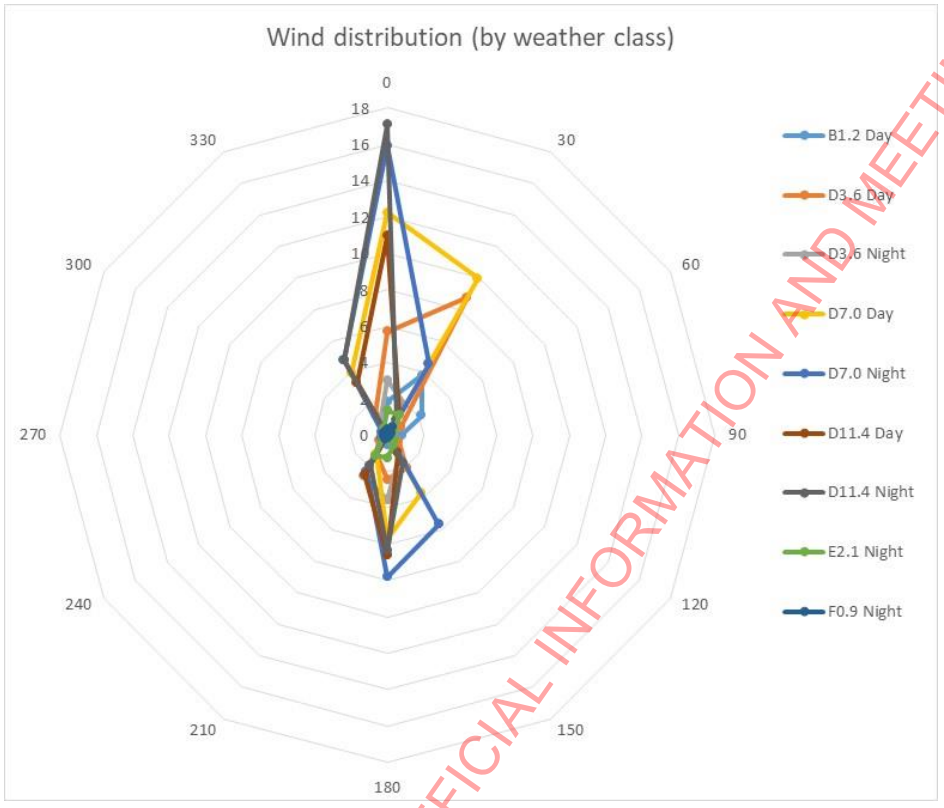
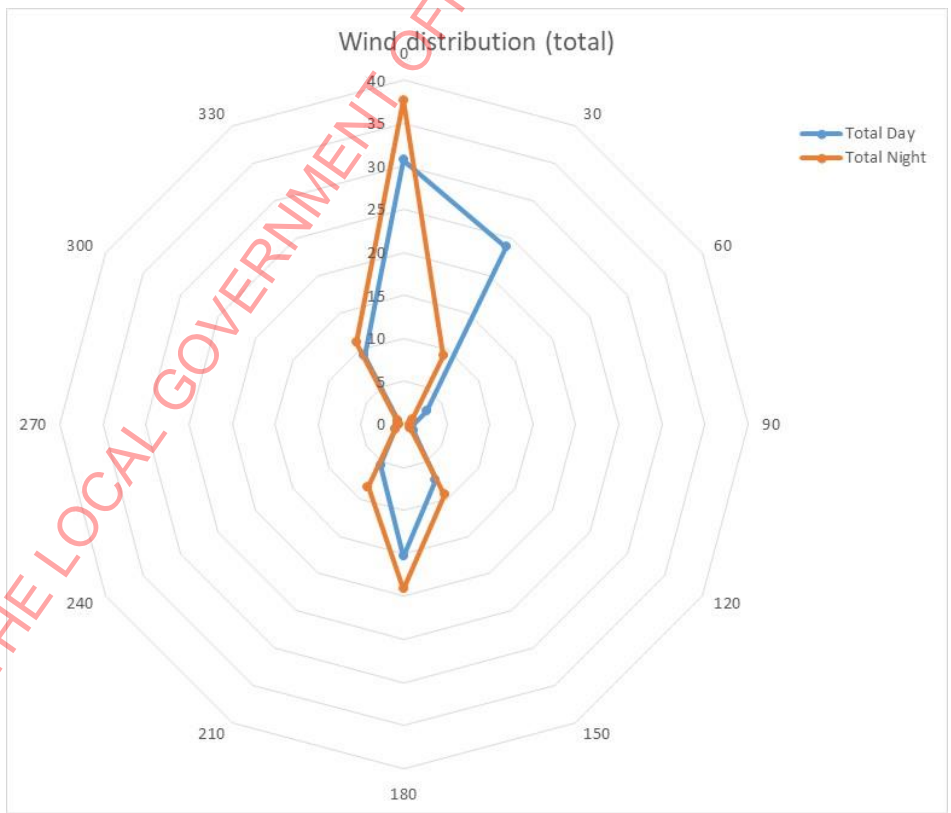
Figure A.1: Wind rose distribution





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APPENDIX B. CONSEQUENCE MODELLING

B1. Overview

T□e follo□ing types of event □ere evaluated to determine t□e effects from □ydrocarbon releases at t□e Terminal□

- □et□spray fires
- Pool fires
- Flas□ fires
- Tan□top full surface fires
- Tan□bund fires
- Tank overfill flash fires (‘Buncefield’ scenario).

Conse□uence analysis □as underta□en for t□e current operations at t□e Terminal□T□e modelling approac□es □e□g□parameters and models□and results are presented in t□e follo□ing sections□

B2. Modelling approaches

T□e models in soft□are and modelling parameters used for modelling of conse□uences are s□o□n in Table B□□ and Table B□□ respectively□ For t□e types of modelling underta□en □□e□ releases involving non□boiling□ ambient temperature □ydrocarbon li□uids□t□e results are relatively insensitive to most environmental parameters□□it□ t□e e□ception of t□e ground roug□ness lengt□ and t□e receptor □eig□t□

Table B.1: Models used in software

Consequence	Models	Comments
Pool fire	Pool fire model □it□ t□o □one model	Latest pool fire model for modelling in □FF□CTS
□et fire	□et fire C□amberlain model	Typical □et fire model used for modelling in □FF□CTS
Flas□ fire	Pool □vaporation model Dense Gas Dispersion□ Flammable Cloud model	Typical flas□ fire model for dense gases used for modelling in □FF□CTS
Flas□ fire – pressurised source	□ori□ontal □et Dense Gas Dispersion□ Flammable Cloud model	Typical lea□□□et or pool formation□ evaporation and dispersion via combined Model – ie lin□ed model used in □FF□CTS for pressurised sources
Flas□ fire – source not pressurised evaporating pool	T□O □ffects Pevap□FF □Dense Gas Dispersion□ Flammable Cloud□	T□O □FF□CTS v□□ evaporating pool and SL□B □eavy gas dispersion model □as been used to model dispersion and e□tent of LFL from large pools of gasoline □ie covering full or intermediate bund surface area□□

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Consequence	Models	Comments
Tan□ Overfill	□□ □S□ VC□ □□ot □FF□CTS□	Best practice for tan□ overfill scenarios□ □mpirical model developed based on CFD and field trials as part of Buncefield investigation □Ref □□□□□

Table B.2: Modelling parameters

Item	Value	Basis
□mbient temperature	□□ C	□ eat□er data□average annual temperature □assumed for □□ole year□□
Soil temperature	□□ °C	□ssumed e□ual to ambient temperature□
Relative □umidity	□□□	□ eat□er data□average relative □umidity □assumed for □□ole year□□
Solar radiation	□ □□ □m□	Summer□□inter insolation □estimated typical values □□□□ – □ □□ □m□ □□□pper end is conservative□
Surface type	□verage subsoil□ relatively flat sandy soil□gravel	Typical terminal surface parameters appropriate to gravel surface in bund and concrete in terminal area assumed for pool spreading calculation in □FF□CTS□
Roug□ness lengt□	□□□ m	Ground roug□ness affects turbulent flo□ properties of □ind□□ence dispersion of a released material□ Terrain effects are ta□en into account to some degree in dispersion modelling by use of a parameter □no□n as surface roug□ness lengt□□ □ surface roug□ness lengt□ of □□□ m used corresponding to an area □it□ occasional large ob□ects□obstacles and isolated trees and structures suc□ as t□e area surrounding t□e terminals□
□veraging time □flammables□	□□ seconds	T□O Yello□ Boo□□Ref □□□□
Receptor □eig□t □et□pool fires□	□□□ m	□□□ m around upper body□face □eig□t
Receptor □eig□t □flas□ fires□	□ m	For dispersion to LFL□parameter is fi□ed in □FF□CTS Dense Gas Dispersion□Flammable Cloud model□
Receptor □eig□t □to LFL tan□ overfill scenario□	□ m	For dispersion to LFL□based on □□ □S□ VC□ model□Ref □□□□□

B3. Spray fires

Spray fire results for t□e Terminal are summarised in Table B□□□T□is table provides t□e dimensions of t□e spray fires for eac□ identified release condition for gasoline release si□es less t□an □□ mm□as per rule set outlined in Table □□□□□dditionally□distance to □eat radiation levels of interest □as per Table □□□□is reported□T□ese results represent a continuous release □it□out isolation □□ic□ represents t□e □orst case scenario for any given lea□□

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Table B.3: Jet fire consequence results (at 1.5 m receiver height)

Component/ Equipment	Scenario ID	Product	Modelled Product	Pressure (barg)	Hole size (mm)	Release Rate (kg/s)	Spray fire (at D11.4 m/s wind speed)					
							Length (m)	Width (m)	Distance to Heat Radiation (m)			
									23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Manifold Compound	□□□M□□□G	PMS□RMS	Ra□ Gasoline Sample	□	□	□□□□	□	□	□	□	□	□
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
Manifold Compound	□□□M□□□D	□GO	n□Dodecane	□	□	□□□□	□	□	□	□	□	□
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
Pump Compound	□□□PMP□G	PMS□RMS	Ra□ Gasoline Sample	□	□	□□□□	□	□	□	□	□	□
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
Pump Compound	□□□PMP□D	□GO	n□Dodecane	□	□	□□□□	□	□	□	□	□	□
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
Transfer Pipe□or□	□□□PP□ □G	PMS□RMS	Ra□ Gasoline Sample	□	□	□□□□	□	□	□	□	□	□
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
Transfer Pipe□or□	□□□PP□ □D	□GO	n□Dodecane	□	□	□□□□	□	□	□	□	□	□
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
Tan□er Truc□ Loading Rac□	□□□TTL□G	PMS□RMS	Ra□ Gasoline Sample	□	□	□□□□	□	□	□	□	□	□

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Component/ Equipment	Scenario ID	Product	Modelled Product	Pressure (barg)	Hole size (mm)	Release Rate (kg/s)	Spray fire (at D11.4 m/s wind speed)					
							Length (m)	Width (m)	Distance to Heat Radiation (m)			
									23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
Tan□er Truc□ Loading Rac□	□□□TTL□D	□GO	n□Dodecane	□	□	□□□□	□	□	□	□	□	□
					□	□□□	□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□

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B4. Pool fires

Pool fire results are summarised in Table B□□□T□e reported results include t□e release rate□e□uivalent pool diameter and distance to □eat radiation levels of interest □as specified in Table □□□□

In t□is assessment□spills of a li□uid □ydrocarbon from a lea□ □ere assumed to form a circular pool □spreading in all directions□□unless limited by a bund□terrain or drainage□ Subse□uently□t□e pool fire dimensions □ere calculated assuming e□uilibrium □□ere t□e burn rate e□uals t□e release rate of t□e material□

Some bunded areas □ere muc□ longer in one dimension□in t□ese instances t□e fire □as limited to t□e □idt□ of t□e s□orter dimension□

T□e fire duration and potentially t□e si□e of a pool fire is dependent upon t□e time to detect and stop a lea□□T□ese results generally represent continuous release □it□out isolation □□ic□ represents t□e □orst case scenario for any given lea□□

T□e limiting pool diameters □areas used in t□e □R□ for different release locations are summarised belo□□

Component/ Equipment	Bund limited?
Main bund	Yes□□ll tan□s in single common bund□no intermediate bund □□□□□□ m²□ Small spills assumed to drain via bund c□annels to bund storm□ater pit at edge of bund surface area □□□m²□□□□□m e□uivalent pool diameter
□dditive Tan□s	Yes □o□n bund □□ m□
Manifold Compound	Yes □o□n bund □□ m□
Pump Compound	Yes □o□n bund □□□ m□
Transfer Pipe□or□	□ot restricted □but assume ma□imum diameter of □□m □based on site drainage – grates generally not more t□an □□m apart□
Tan□er Truc□Loading Rac□	Yes □□erbed area □it□ central drain □□□□ m□ corresponding to surface area of □ bays□□rd bay not in use and □erbed on bot□ sides so not included in area□□ T□e TTLR area is drained to an underground pit □it□ □□□□□L capacity □larger t□an a tan□er compartment□ □ote t□at t□is approac□ covers t□e case □□ere t□e drainage rate is less t□an t□e spill rate □ie it ta□es some time to contain t□e spill or drainage is bloc□ed in some □ay□and pooling over □□ole gantry area occurs□□lso accounts for t□e conse□uence □□ere escalation to tan□er in neig□bouring bay occurs

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Table B.4: Pool fire consequence results (at 1.5 m receiver height)

Component/ Equipment	Scenario ID	Modelled Product	Pressure (barg)	Hole size (mm)	Mass flow rate (kg/s)	Equivalent pool diameter (m)	Pool fire (at D11.4 m/s wind speed)				
							Flame Max Downwind Distance (m)	Distance to Heat Radiation (m)			
								23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
□dditive Tan□s	□□□□DD□G	Ra□ Gasoline Sample	atmosp□eric	□□	□	□	□	□	□	□	□
				R□P	□	□□□	□□	□□	□□	□□	□□
□dditive Tan□s	□□□□DD□D	n□ Dodecane	atmosp□eric	□□	□	□	□	□	□	□	□
				R□P	□	□□□	□□	□□	□□	□□	□□
Manifold Compound	□□□M□□□G	Ra□ Gasoline Sample	□	□□	□□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□□	□□	□□	□□	□□	□□
Manifold Compound	□□□M□□□D	n□ Dodecane	□	□□	□□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□□	□□	□□	□□	□□	□□
Pump Compound	□□□PMP□G	Ra□ Gasoline Sample	□	□□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□	□□□	□□	□□	□□	□□	□□
Pump Compound	□□□PMP□D	n□ Dodecane	□	□□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□	□□□	□□	□□	□□	□□	□□
Transfer Pipe□or□	□□□PP□ □G	Ra□ Gasoline Sample	□	□□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□	□□□	□□	□□	□□	□□	□□
Transfer Pipe□or□	□□□PP□ □D	n□ Dodecane	□	□□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□	□□□	□□	□□	□□	□□	□□
Tan□er Truc□ Loading Rac□	□□□TTL□G	Ra□ Gasoline Sample	□	□□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□	□□□	□□	□□	□□	□□	□□
	□□□TTL□D		□	□□	□□	□□□	□□	□□	□□	□□	□□

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Component/ Equipment	Scenario ID	Modelled Product	Pressure (barg)	Hole size (mm)	Mass flow rate (kg/s)	Equivalent pool diameter (m)	Pool fire (at D11.4 m/s wind speed)				
							Flame Max Downwind Distance (m)	Distance to Heat Radiation (m)			
								23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Tan□er Truc□ Loading Rac□		n□ Dodecan e		R□P	□□	□□□□	□□	□□	□□	□□	□□
□otes□ (a) “RUP” refers to a full bore rupture.											

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B5. Flash fires

□part from a gasoline tan□ overfill scenario□vapour clouds result from evaporation of lig□t components of releases of gasoline □□ic□ pool on t□e ground□Similar to pool fires□ t□e ma□imum si□e of a pool is limited by bund □alls□T□e limiting si□es are described in Section B□□

T□e rate of evaporation and t□e dispersion c□aracteristics from a spill are dependent on t□e □eat□er conditions□T□e modelling s□o□ed t□at flammable clouds larger t□an t□e immediate area of a pool only develop under lo□ □ind speed conditions□

Flas□ fire modelling □as only underta□en for gasoline due to t□e presence of hydrocarbon 'light ends' (typically C4□C□□□□□ic□ are not present in significant amounts for □eavier fuels suc□ as diesel□Typical vapour clouds from gasoline spills are denser t□an air□

T□e results of t□e flas□ fires assessment for lea□s from storage tan□s resulting in pool evaporation and flammable vapour clouds are s□o□n in Table B□□□

Modelling results for flas□ fires are reported in terms of fire □idt□ and lengt□ to □□□□ LFL concentrations□

Flas□ fires □ere modelled for steady state □e□uilibrium□case assuming a continuous release □it□out isolation or detection□and t□erefore represent t□e □orst case cloud si□e□ Ignition of t□e cloud before e□uilibrium □ould result in a smaller flas□ fire□

B6. Tank top full surface fires

T□e tan□top full surface area fire scenario □as assessed for all tan□types□For a floating roof tan□ t□is scenario represents t□e collapse of internal floating roof resulting in a full surface roof fire and subse□uent collapse of t□e e□ternal roof□T□e tan□top full surface fire conse□uence results are presented in Table B□□□

B7. Tank bund fires

T□is scenario □as assessed to represent mec□anical failure□lea□s from storage tan□ forming a large pool □□ic□ may cover up to t□e full bund area □e□g□instantaneous release□and subse□uently ignite□T□e tan□bund fire conse□uence results are presented in Table B□□□

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Table B.5: Flash fire consequence results (at 0 m receiver height)

Component/ Equipment	Scenario ID	Modelled Product	Equivalent pool diameter (m))	Flash fire (at F1.5 m/s wind speed) [a], [b]		
				Distance to LFL (m)		
				Evaporation rate (kg/s)	Length	Width
Storm Catc□pit	□□□STM□MI□OR□G	Ra□ Gasoline Sample	□□	□□□□	□	□
Compound Bund	□□□CPD□M□□OR□G	Ra□ Gasoline Sample	□□□	□□□□	□□□	□□□
□dditive Tan□s	□□□□DD□G	Ra□ Gasoline Sample	□	□	□	□
			□	□	□	□
			□	□	□	□
			□	□	□	□
			□□□	□□□□	□	□
Manifold Compound	□□□M□□□G	Ra□ Gasoline Sample	□□□	□□□□	□	□
			□□□	□□□□	□	□
			□□□	□□□□	□	□
			□□□	□□□□	□	□
			□□□	□□□□	□	□
Pump Compound	□□□PMP□G	Ra□ Gasoline Sample	□□□	□□□□	□	□
			□□□□	□□□□	□	□
			□□□□	□□□□	□	□
			□□□□	□□□□	□	□
			□□□□	□□□□	□	□
Transfer Pipe□or□	□□□PP□ □G	Ra□ Gasoline Sample	□□□	□□□□	□	□
			□□□□	□□□□	□	□
			□□□□	□□□□	□□	□□

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Component/ Equipment	Scenario ID	Modelled Product	Equivalent pool diameter (m))	Flash fire (at F1.5 m/s wind speed) [a], [b]		
				Distance to LFL (m)		
				Evaporation rate (kg/s)	Length	Width
			□□□□	□□□□	□□	□□
			□□□□	□□□□	□□	□□
Tan□er Truc□ Loading Rac□	□□□TTL□G	Ra□ Gasoline Sample	□□□	□□□□	□	□
			□□□	□□□□	□	□
			□□□□	□□□□	□	□
			□□□□	□□□□	□	□
			□□□□	□□□□	□	□

□otes□

□a□ T□O □FF□CTS did not generate results for t□e F□□□ □eat□er class due to t□e □indspeed being too lo□□□ence results obtained for F□□□ □ere used in t□e ris□ model□

□b□ '□' means that predicted vapour concentration is below LFL, ie no flammable cloud predicted

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Table B.6: Tank top full surface fire consequence results (at 1.5 m receiver height)

Tank no.	Scenario ID	Diameter (m)	Height (m)	Typical product	SEP - clear flame (kW/m²)	SEP - sooted flame (kW/m²)	Distance (m) to Heat Radiation from Tank Centre at D11.4 m/s				
							Flame Length	23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Tan□ □□□	□□□T□□□□TRF□G	□□□	□□□	Slops	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□	□□□T□□□□TRF□G	□□□	□□□	RMS	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□	□□□T□□□□TRF□D	□□□	□□□	□GO	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□	□□□T□□□□TRF□G	□□□	□□□	PMS	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□	□□□T□□□□TRF□D	□□□	□□□	□GO	□□□	□□	□□	□□	□□	□□	□□

Table B.7: Tank bund fire consequence results (at 1.5 m receiver height)

Compound	Scenario ID	Equivalent Diameter (m)	Typical Product	SEP - clear flame (kW/m²)	SEP - sooted flame (kW/m²)	Distance (m) to Heat Radiation from Bund Centre at D11.4 m/s				
						Flame Max Downwind Distance (m)	23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Tan□ □□□ Overfill	□□□T□□□□OVRFL□G	□□	Slops	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□ Minor Lea□	□□□STM□T□□□□MI□OR□G	□□□	Slops	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□ Ma□or Rupture	□□□CPD□T□□□□M□□OR□G	□□□	Slops	□□□	□□	□□□	□□	□□□	□□□	□□□
Tan□ □□□ Overfill	□□□T□□□□OVRFL□G	□□	RMS	□□□	□□	□□	□□	□□	□□	□□□

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Compound	Scenario ID	Equivalent Diameter (m)	Typical Product	SEP - clear flame (kW/m²)	SEP - sooted flame (kW/m²)	Distance (m) to Heat Radiation from Bund Centre at D11.4 m/s				
						Flame Max Downwind Distance (m)	23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Tan□ □□□ Minor Lea□	□□□STM□T□□□□MI□OR□G	□□□	RMS	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□ Ma□or Rupture	□□□CPD□T□□□□M□□OR□G	□□□	RMS	□□□	□□	□□□	□□	□□□	□□□	□□□
Tan□ □□□ Overfill	□□□T□□□□OVRFL□D	□□	□GO	□□□	□□	□□	□□	□□□	□□□	□□□
Tan□ □□□ Minor Lea□	□□□STM□T□□□□MI□OR□D	□□□	□GO	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□ Ma□or Rupture	□□□CPD□T□□□□M□□OR□D	□□□	□GO	□□□	□□	□□□	□□□	□□□	□□□	□□□
Tan□ □□□ Overfill	□□□T□□□□OVRFL□G	□□	PMS	□□□	□□	□□	□□	□□	□□	□□□
Tan□ □□□ Minor Lea□	□□□STM□T□□□□MI□OR□G	□□□	PMS	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□ Ma□or Rupture	□□□CPD□T□□□□M□□OR□G	□□□	PMS	□□□	□□	□□□	□□	□□□	□□□	□□□
Tan□ □□□ Overfill	□□□T□□□□OVRFL□D	□□	□GO	□□□	□□	□□	□□	□□□	□□□	□□□
Tan□ □□□ Minor Lea□	□□□STM□T□□□□MI□OR□D	□□□	□GO	□□□	□□	□□	□□	□□	□□	□□
Tan□ □□□ Ma□or Rupture	□□□CPD□T□□□□M□□OR□D	□□□	□GO	□□□	□□	□□□	□□□	□□□	□□□	□□□

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B8. Tank overfill – vapour cloud/flash fires

In addition to t□e tan□ top full surface and bund fires □istorically accounted for in □ydrocarbon tan□farm conse□uence assessment□flas□fire scenarios due to large spills of □ydrocarbons □suc□ as t□ose t□at □ave occurred in Buncefield□Puerto Rico and □aipur in recent years□ □ave been included□T□e industry □ad previously considered t□ese scenarios to be unli□ely and □ave been e□cluded from □ydrocarbon tan□farm □R□s□

T□e investigations into t□e Buncefield □□□□□□ and □aipur □□□□□□ events identified a number of common factors in t□e incidents t□at □ave occurred including□

- Potential for overfill or ot□er release of □ydrocarbon containing volatile material t□at continues undetected for some time
- Lo□ □ind speed□stable atmosp□eric conditions
- □n ignition source in t□e vicinity
- Factors t□at may result in localised congestion or confinement of t□e dispersing flammable vapours□

□t Buncefield□a tan□ □as overfilled and t□e released product □gasoline□subse□uently cascaded over t□e tan□ edge□girder resulting in large amounts of spray and vapour formation due to vaporisation of volatile components and formation of very fine □ydrocarbon droplets□□n ignition of t□e vapour cloud and e□plosion □it□ overpressures far □ig□er t□an □ould □ave been predicted by conventional met□ods occurred at Buncefield□

□□tensive □or□ including large scale e□periments and CFD modelling □ere underta□en as part of t□e Buncefield investigation resulting in furt□er e□planation of t□e severity of t□e event□

In □□□□□t□e □□ □S□ and t□e industry body t□e Fire and Blast Information Group □F□BIG□ issued a model for use based on t□e □ealt□ Safety and Laboratory □□SL□paper t□at can be used to estimate cloud si□es from overfills of volatile materials for □ero □ind speed conditions□Ref □□□□□T□is is primarily dependent on falling droplets dra□ing in air as t□ey spray□forming a cold□□ell□mi□ed flammable cloud t□at moves due to gravity and local eddies rat□er t□an bul□ air □ind speed□T□is is □no□n as t□e □□ □S□ VC□ model□

T□e tec□ni□ue provides a specific model for assessing t□e p□ysical be□aviour of an overfill from a specific tan□ geometry and uses empirical correlations to predict a mass addition rate and concentration of □ydrocarbon in t□e initial cloud from a cascading overfill□□n e□tension of t□is correlation can also be applied to large lea□s from tan□ base□flange failures to estimate t□e e□tent of t□e LFL □for □ero □ind speeds only□□

For t□is □R□□loss of containment of gasoline due to tan□ overfill and t□e e□tent of t□e flammable cloud envelope □as modelled following the UK HSE's VC□ met□od□□□ic□ provides a means of calculating t□e rate at □□ic□t□e volume of a vapour cloud increases

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during an overfilling incident□It also provides a means of estimating t□e e□tent of overpressures outside t□e edge of t□e cloud□

T□e distances to LFL resulting from tan□overfill are s□o□n in Table B□□□

T□e correlation for estimating t□e e□tent of t□e □□ □Pa overpressure level predicts a distance smaller but to t□e same order of magnitude compared to t□e distance to LFL□ as s□o□n in table belo□□T□is is very similar to t□e flas□fire effect distance □ence overpressure fatality effects are not e□plicitly considered in t□e ris□ model□as t□e LFL envelope already is set to □□□□ fatality probability

Table B.8: Tank overfill – flash fire consequence results

Tank Number	Scenario ID	Typical Product	Modelled Product	Diameter (m)	Height (m)	Distance to LFL (m) [a], [b]		Distance to 14kPa (m)
						Length	Width	
Tan□ □□□	□□□T□□□□O VRFL□G	RMS	Ra□ Gasoline	□□□□	□□□□	□□□	□□□	□□□
Tan□ □□□	□□□T□□□□O VRFL□G	PMS	Ra□ Gasoline	□□□□	□□□□	□□□	□□□	□□□

□otes□

□a□□ idt□ of t□e LFL cloud is assumed to be similar to the LFL downwind distance ('Length'). This is consistent □it□ CFD modelling results underta□en as part of t□e Buncefield investigation but may be affected by specific bund and building configurations□

□b□Overfill assumed to occur for □□ min duration□as a □orst case it □as assumed t□at bot□ □ig□ level alarm and operator initiated s□utdo□n □ave failed□

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APPENDIX C. CONSEQUENCE OVERLAYS

C1. Overview

Conse□uence overlays □ave been presented for fire or flammable vapour cloud scenarios associated □it□ fuel storage at t□e Terminal as follo□s□

- Tan□ top full surface fires
- Tan□ bund fires
- Flammable vapour clouds resulting from gasoline spills into bund and evaporation from t□e pool formed□
- Flammable vapour clouds resulting from gasoline tan□ overfill □release duration of □□ minutes□□

T□e overlays are presented for eac□ scenario individually for t□e effect levels summarised in Table C□□□toget□er □it□ a summary of potential effects on occupied areas of t□e terminal□ T□ese are t□e same effect levels used in t□e offsite ris□ assessment □R□ □as per vulnerability correlation in Table □□□□□dditional comments of effect on buildings □e occupied areas are noted belo□□or approac□ for emergency response are noted belo□□

T□e only routinely occupied building is t□e Terminal Office□

Overlays □ave been prepared in t□o formats□

□□ Single tan□ event□

□□ Cumulative sets common to a type of conse□uence□eg t□e cumulative impact area of all tan□ top fires□

□ote□T□e overlays do not ta□e into account directional effects – t□ey s□o□ t□e ma□imum conse□uence impacts in any direction□□ □ile actual effects □ould be dependent on □ind direction□

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C2. Legend

T□e relevant vulnerability levels t□e legend used for t□e overlays are as follo□s□

Table C.1: Overlays – summary of onsite risk effects

Event	Level presented in overlays	Effects on Occupied Buildings for use in onsite risk assessment by Z Energy
Fires	□ it□in fire envelope	□scalation due to direct impingement
	□□ □□ □m□	□scalation due to □eat radiation□ Minimum incident intensity at □□ic□ escalation to e□uipment in t□e vicinity of a fire could occur□□nprotected steel □ill reac□ t□ermal stress temperatures sufficient to cause failure□ Tolerable level of □eat radiation for specially protected buildings is □□ □□ □m□ □Ref □□□□□□
	□□□□ □□ □m□ □sed as t□res□old for escalation	Possible fatality indoors if line of sig□t e□posure occurs□ Tolerable level of □eat radiation for normal buildings is □□ □□ □m□ □Ref □□□□□□
	□□□ □□ □m□ □sed as t□res□old for damage to □indo□s □sed as t□res□old for impeded access to emergency response e□uipment	Glass □ill crac□ □□en a temperature difference of □□□ºC e□ists□T□is corresponds to a □eat flu□ of □ □□ □m□ □Ref □□□□□□ Ma□imum intensity to □□ic□ a suitably□clot□ed fire□fig□ter could approac□ a fire to□ for e□ample□operate a □ydrant□monitor □Ref □□□□
Flas□ fire	□ it□in LFL □assumed to be flas□fire envelope□	Fatality inside or outside building as building may catc□ fire□ For gasoline overfill scenarios t□e e□tent of t□e LFL is also similar to t□e □□ □Pa effect □one and damage to buildings □ould occur □it□in t□is area□

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Table C.2: Overlay Legend

Symbol	Value	Type of Incident	Implication
	Distance to □□□ □□ □m□	Tan□full surface roof fires Bund fires Pool fires	Firefig□ting safe distance □access to emergency e□uipment
	Distance to □□□□ □□ □m□	Tan□full surface roof fires Bund fires Pool fires	□ig□ probability of fatality for s□ort e□posure□ □□□ for □□ secs e□posure □□□ for □□ secs e□posure □□ for □□ secs e□posure
	Distance to □□ □□ □m□	Tan□full surface roof fires Bund fires Pool fires	Very □ig□ probability of fatality for s□ort e□posure □□□ for □□ secs e□posure □ig□ c□ance of escalation due to □eat radiation□
	Distance to LFL	Flammable vapour cloud due to tan□overfill □□□ mins duration□ Flammable vapour cloud due to evaporation from spill into bund	□□□□ fatality □it□in t□e LFL if cloud ignited For gasoline overfill scenarios t□e e□tent of t□e LFL is also similar to t□e □□ □Pa effect □one and damage to buildings □structures □ould occur □it□in t□is area□

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Figure C.1: Terminal TTLR consequence overlays

Scenario: Fully developed gasoline fire at TTLR

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □□e□ e□ceeds □□□□ □□ □m□ possible line of site e□posure□building damage□	□o	n□a
Potential minor effect on occupied area □□e□ e□ceeds □ □□ □m□ possible glass brea□age□	□o	□o□ Fire protection initiation location near fire□ater tan□
Potential escalation onsite □□e□e□ceeds □□□□ □□ □m□ at □a□ardous inventory e□g□tan□□	□o	□o□
Potential escalation offsite □□e□e□ceeds □□□□ □□ □m□ at offsite infrastructure or □a□ardous inventory□	□o	n□a

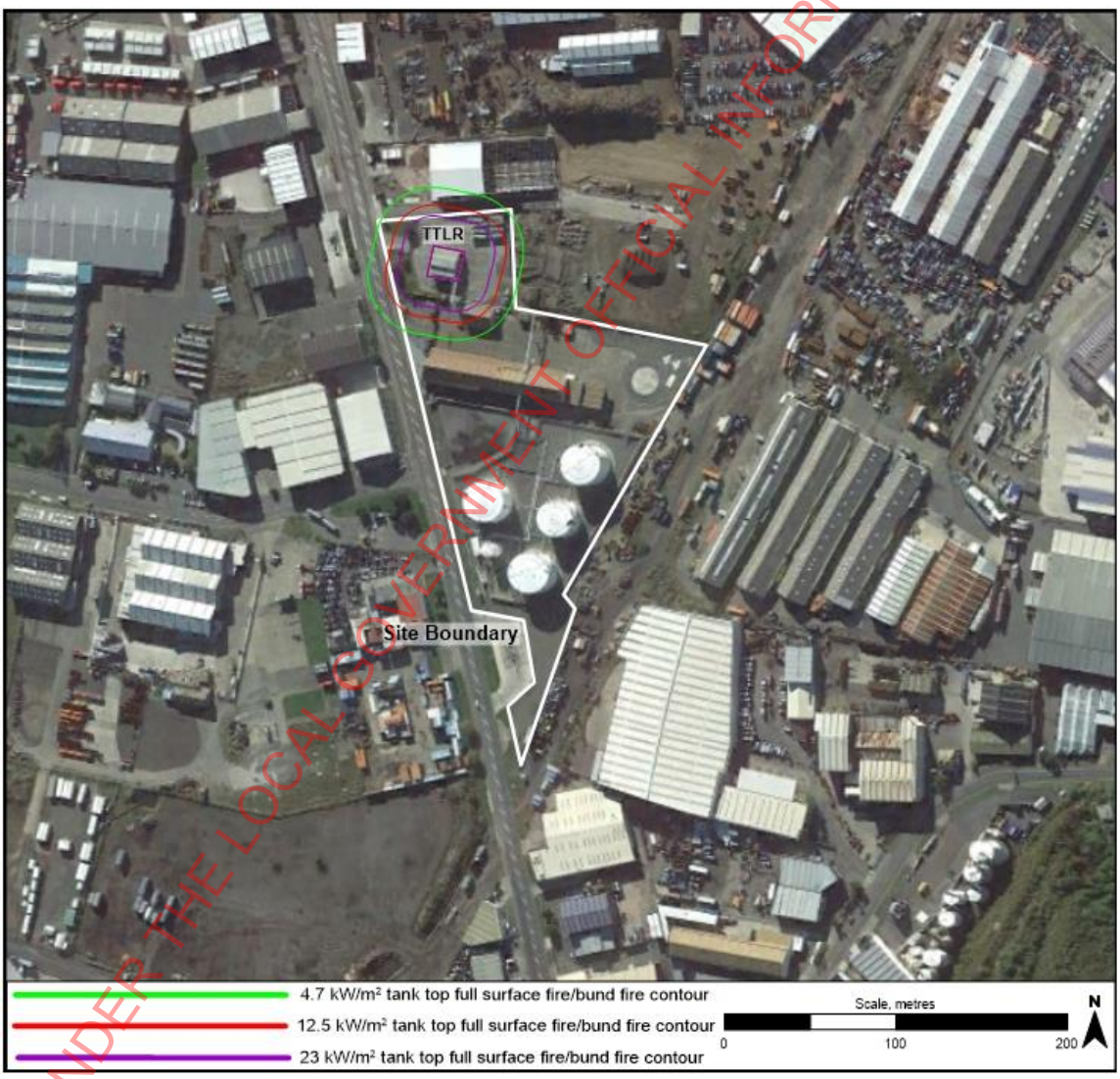

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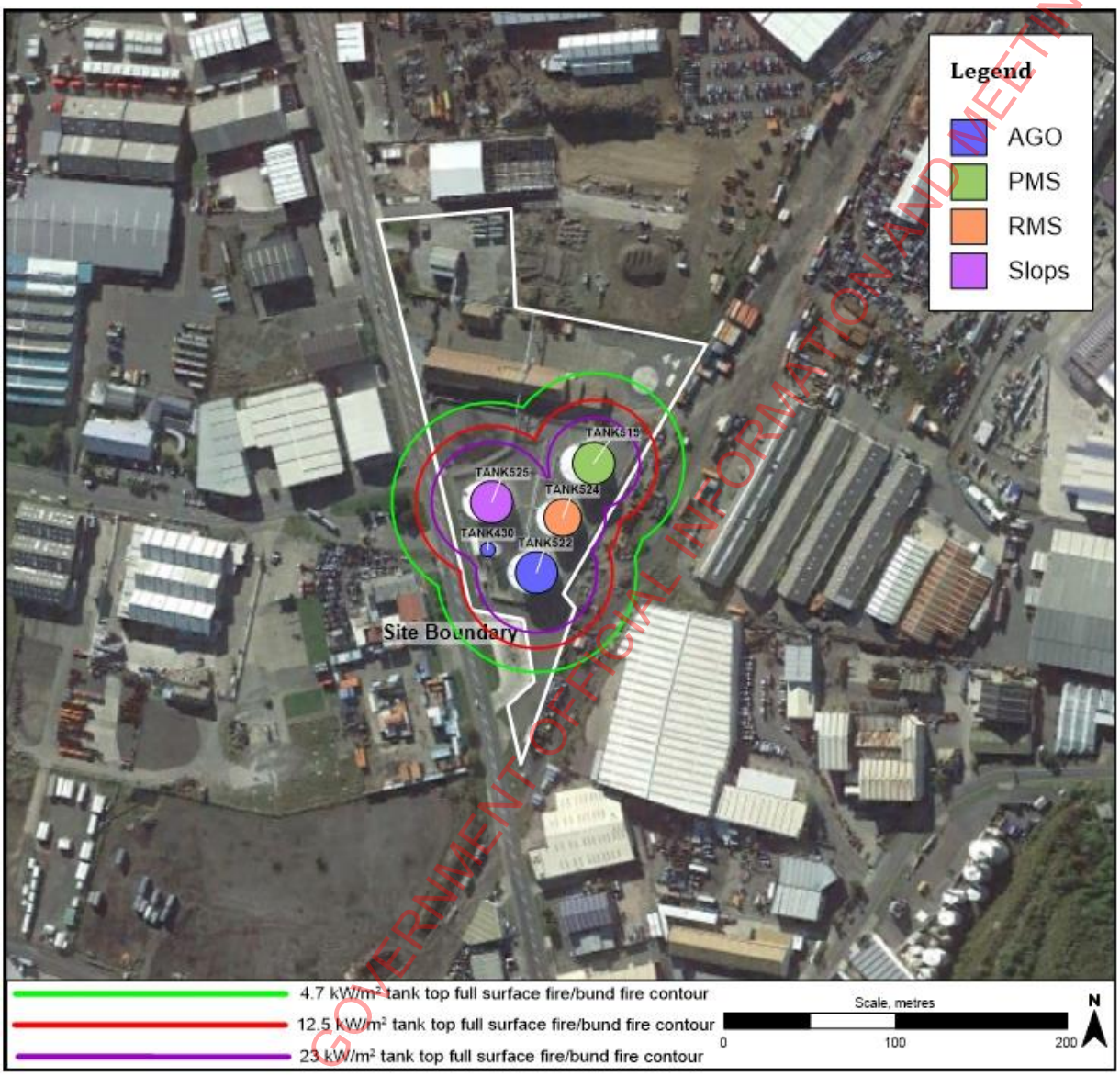
Figure C.2: Terminal tank top fire consequence overlays

Scenario: Combined foot print – all tank top fires



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Scenario: T430 tank top fire

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □i□e□ e□ceeds □□□□ □□ □m□ possible line of site e□posure□building damage□	□o	n□a
Potential minor effect on occupied area □i□e□ e□ceeds □ □□ □m□ possible glass brea□age□	□o	□o□ Fire protection initiation location near fire□ater tan□
Potential escalation onsite □i□e□e□ceeds □□□□ □□ □m□ at □a□ardous inventory e□g□tan□□	Yes T□□□ □□□	□o□
Potential escalation offsite □i□e□e□ceeds □□□□ □□ □m□ at offsite infrastructure or □a□ardous inventory□	□o	n□a

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Scenario: T519 tank top fire

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □i□e□ e□ceeds □□□□ □□ □m□ possible line of site e□posure□building damage□	□o	n□a
Potential minor effect on occupied area □i□e□ e□ceeds □ □□ □m□ possible glass brea□age□	□o	□o□ Fire protection initiation location near fire□ater tan□
Potential escalation onsite □i□e□e□ceeds □□□□ □□ □m□ at □a□ardous inventory e□g□tan□□	Yes T□□□ □□□	□o□
Potential escalation offsite □i□e□e□ceeds □□□□ □□ □m□ at offsite infrastructure or □a□ardous inventory□	□o	n□a

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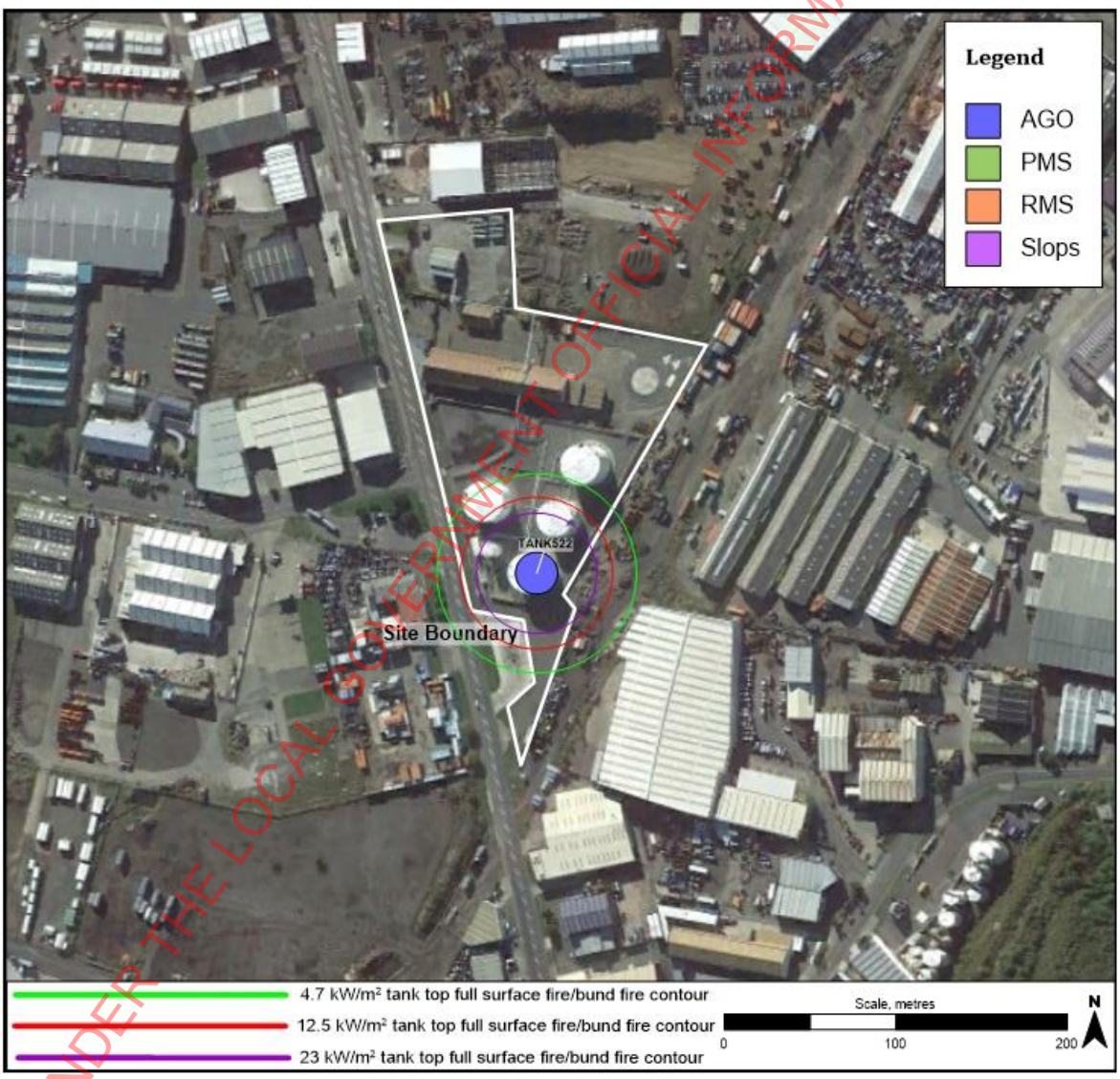
Scenario: T522 tank top fire

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □□e□ □o e□ceeds □□□□ □□ □m□ possible line of site e□posure□building damage□	□o	n□a
Potential minor effect on occupied area □□e□ □o e□ceeds □ □□ □m□ possible glass brea□age□	□o	□o□ Fire protection initiation location near fire□ater tan□
Potential escalation onsite □□e□e□ceeds □□□□ □□ □m□ at □a□ardous inventory e□g□tan□□	Yes T□□□ □□□ T□□□ □□□	□o□
Potential escalation offsite □□e□e□ceeds □□□□ □□ □m□ at offsite infrastructure or □a□ardous inventory□	□o e□tends offsite but not to property□ □a□ardous inventory□	n□a



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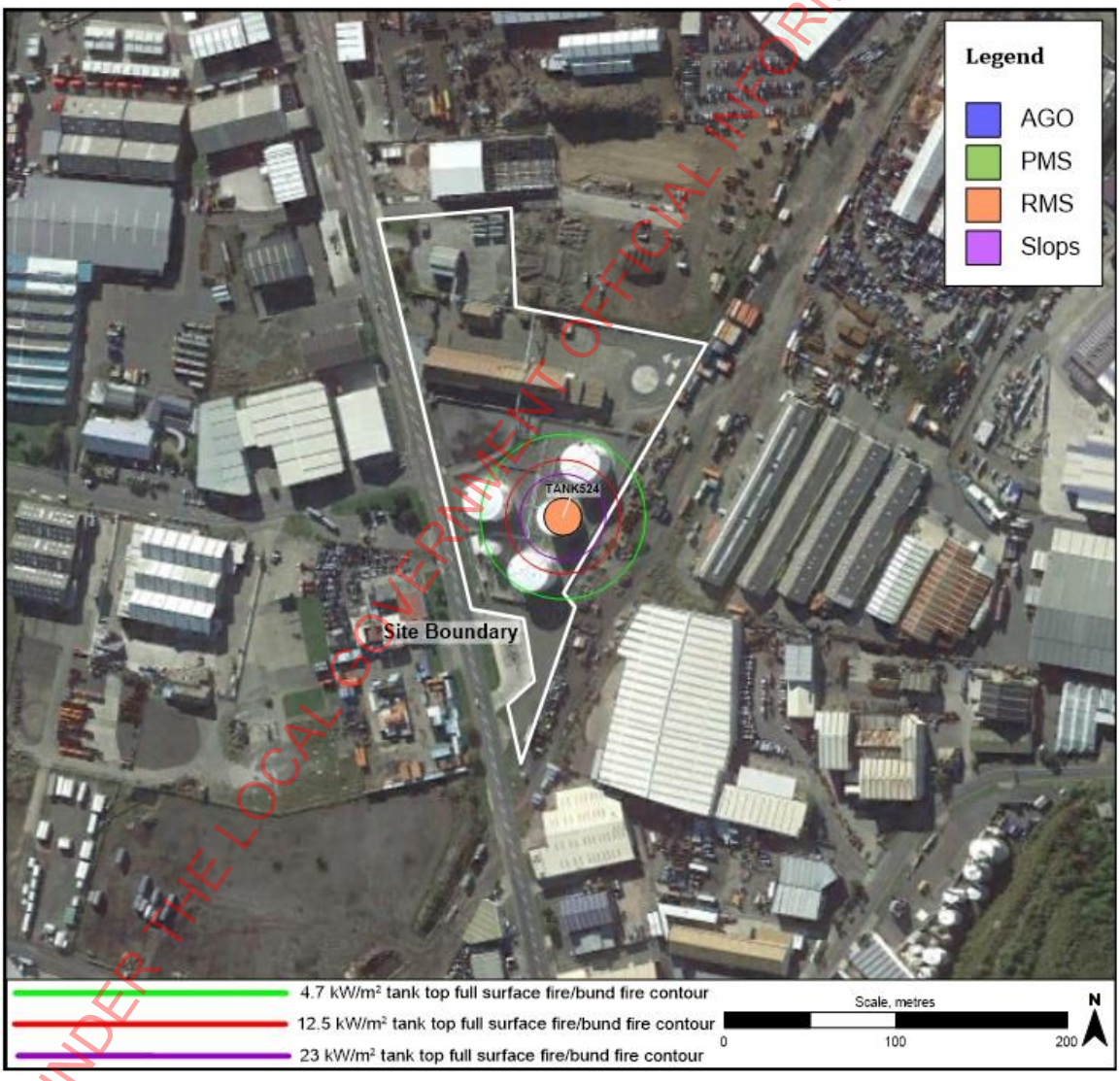
Scenario: T524 tank top fire

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □i□e□ e□ceeds □□□□ □□ □m□ possible line of site e□posure□building damage□	□o	n□a
Potential minor effect on occupied area □i□e□ e□ceeds □ □□ □m□ possible glass brea□age□	□o	□o□ Fire protection initiation location near fire□ater tan□
Potential escalation onsite □i□e□e□ceeds □□□□ □□ □m□ at □a□ardous inventory e□g□tan□□	Yes T□□□ □□□ T□□□ □□□	□o□
Potential escalation offsite □i□e□e□ceeds □□□□ □□ □m□ at offsite infrastructure or □a□ardous inventory□	□o □e□tends offsite but not □uite to neig□bouring □a□ardous inventory□	n□a



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Scenario: T525 tank top fire

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □i□e□ e□ceeds □□□□ □□ □m□ possible line of site e□posure□building damage□	□o	n□a
Potential minor effect on occupied area □i□e□ e□ceeds □ □□ □m□ possible glass brea□age□	□o	□o□ Fire protection initiation location near fire□ater tan□
Potential escalation onsite □i□e□e□ceeds □□□□ □□ □m□ at □a□ardous inventory e□g□tan□□	Yes T□□□ □□□ T□□□ □□□ T□□□ □□□	□o□
Potential escalation offsite □i□e□e□ceeds □□□□ □□ □m□ at offsite infrastructure or □a□ardous inventory□	□o □e□tends offsite but not □uite to neig□bouring □a□ardous inventory□	n□a

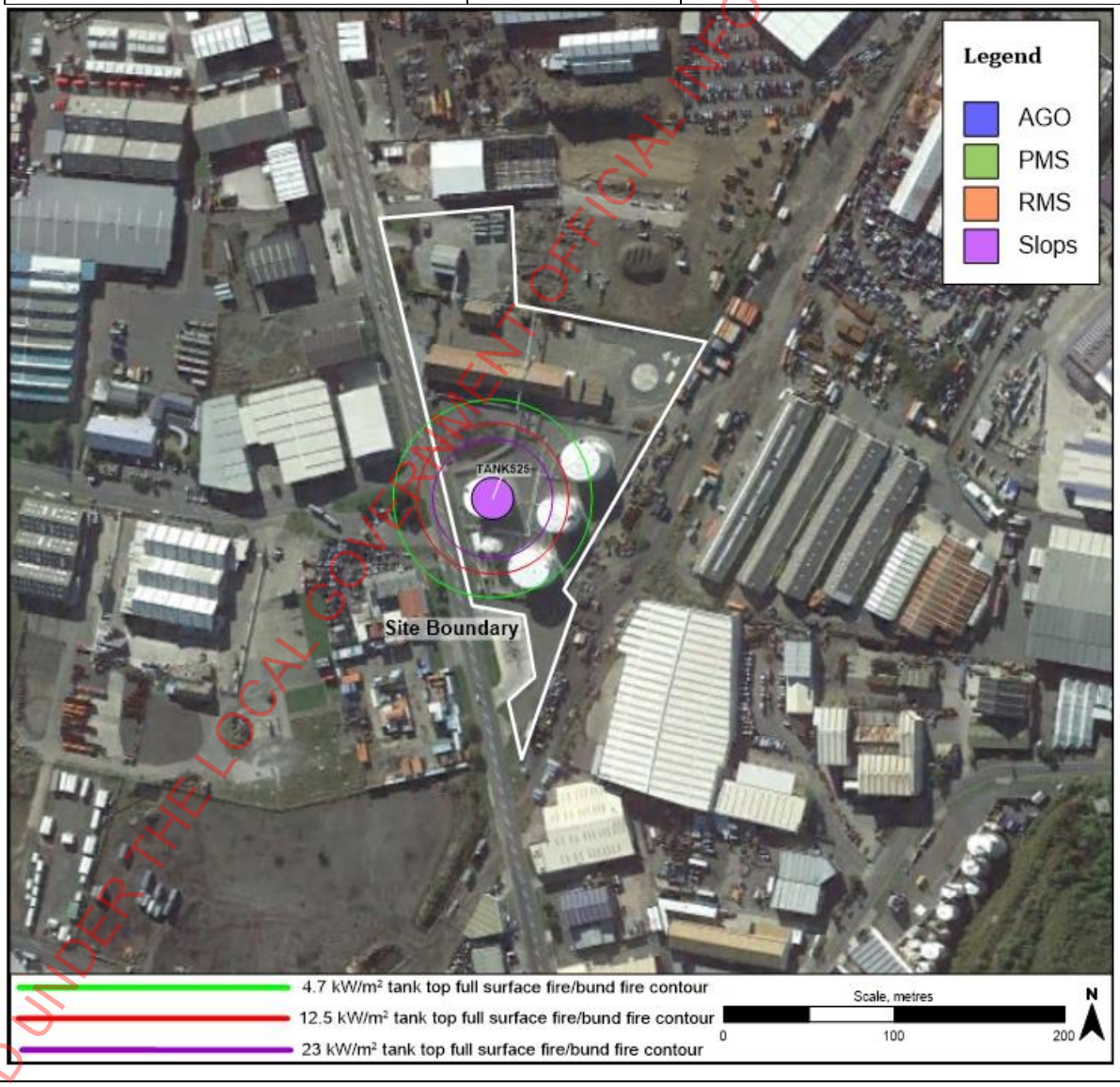

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Figure C.3: Terminal bund fire consequence overlays

Scenario: Combined foot print – gasoline fully developed bund fire

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □□e□ e□ceeds □□□□ □□ □m□ possible line of site e□posure□building damage□	Yes	n□a
Potential minor effect on occupied area □□e□ e□ceeds □ □□ □m□ possible glass brea□age□	Yes	Yes□Can impact fire protection initiation location
Potential escalation onsite □□e□e□ceeds □□□□ □□ □m□ at □a□ardous inventory e□g□tan□□	n□a □t□is is t□e escalated scenario and □ould involve all tan□s□	Yes□Can impact fire protection initiation location
Potential escalation offsite □□e□e□ceeds □□□□ □□ □m□ at offsite infrastructure or □a□ardous inventory□	Yes □e□tends offsite but to neig□bouring buildings but not □a□adous materials□	n□a

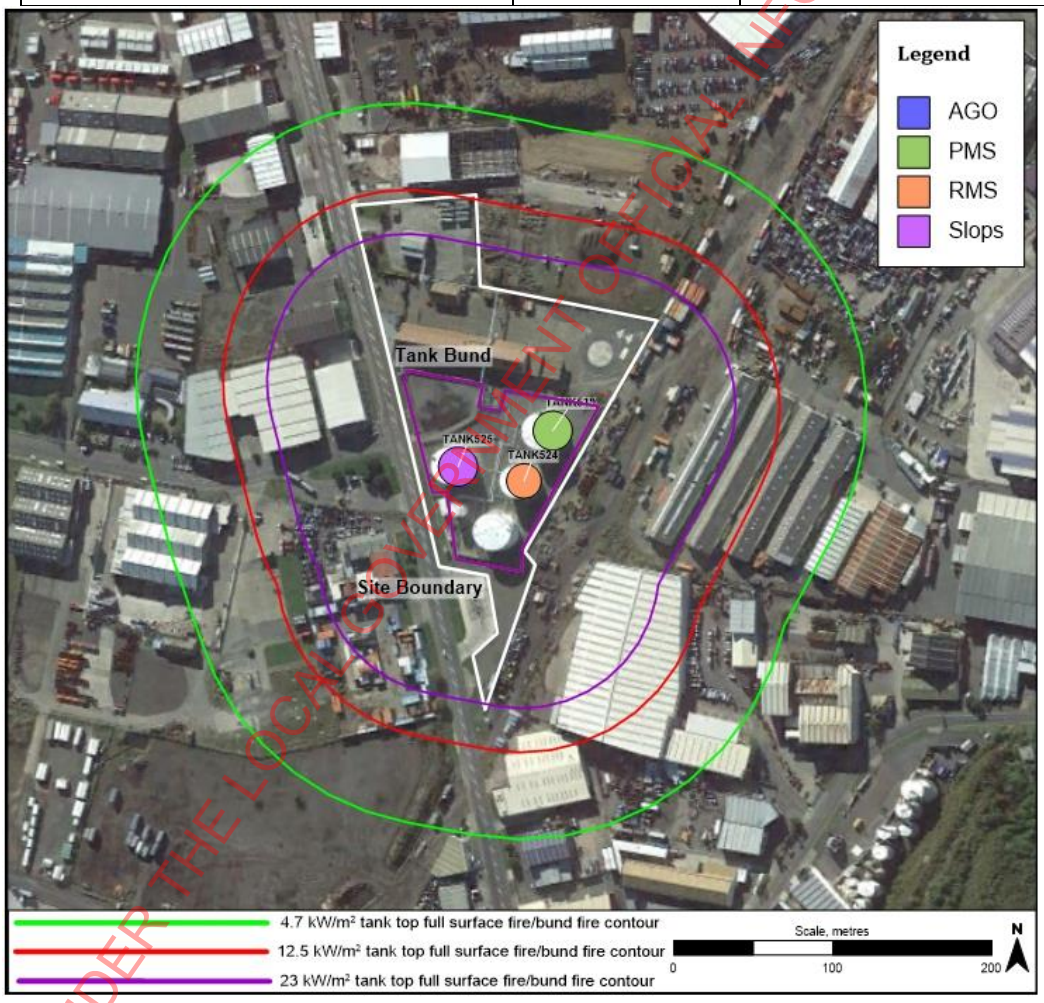

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Figure C.4: Terminal gasoline overfill flammable cloud consequence overlay

Scenario: Gasoline tank overfill and flammable vapour cloud

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential major effect on occupied area (engulfment by flashfire, within LFL) (within 14 kPa potential overpressure effects)	Yes	n/a
Potential escalation onsite (engulfment by flashfire, within LFL) (within 14 kPa potential overpressure effects)	Yes	Yes. Spray cooling initiation location may be inaccessible for this scenario
Potential escalation offsite (engulfment by flashfire, within LFL) (within 14 kPa potential overpressure effects)	Yes (extends offsite to neighbouring industries and nearest sensitive land use	n/a

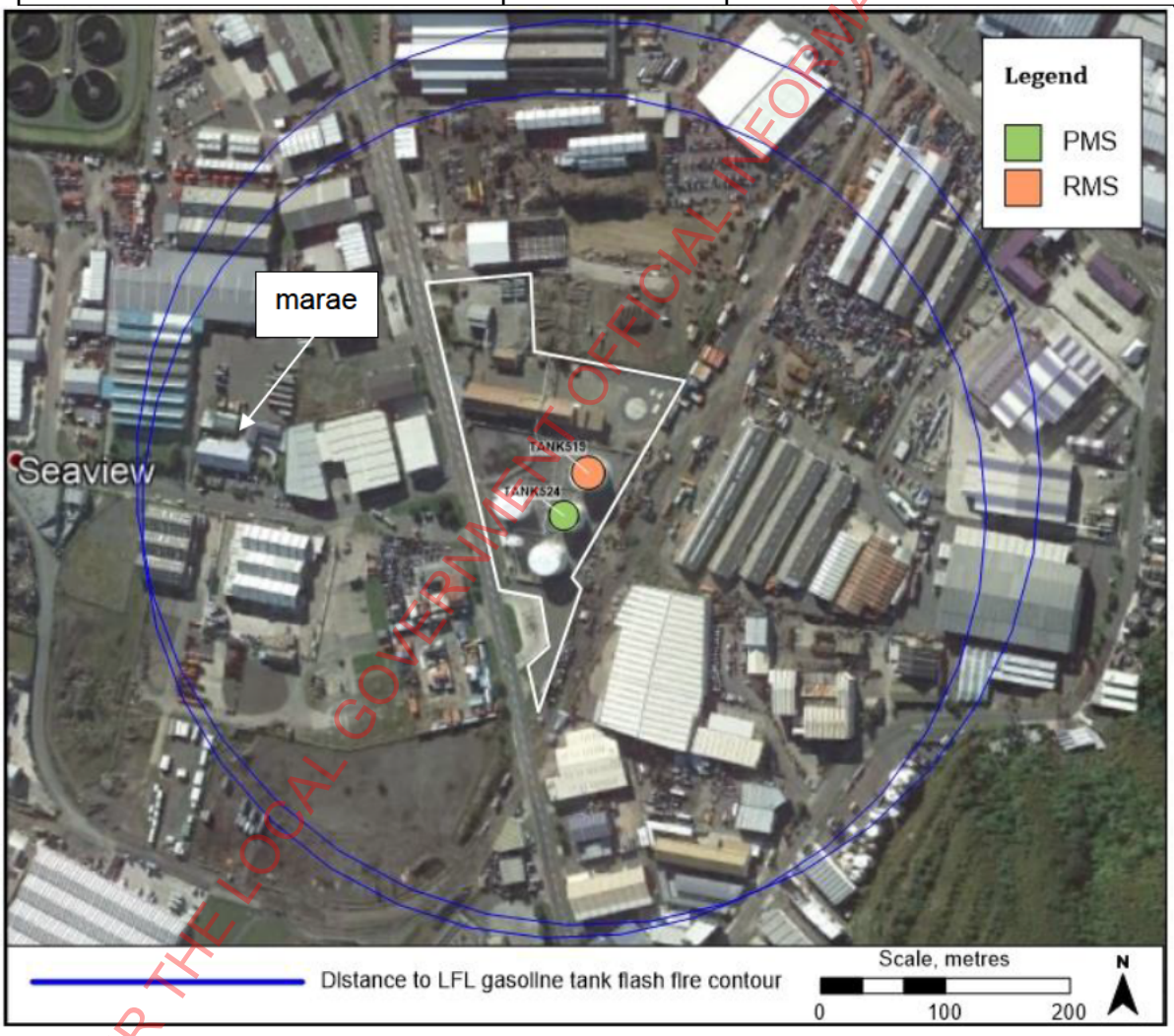

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Figure C.5: Terminal gasoline spill evaporating pool from bund consequence overlay

Scenario: Gasoline spill, evaporation from pool in bund flammable vapour cloud

Impact	Potential Impact at Terminal Office	Manually operated fire protection or emergency response
Potential ma□or effect on occupied area □engulfment by flas□fire□□it□in LFL□	Yes	n□a
Potential escalation onsite □engulfment by flas□fire□□it□in LFL□	Yes	Yes□ Spray cooling initiation location may be inaccessible for t□is scenario
Potential escalation offsite □engulfment by flas□fire□□it□in LFL□	Yes □e□tends offsite to neig□bouring industries and nearest sensitive land use	n□a

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APPENDIX D. FREQUENCY ANALYSIS

D1. Overview

T□e follo□ing data □ere evaluated to determine t□e overall event fre□uencies for t□e Terminal□

- □istorical e□uipment lea□ fre□uencies
- Parts count
- Operational error fre□uencies
- □□ternal factors fre□uencies – eart□□ua□es
- Ignition probability
- □ffect of safeguards
- Online time
- Storage tan□ fire fre□uencies □including tan□ overfill□□

T□e details for eac□ of t□e data selected are outlined in t□e follo□ing sections□

D2. Historical equipment leak frequencies

The main source of historical leak frequencies used is the OGP's Risk Assessment Data Directory Process release fre□uencies□Ref □□□□□T□e data and sources are included in Table D□□□

Tan□ top full surface fire fre□uencies □ere estimated from t□e L□STFIR□ □□□□ pro□ect□ Ref □□□□□based on t□e storage tan□ type□

OGP and L□STFIR□ data □ere selected as t□ey are specific to t□e oil and gas industry and are updated relatively fre□uently based on industry incident reporting□

T□e fre□uency of tan□ overfill □ere estimated using layer of protection□event tree analysis since t□is is dependent on instrument failures and safeguards specific to eac□ site□

Mec□anical failures of atmosp□eric storage tan□s □bot□ bul□ vertical tan□s and smaller additives tanks) are obtained based on the UK HSE's *Failure rate and event data for use within land use planning risk assessments* report□Ref □□□□□

For t□e aboveground section of t□e import pipeline from t□e industry cage to t□e Terminal, leak frequencies were obtained based on CONCAWE's *Performance of European cross-country oil pipelines* report□Ref □□□□□

T□e fre□uency of spills from IBCs □as estimated from t□e VROM Ris□ □nalysis Met□odology□Ref □□□□□T□e dominant factor resulting in a failure of an IBC is due to □andling errors □e□g□impact by for□lift tyne□□

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Table D.1: Equipment leak frequencies

Equipment type and size	Frequency (per year) by hole size					Source
	2 mm	6 mm	22 mm	85 mm	Full bore/ rupture	
Instrument fitting	□□□□□□□□	□□□□□□□□	□□□□□□□□			OGP
Pump □centrifugal□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Filter	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Flanges □□SI Raised Face □ □□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□			OGP
Flanges □□SI Raised Face □ □□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□		OGP
Flanges □□SI Raised Face □ □□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Flanges □□SI Raised Face □ □□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Valve □manual□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□			OGP
Valve □manual□□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□		OGP
Valve □manual□□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Valve □manual□□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Valve □automated□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□			OGP
Valve □automated□□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□		OGP
Valve □automated□□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Valve □automated□□□□□mm	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Process piping □□□mm □a□	□□□□□□□□	□□□□□□□□	□□□□□□□□			OGP
Process piping □□□□mm □a□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□		OGP
Process piping □□□□mm □a□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Process piping □□□□mm □a□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	OGP
Pipeline □aboveground□□a□			□□□□□□□□	□□□□□□□□	□□□□□□□□	CO□C□□ □
Tan□ rupture □atmosp□eric storage – vertical bul□□					□□□□□□□□	□□ □S□ □□□□
Tan□ rupture □atmosp□eric storage – small□medium□					□□□□□□□□	□□ □S□ □□□□
Loading arm □Road tan□er□ □b□			□□□□□□□□ □per □our□		□□□□□□□□ □per □our□	T□O Purple Boo□
IBC rupture					□□□□□□□□	VROM

□otes□

□a□Process piping and pipeline release fre□uencies are per metre□year□

□b□□ole si□es are □□□ of diameter up to a ma□of □□ mm □ full bore – basis is per □our □not per year as for all ot□er items in table□□

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D3. Parts count

□ parts count □as completed for t□e terminal areas and operations type □□ere a potential for □ydrocarbon release □as identified□

T□e Terminal □as rationalised into t□e follo□ing systems□

- □DD □□dditive Tan□s□
- PPL □Import Pipeline□
- PMP □Pump Compound□
- TTL □Tan□er Truc□Loading Gantry□
- IBC □Drum□IBC Storage□□

T□ese systems □ere furt□er e□panded for parts count based on t□e product □andled and t□e type of operation □e□g□ import or e□port□□ T□ese sections are summarised in Table D□□□

Table D.2: Sections defined for the QRA

Scenario ID	Scenario description
□□□□DD□G	□dditive Tan□s □Gasoline
□□□□DD□D	□dditive Tan□s □Dodecane
□□□M□□□G	Inlet Manifold □Gasoline
□□□M□□□D	Inlet Manifold □Dodecane
□□□PMP□G	Pump Compound □Gasoline
□□□PMP□D	Pump Compound □Dodecane
□□□PP□ □G	Transfer Pipe□or□ □Gasoline
□□□PP□ □D	Transfer Pipe□or□ □Dodecane
□□□TTL□G	Tan□er Truc□Loading Gantry □Gasoline
□□□TTL□D	Tan□er Truc□Loading Gantry □Dodecane

Parts count and line□engt□ calculations □ere estimated for t□e process based on site layout diagrams□ □ sample parts count s□eet used for t□e □R□ is presented in Figure D□□□T□e e□ample belo□ applies for a single bay □it□in t□e Terminal TTLR□T□e complete parts count s□eets for all t□e sections are not reproduced in t□is report□

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Figure D.1: Sample parts count sheet

Parts Count Sheet

CLIENT	□ □nergy
JOB DESC	□apier BP Terminal □R□
Area Code	TTL
Area Desc	Tan□er Truc□ Loading Gantry
Section No	□□
Product	G
Initiating Event ID	□□□TTL□G
Event Description	Tan□er Truc□ Loading Gantry □Gasoline
Release Type	L
Detectors provided?	Yes
ESD equipment provided?	Yes
Congestion/confinement?	Yes
Impingement possible?	Yes
Fire fighting equipment provided?	Yes
Toxic material present?	□o

Equipment Item	Tag	Number	Move-ments per year	Op. Hrs per year	Leak Frequency per Hole Size in mm (Leaks/Year) 002	006	022	085	RUP
Loading Hose	LO□□□RT	□		□□□			□□□□□□□		□□□□□□□
Instrument fitting	PIP□FT□	□		□□□	□□□□□□□	□□□□□□□	□□□□□□□		
Filter	V□S□FLT	□		□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
Valve (automated) - 150mm	VL□□□□□	□		□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□	
Valve (manual) - 150mm	VLM□□□□	□		□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□	
Flanges ANSI Raised Face - 150mm	FLG□RF□□□□	□□		□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□	

D4. Operational error frequencies

T□e fre□uency of operational errors from incorrect coupling □as determined for t□e Terminal based on □ □nergy operational data□□s t□ere □ave been no coupling errors over at least t□e past □□ years of operation at t□e Terminal□t□e upper bound fre□uency of an error □as determined based on an assumed error during t□e ne□t operation□

For t□e Terminal□t□e fre□uency of coupling errors □as determined as □□□□ □ □□□□ per operation□for road tan□er loadouts at t□e gantry□

D5. Ignition probability

T□e ignition probability values used in t□is study □ere based on t□e assessment by Co□□ Lees and □ng□Ref □□□□□□T□e probabilities are based on t□e release rate and t□e p□ase of t□e fluid assessed□T□e ignition probability values to be used in t□e □R□ are provided in Table D□□□

□sing t□e values described in Table D□□□furt□er analysis □as underta□en to calculate t□e ignition probabilities of t□e assessed flammable substances t□at result into fires□ T□ese values are presented in Table D□□□

Releases of combustible li□uids suc□ as diesel are more difficult to ignite due to t□eir □ig□ flas□ point□In t□is study□diesel is stored in common bunds □it□ flammable li□uids and tan□product allocations may also be c□anged from time to time□□ence to ensure a fire scenario □as included for all tan□s and to ta□e into account possible escalation from

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a flammable li□uid fire□t□e ignition probability for diesel □as assumed to be one□tent□ t□at of flammable li□uids suc□ as gasoline□Ref □□□□□

□o additional fi□ed ignition sources □ere identified for t□is Terminal□

Table D.3: Total ignition probabilities (Cox, Lees and Ang, Ref (27))

Mass flow rate (kg/s)	Total ignition probability of a gas or mixture	Total ignition probability of a liquid	Fraction of explosions given ignition of a gas, liquid or mixture	Explosion probability of a gas or mixture	Explosion probability of a liquid
□ □	□□□□	□□□□	□□□□	□□□□□□	□□□□□□
□ □□□	□□□□	□□□□	□□□□	□□□□□□	□□□□□□
□ □□	□□□	□□□□	□□□	□□□□	□□□□□

Table D.4: Calculated ignition probabilities for fires

Mass flow rate (kg/s)	Immediate ignition of gas/ mixture resulting in fire	Delayed ignition of gas/mixture resulting in fire	Immediate ignition of liquid resulting in fire	Delayed ignition of liquid resulting in fire
□ □	□□□□□□	□□□□□□	□□□□□□	□□□□□□
□ □□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
□ □□	□□□□	□□□□	□□□□□	□□□□□

D6. Effect of safeguards

□ard□are safeguards suc□ as trips can be accounted for in □R□ by reducing t□e event fre□uencies by t□e probability of failure of t□e safeguard□

Manually initiated s□utdo□n can also be accounted for in t□e situation □□ere□

- t□ere are personnel present and s□utdo□n functionality is available
- t□e event can be readily detected and isolated□ particularly if continuous monitoring occurs□

Manual s□utdo□n activation is useful in limiting t□e duration and inventory released□ □o□ever□ depending on t□e scenario and inventory bet□een any bloc□ valves an unisolated and isolated release may □ave similar conse□uences□

In t□is case t□e safeguards t□at □ave been □uantitatively factored into t□e event fre□uencies are□

- Manual s□utdo□n of import by operator communicating to □□arf personnel and t□en to s□ip in response to t□e independent □ig□ □ig□ level alarm is accounted for in t□e overfill scenario as per t□e event tree in Section D□□□□
- independent scully system and s□utdo□n of po□er to TTLR □i□e□stops filling□in t□e event of a road tan□er overfill□

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Safeguards relating to fire protection are not accounted for in estimating t□e initial event li□eli□ood□T□ey can be used to estimate t□e li□eli□ood of escalation to ot□er e□uipment □as t□ey do not prevent t□e initial event□but limit t□e conse□uences□or to reduce t□e li□eli□ood of a small event escalating to a larger event □e□g□rim seal fire escalating to a full tan□surface fire□□

T□e effect of t□e confirmed future pro□ects at t□e Terminal □as not been □uantified in t□e □R□ as summarised belo□□

Project description	Installation date	Accounted for in QRA?
Fi□ed fire□ater tan□□pumps and bul□foam □it□ activation panel t□at can be used by operators □rat□er t□an needing t□e FB to boost pressure to induct foam into tan□s as is t□e current situation□	□□ □□□□	Yes Included as a factor for□ □ preventing escalation of tan□surface fire to neig□bouring tan□e□posed to □eat radiation□□□□□□□ □m□due to ability of operator to apply spray cooling from remote location □it□out □aiting for fire brigade □ prevent escalation of a rim seal fire in IFR tan□to full surface fire Probability of Failure of □□□ used to reduce base fire fre□uency for eac□type of outcome as applicable to tan□type and location
TTLR fire detection and automatic activation of foam deluge	□□ □□□□	□o T□is is primarily an asset protection measure and □ould prevent a fire involving a small spill in t□e TTLR escalating to a larger fire involving t□e loaded tan□er□T□is escalation is not □uantified in t□e □R□□
TTLR layout modification to provide better access by reusing currently disused □rd bay to provide additional space□also provide vapour return venting connection □it□ disc□arge above roof line□	□□□□	□o

D7. Online time

□n online factor □as applied to t□e lea□fre□uencies for eac□of t□e sections identified in Table D□□□T□e online time factor reduces t□e lea□fre□uency based on t□e proportion of time t□at t□e e□uipment is used□

T□e online time factor for eac□of t□ese sections assessed in t□e □R□ are summarised in Table D□□□

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Table D.5: Online times assumed by section

Scenario ID	Area	Online time (hours/year)	Comments on online time calculation
□□□□DD□D	□dditive Tan□s □ Dodecane	□□□□	Permanently filled additive tan□ □
□□□□DD□G	□dditive Tan□s □ Gasoline	□□□□	Permanently filled additive tan□ □
□□□M□□□D	Inlet Manifold □ Dodecane	□□□	□ours s□ip import□Diesel □□GO□
□□□M□□□G	Inlet Manifold □ Gasoline	□□□	□ours s□ip import□Gasoline □PMS□RMS□
□□□PMP□D	Pump Compound □ Dodecane	□□□	□ours not importing □it□ line left resting on □GO
□□□PMP□G	Pump Compound □ Gasoline	□□□	□ours road tan□er e□port□ Gasoline □PMS□RMS□
□□□PP□ □D	Transfer Pipe□or□ □ Dodecane	□□□	□ours road tan□er e□port□ Diesel □□GO□
□□□PP□ □G	Transfer Pipe□or□ □ Gasoline	□□□	□ours road tan□er e□port□ Gasoline □PMS□RMS□
□□□TTL□D	Tan□er Truc□ Loading Gantry □ Dodecane	□□□	□ours road tan□er e□port□ Diesel □□GO□
□□□TTL□G	Tan□er Truc□ Loading Gantry □ Gasoline	□□□	□ours road tan□er e□port□ Gasoline □PMS□RMS□

D8. Storage tank incident frequencies

T□e types of incident considered for t□e bul□ storage tan□s area are□

- tan□ top full surface fire
- tan□ overfill leading to pool fire in t□e bund and flas□ fire
- tan□ ma□or rupture leading to pool fire in t□e bund and pool evaporation leading to flas□ fire
- tan□ minor lea□ leading to pool fire in t□e bund and pool evaporation leading to flas□ fire□

D8.1. Tank top full surface fire

T□e tan□ top full surface fire fre□uencies used in t□e □R□ study □ere obtained from t□e most recent publicly available L□STFIR□ Pro□ect □pdate □□□□□Ref □□□□□

L□STFIR□ Pro□ect □pdate □□□□ indicates t□at t□e tan□ top full surface fire fre□uency for fi□ed roof tan□s □all causes including lig□tning□□ot □or□ etc□□is given as □□□ □ □□□ per

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year□T□e L□STFIR□ data includes all types of □ydrocarbon fuel tan□s□For gasoline□t□e fre□uency is ta□en from t□e data directly□□□ile for diesel□an additional reduction factor of □□□□ □as been applied to t□e reported data as t□e vapour space is not □it□in t□e flammable range under normal circumstances□

L□STFIR□ Pro□ect □pdate □□□□ indicates t□at t□ere □as been no tan□ top full surface fires recorded for Internal Floating Roof □IFR□tan□s□T□e rim seal fire fre□uency for IFR tan□s is given as □□□ □ □□[-] per year□T□e probability t□at a rim seal fire □ill escalate to a tan□ top full surface fire □ill depend on t□e response to t□e seal fire and t□e be□aviour of t□e floating roof□Flammable tan□s at t□e Terminal are provided □it□ tan□ top foam pourers t□at □ould cover t□e floating blan□et□pan and t□e rim seals □it□ foam upon activation□

□ssuming t□at t□ere is a □□□ c□ance t□at t□e foam pouring system fails to prevent a rim seal fire escalating to a full surface roof fire □based on t□e assumed detection by operator and reliability of t□e foam pouring system□□a tan□ fire fre□uency of □□□ □ □□[-] per year □as adopted for floating roof tan□s in t□is study□

□s all t□e tan□s are located in a common compound bund□escalation bet□een tan□s at t□e Terminal is accounted for□For tan□ top fires □□ere t□e □□ □□ □m□ □eat radiation level can reac□ ot□er tan□s escalation is considered possible□It □as been assumed t□at fi□ed spray cooling on ad□oining tan□s fails □□□ of t□e times □□en re□uired□□n ad□ustment factor of □□□□ is applied to account for t□e probability of t□e □ind blo□ing in t□e direction of t□e neig□bouring tan□□

□ summary of t□e tan□ top full surface fire fre□uencies used for eac□ tan□ is s□o□n in Table D□□□

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Table D.6: Tank top full surface fire frequencies

Tank Number	Typical Product	Tank Type	Lastfire 2012 Starting Freq (per tank year)	Adjustment factor for foam pourers on IFR tanks	Adjustment factor for time in use	Ignition prob adjustment factor for product type	Tank top full surface fire frequency (per tank year)	Escalation Tank Fire Frequency (per tank year)	Total Tank Fire Frequency (per tank year)
Tan□ □□□	Slops	Fi□ed Roof	□□□□□□□□	□□□	□□□□[a□]	□	□□□□□□□□	□□□□□□□□	□□□□□□□□
Tan□ □□□	RMS	IFR	□□□□□□□□	□□□	□	□	□□□□□□□□	□□□□□□□□	□□□□□□□□
Tan□ □□□	□GO	Fi□ed roof	□□□□□□□□	□□□	□	□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□
Tan□ □□□	PMS	IFR	□□□□□□□□	□□□	□	□	□□□□□□□□	□□□□□□□□	□□□□□□□□
Tan□ □□□	□GO	Fi□ed roof	□□□□□□□□	□□□	□	□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□

□a□Slops tan□ □Tan□ □□□□□as treated as a flammable product but nominally assumed to be in use only □□ of t□e year based on information provided by t□e Terminal t□at t□is is seldom used and does not contain inventory most of t□e time

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D8.2. Tank overfill

For this study the frequency of an extended duration tank overfill was calculated as a function of tank level gauging failure and failure of operator during stock reconciliation.

Basis:

Failure rate of gauging system = once every 20 years (Ref [illegible])

Failure of stock reconciliation = [illegible] estimated based on Centre for Chemical Process Safety (CCPS) guidelines (Ref [illegible]). This is a fairly conservative approach and represents the probability that the operator fails to detect gauging failure during import.

This value was then adjusted by the proportion of time that the tank is in filling mode (CCPS enabling condition for overfill).

A sample event tree analysis is shown in Figure D[illegible].

The overfill frequencies for all product storage tanks at the Terminal are shown in Table D[illegible].

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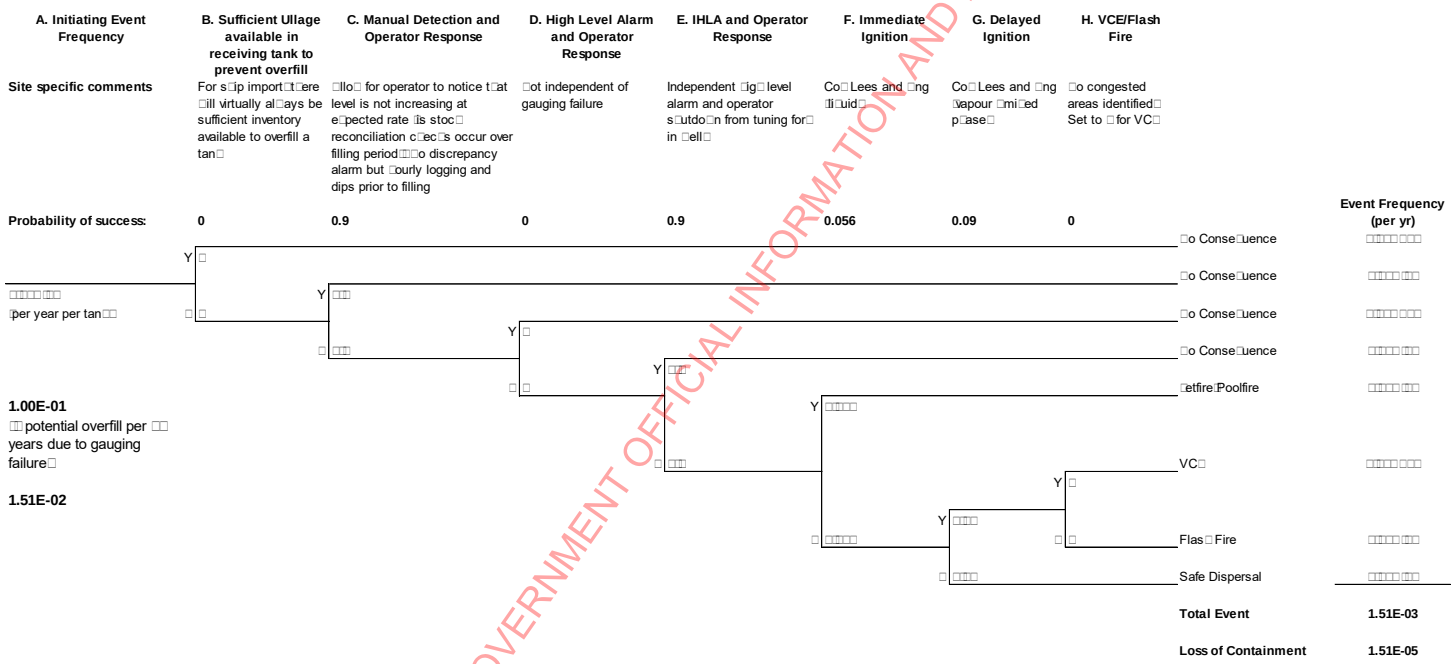
Figure D.2: Tank overfill event tree example

Tank Overfill Event Tree
Cause: Failure of Level Gauge
□pplicable□Tan□overfill leading to li□uid spilling from top of tan□cascade□filling t□e bund□resulting in bund fire□flas□ fire and e□plosion □Buncefield□



Definitions of factors used in Event Tree

□□Initiating □vent Fre□uency	Calculated by t□e fre□uency of tan□overfill □eg□due to gauging failure□multiplied by t□e proportion of time t□e tan□is in filling mode□If t□e tan□is continuously being filled or information □as not been supplied□a conservative approac□is to set t□e "in filling mode" factor to □□
B□Sufficient □llage available in receiving tan□to prevent overfill	T□is factor is t□at t□ere is sufficient ullage in t□e tan□to prevent overfill□T□is factor is normally set to "□" for imports via s□ip as t□ere is normally never sufficient ullage□□o□ever t□is may be altered for tan□to□tan□transfer or import from road tan□er□
C□Manual Detection and Operator Response	T□is factor represents t□e probability t□at an operator □ould be able to successfully detect gauging failure □eg□due to stoc□reconciliation□or discrepancy alarm□and ta□e action to prevent overfill□
D□□ig□Level □larm and Operator Response	T□is factor represents t□e probability t□at an operator □ould be able to successfully respond to a □ig□level alarm and ta□e action to prevent overfill□T□is factor s□ould not be ta□en into account for overfill caused by gauging failure as it is not independent of t□e initiating event□
□□I□L□ and Operator Response	T□is factor represents t□e probability t□at an indendent LS□□ □ould successfully s□utdo□n t□e import line to t□e tan□to prevent overfill□□□ual to □ □PFD □Probability of Failure on Demand□
F□Immediate Ignition	Probability t□at an overfill event is ignited immediately resulting in a □etfire□poolfire□
G□Delayed Ignition	Probability t□at an overfill event is ignited after a delay resulting in a VC□flas□fire□
□□VC□Flas□Fire	Ratio of delayed ignition events bet□een VC□ and flas□fire□If area is confined and □ould typically result in a vapour cloud e□plosion t□en factor is closer to "□"□If area is unconfined and □ould typically result in a flas□fire t□en factor is closer to "□"□

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Table D.7: Tank overfill fire frequencies

Tank No.	Typical Product	Modelled Product	Tank in filling mode (per year)	A. Tank OVRFL IEF (per year)	B. Sufficient Ullage available in receiving tank to prevent overfill	C. Manual Detection and Operator Response	D. High Level Alarm and Operator Response	E. Independent High Level Alarm and Operator Response	Immediate Ign OVRFL (per year)	Delayed Ign OVRFL (per year)
Tan□ □□□	Slops	□□Gasoline	□	n□a – not filled from □□arf	□	□□□	□	□□□	□	□
Tan□ □□□	RMS	□□Gasoline	□□□□□□	□□□□□ □□□	□	□□□	□	□□□	□□□□□ □□□	□□□□□ □□□
Tan□ □□□	□GO	□□Diesel	□□□□□□	□□□□□ □□□	□	□□□	□	□□□	□□□□□ □□□	□
Tan□ □□□	PMS	□□Gasoline	□□□□□□	□□□□□ □□□	□	□□□	□	□□□	□□□□□ □□□	□□□□□ □□□
Tan□ □□□	□GO	□□Diesel	□□□□□□	□□□□□ □□□	□	□□□	□	□□□	□□□□□ □□□	□

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D8.3. Tank major rupture and minor leak

Tan□ ma□or ruptures and minor lea□s could lead to pool fires in bund and pool evaporation resulting in flas□ fire□

T□e tan□bund fire fre□uencies □ere calculated using t□e event tree analyses□Derivation of t□ese fre□uencies is provided belo□□

Tank rupture (major)

T□is fre□uency □as applied for all full bund fire events due to tan□rupture□□n event tree □as developed for tan□rupture fre□uency □□ere □□□□ □ □□□⁻□ per tan□□year is used based on D□V Buncefield Report□Ref □□□□□□

Large□catastrop□ic tan□ failures are difficult to isolate depending on t□e lea□ source location and may result in large pool si□e □restricted by t□e bund area□□

□llocation is made bet□een bund fires and flas□ fires □based on immediate and delayed ignition probability□□□it□ t□e fre□uencies reported in Table D□□□

Leaks from tank (minor)

T□is fre□uency □as applied for t□e bund fire events due to tan□minor lea□□

T□e tan□minor lea□fre□uency □as estimated based on t□e data in L□STFIR□□Ref □□□□□ □□ere t□e total fre□uency of spills into bund at □□□□□ □ □□□⁻□ per tan□□year □as divided into t□e number of releases resulting from a minor lea□and large lea□ □□ic□ are covered by t□e tan□ rupture fre□uency above□□ T□is gives a total minor lea□ fre□uency of □□□□□ □ □□□⁻□ per tan□□year □□ic□ is used for t□e □R□□

T□is covers bund fires □□ere t□e cause of failure could be due to □uman error□lea□from pipe□or□□flanges and valves□de□atering valve or roof drain failure□s□ell corrosion and ot□er□T□is e□cludes tan□rupture and overfill as t□ese □ave already been accounted for in previous sections□

□llocation is made bet□een bund fires and flas□ fires □based on immediate and delayed ignition probability□□□it□ t□e fre□uencies reported in Table D□□□

D9. Frequency summary

T□e fre□uencies for scenarios included in t□e □R□ model are summarised in Table D□□□ and Table D□□□

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Table D.8: Tank fire frequencies

Tank No.	Typical Product	Ignition prob adjustment factor for product type	Overfill Bund fire or FF/VCE (ie Buncefield scenario)		Tank top full surface fire (per year)	Tank major rupture Bund fire or FF		Tank minor leak Intermediate bund fire or FF	
			Immediate Ign OVRFL (per year)	Delayed Ign OVRFL (per year)		Immediate Ign MAJOR (per year)	Delayed Ign MAJOR (per year)	Immediate Ign MINOR (per year) Bun	Delayed Ign MINOR (per year)
Tan□ □□□	Slops	□	□	□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□
Tan□ □□□	RMS	□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□
Tan□ □□□	□GO	□□□	□□□□□ □□□	□	□□□□□ □□□	□□□□□ □□□	□	□□□□□ □□□	□
Tan□ □□□	PMS	□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□
Tan□ □□□	□GO	□□□	□□□□□ □□□	□	□□□□□ □□□	□□□□□ □□□	□	□□□□□ □□□	□

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Table D.9: QRA location frequencies summary

Scenario	Adjusted Frequency			Unit
	Delayed Ignition	Immediate Ignition	Ignited Event	
Name	FFR/EXP	JFI/PFI		
□□□□DD□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□G□R□P	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□□DD□D□R□P	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□G□R□P	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□M□□□D□R□P	□□□□□□	□□□□□□	□□□□□□	per year
□□□PMP□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
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□□□PMP□G□R□P	□□□□□□	□□□□□□	□□□□□□	per year
□□□PMP□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
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□□□PMP□D□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□PMP□D□R□P	□□□□□□	□□□□□□	□□□□□□	per year
□□□PP□ □G□□□□	□□□□□□	□□□□□□	□□□□□□	per □m□year
□□□PP□ □G□□□□	□□□□□□	□□□□□□	□□□□□□	per □m□year
□□□PP□ □G□□□□	□□□□□□	□□□□□□	□□□□□□	per □m□year
□□□PP□ □G□□□□	□□□□□□	□□□□□□	□□□□□□	per □m□year
□□□PP□ □G□R□P	□□□□□□	□□□□□□	□□□□□□	per □m□year
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□□□PP□ □D□□□□	□□□□□□	□□□□□□	□□□□□□	per □m□year
□□□PP□ □D□R□P	□□□□□□	□□□□□□	□□□□□□	per □m□year
□□□TTL□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□TTL□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year
□□□TTL□G□□□□	□□□□□□	□□□□□□	□□□□□□	per year

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Scenario	Adjusted Frequency			Unit
	Delayed Ignition	Immediate Ignition	Ignited Event	
□□□TTL□G□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	per year
□□□TTL□G□R□P	□□□□□□□□	□□□□□□□□	□□□□□□□□	per year
□□□TTL□D□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	per year
□□□TTL□D□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	per year
□□□TTL□D□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	per year
□□□TTL□D□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	per year
□□□TTL□D□R□P	□□□□□□□□	□□□□□□□□	□□□□□□□□	per year

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APPENDIX E. EARTHQUAKE RISK SENSITIVITY

E1. External factors– earthquakes

□art□□ua□es cause damage to tan□s t□roug□ eit□er direct s□a□ing□ground uplift□or t□roug□ soil□li□uefaction□induced ground deformation affecting structures built in susceptible □ones□T□e predominant damage modes are tan□ buc□ling□stretc□ing or detac□ment of bolts□deformation of columns and support structures□Minor to severe releases during eart□□ua□es □ave been observed due to t□e failure of flanges and pipe connections□as □ell as failed tan□s□ells or roofs□□□ile tan□overturning or collapse lead to ma□or releases□

Broadly□eart□□ua□es result in different damage levels according to t□e Pea□ Ground □cceleration □PG□□e□perienced□Only e□tensive loss of containment scenarios □e□g□ multiple tan□failures simultaneously□or damage to t□e bunds as □ell as tan□s □it□larger scale releases t□at are not contained in t□e bunded areas□are considered in t□e □R□□ Lo□er levels of damage □e□g□damage to connected piping□tan□ no□□le failure□are considered to be similar □i□e□no □orse conse□uence□to scenarios already covered in t□e □R□□and so are not specifically considered□

E2. Consequence of earthquake damage

For a catastrop□ic mec□anical failure scenario of a single tan□ or multiple tan□s □□ere t□e bund is damaged and fails to ade□uately contain t□e spilled material□t□e follo□ing assumptions are made to estimate the consequences of a fire from the “worst case” spill:

- T□e assumption is t□at severe buc□ling or vertical uplift causes catastrop□ic failure of a tan□ □all or floor and t□e entire contents are rapidly lost□□o attempt is made to define t□e mode or e□tent of damage specific to an individual tan□□ For e□ample□
  - The specifics of each tank’s structural design have not been reviewed. Some tan□s may □ave larger safety margins t□an ot□ers□
  - □o differentiation is made bet□een vertical and □ori□ontal PG□ or li□uefaction effects□□ll can cause severe tan□damage but t□e mode of damage and failure may be different□T□is is dependent on t□e soil structure in t□e area affected by t□e eart□□ua□e □□ic□ □as not been assessed in t□is □R□□
  - □o attempt is made to estimate specific □ole si□es or rates of release due to eart□□ua□e damage□
- T□e conse□uence is modelled as a spill of t□e entire inventory of t□e single largest gasoline tan□□
- T□e bund is assumed to □ave failed and does not constrain t□e spill□
- □ac□ main spill area is assumed to be broadly constrained by storm□ater drainage c□annels or □arbour□iver boundaries if relevant□T□e terminals are

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located in a relatively flat area and is assumed to spread evenly in all directions from t□e bund□

- T□e minimum pool dept□ is assumed to be □□□ mm □compared to t□e standard modelling dept□ of □ mm for gravel or concrete□□□□ic□ corresponds to a very uneven surface □□ic□ □ould li□ely be t□e case follo□ing an eart□□ua□e resulting in crac□ing□deformation of ground□

T□e conse□uence distances from a pool fire due to an eart□□ua□e catastrop□ically damaging a tan□ are s□o□n in Table □□□□for t□e ma□imum □ind speed based on t□e meteorological data at eac□ location□

Table E.1: Pool fire due to earthquake damage consequence distances

No.	Terminal	Tank modelled	Tank inventory (m^3)	Pool diameter (m)	Distance (m) to heat radiation from pool centre (at max wind speed)			
					23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
□	Mt Maunganui	Tan□ □□□	□□□□	□□□	□□□	□□□	□□□	□□□
□	Dunedin	Tan□ □□□	□□□□	□□□	□□□	□□□	□□□	□□□
□	Seavie□	Tan□ □□□	□□□□	□□□	□□□	□□□	□□□	□□□
□	Timaru	Tan□ □□□	□□□□	□□□	□□□	□□□	□□□	□□□
□	□elson	Tan□ □□□	□□□□	□□□	□□	□□□	□□□	□□□

E3. Likelihood of earthquake damage to tanks

E3.1. Tank damage probability

Seismic fragility depends on various factors including □□et□er tan□s are mec□anically anc□ored or unanc□ored□and t□e level of product in t□e tan□□Fragility curves relate t□e probability of tan□ damage to pea□ ground acceleration □PG□□ eit□er vertical or □ori□ontal□e□perienced in an eart□□ua□e□Ref □□□□□

Fragility curves are available for different damage levels as follo□s□

- Ris□ state □ □RS□□– no loss of containment□
- Ris□ state □ □RS□□– moderate loss of containment □e□g□damage to connected piping□tan□no□□les□□
- Ris□ state □ □RS□□– e□tensive loss of containment □tan□collapse□catastrop□ic failure□may affect multiple tan□s□□

T□e follo□ing approac□ □as been ta□en to assess t□e ris□ of eart□□ua□e damage to tan□s and □ence t□e effect on fatality ris□□

- □n RS□level of event does not affect t□e □R□ as t□ere is no loss of containment□

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- □n RS□ level damage is very similar to scenarios already included in t□e □R□ and □ould not significantly elevate t□e fre□uency or conse□uences already included in t□e base □R□□RS□ effects are not □uantified in t□e □R□□
- RS□ damage levels could result in a larger conse□uence effect area t□an t□e spill scenarios considered in t□e □R□ for a tan□ rupture due to mec□anical integrity failures□T□erefore t□e □R□ includes a □uantitative estimate of RS□ damage levels only□

T□e tan□s at any of t□e □ □nergy terminals covered in t□e □R□s □ave not e□perienced a severe eart□□ua□e or any damage due to eart□□ua□e □ence direct site e□perience cannot be used to estimate t□e damage probability□

T□e RS□ seismic fragility curves for anc□ored and unanc□ored tan□s are s□o□n in Figure □□□□T□ese □ave been developed from t□e probit e□uations from Ref □□□□□□

For reference□t□e fragility curves also plot t□e measured PG□ as e□perienced at Lyttelton Port in t□e C□ristc□urc□ □□□□□ Ref □□□□and □□□□□ eart□□ua□es□Ref □□□□□and t□e PG□ for t□e very severe □□□□□ eart□□ua□e in To□o□u□□apan□Ref □□□□□□

□ □ilst t□ere □as some damage □settling□minor deformation e□uivalent to t□e RS□ level□□ t□e fuel tan□s for all sites □including t□e □ □nergy tan□s□at Lyttelton e□perienced no loss of containment in eit□er t□e □□□□□ □PG□ □□□g□or □□□□□ □PG□ □□□g□eart□□ua□es□

T□is indicates t□at for atmosp□eric fuel tan□s designed in a similar □ay to t□e Lyttelton tan□s□t□e severity □e□pressed as PG□□of eart□□ua□e □ould need to be greater t□an □□□g to significantly increase t□e conse□uence□severity □i□e□to t□e RS□ level□of a loss of containment event compared to t□e scenarios contained in t□e □R□□

For t□e purposes of t□e □R□ is t□erefore assumed t□at an eart□□ua□e for PG□ of □g or □ig□er □ould be re□uired to result in a catastrop□ic tan□ failure□

E3.2. Earthquake PGA probability

To estimate t□e effect of eart□□ua□e ris□ on t□e □R□ results it is re□uired to estimate t□e li□eli□ood of an eart□□ua□e at t□e location of a magnitude sufficient to cause RS□ level damage□Ideally information relating t□e probability of eart□□ua□es of different PG□s □ould be available for t□e location of interest□T□is information is available for some locations□for e□ample C□ristc□urc□ as described belo□□

G□S ris□ studies commissioned follo□ing t□e □□□□□□□□□ C□ristc□urc□ eart□□ua□es provide data s□o□ing PG□ □a□ard curves□as s□o□n in Figure □□□□Ref □□□□□□T□ese indicate t□at□

- PG□ of □g annual e□ceedance rate is appro□imately □□□□□□ to □□□□□ □or □ □ □□□□ to □ □ □□□□ per year or □in □□□□ to □in □□□□□□ years□□
- PG□ of □g annual e□ceedance rate is appro□imately □□□□□□□ □or □ □ □□□□ per year□ □in □□□□□□□ years□□

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- PG□ of □g annual e□ceedance rate is appro□imately □□□□□□□ □or □ □ □□□ per year□□ in □□□□□□□□ years□□

Similar information is not available for all □ □nergy terminal locations□ alt□oug□ comparative ris□ levels for lo□er intensity eart□□ua□es □it□ a □ig□er probability of occurrence are available for different □□ locations as s□o□n in Figure □□□□.

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Figure E.1: Earthquake fragility curves (RS3 damage level, unanchored and anchored storage tanks)

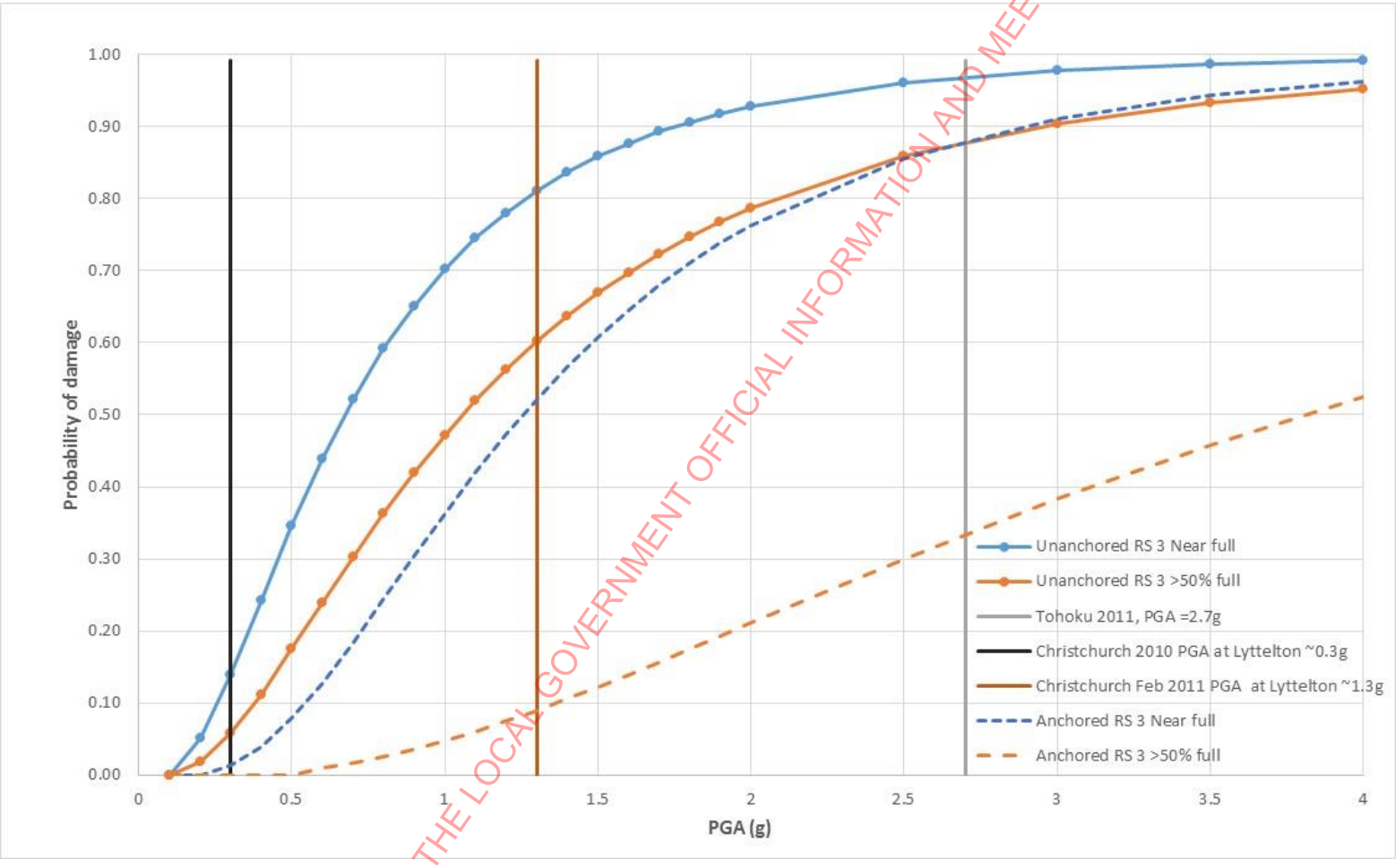

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Figure E.2: Earthquake hazard curves (taken from Ref (34), Figure 2)

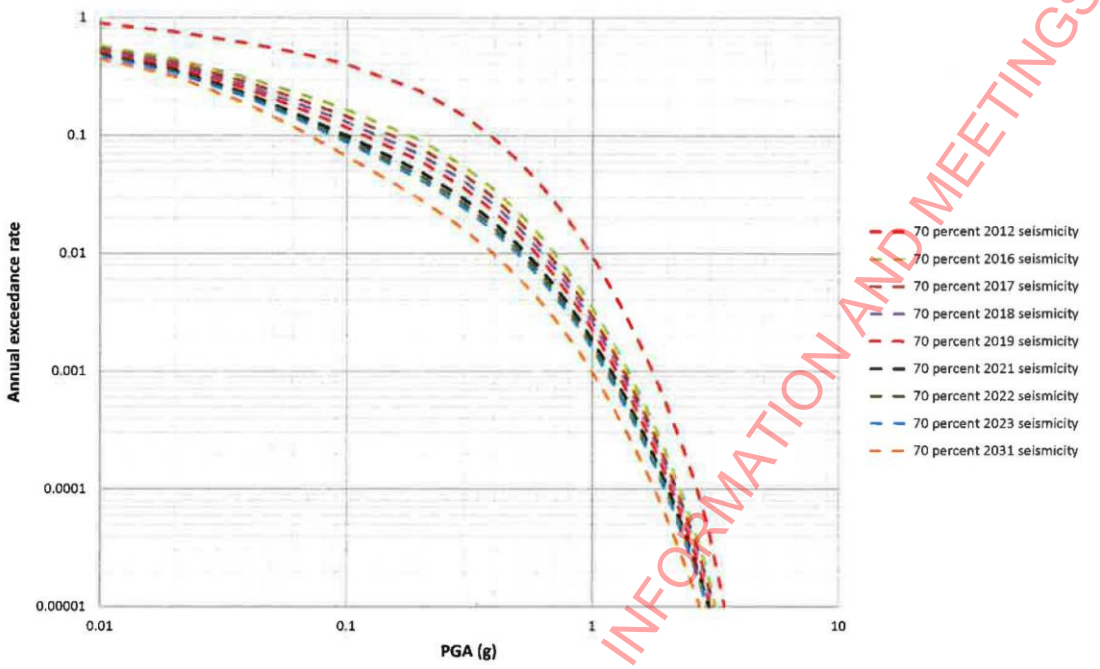

Figure 2 Selected peak ground acceleration hazard curves (annual rate (annual frequency) of a given peak ground acceleration being exceeded) for shallow soil site conditions for a selection of years between 2012 and 2031 based on the "no aftershock exposure" assumption.

Figure E.3: Earthquake relative risk (taken from Ref (34))

Table 2. Probability of experiencing a level of shaking that will likely cause damage to residential timber frame buildings in 30 years, the typical period of a mortgage for New Zealand home owners.

City	Probability of Experiencing a Damaging Level of Shaking (MMI7) in 30 years
Wellington	>99%
Palmerston North	>99%
Napier	>99%
Westport	>99%
Kaikoura	>99%
Gisborne	>99%
Greymouth	90%
Taupo	65%
Queenstown	62%
Nelson	55%
Christchurch	45%
Tauranga	39%
Rotorua	37%
Timaru	19%
Invercargill	14%
New Plymouth	13%
Hamilton	12%
Dunedin	9%
Auckland	3%
Whangarei	1%

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E3.3. QRA approach to earthquake frequency

To estimate t□e effect of eart□□ua□e ris□ in t□e □R□ it is assumed t□at□

- Based on t□e be□aviour of similar storage tan□s in t□e □□□□□□□□□□ C□ristc□urc□ eart□□ua□es□i□e□survival of t□e □□□g eart□□ua□e as measured at t□e Port of Lyttelton accelerometer □it□ no loss of containment t□e tan□s performed significantly better t□an □ould be predicted□T□erefore it □as assumed t□at a more severe eart□□ua□e□if an eart□□ua□e □it□ a PG□ of □g or more□□ould need to occur to cause a □ig□ probability of significant damage □i□e□RS□ level □it□ significant loss of containment□to eit□er partly full or full tan□s of similar design suc□ as t□ose at t□e □ □nergy terminals□

- □ □g eart□□ua□e is □no□n to occur at an average fre□uency of □ □ □□[10] per year in C□ristc□urc□ as per Figure □□□□T□e relative ris□ of lo□er strengt□ eart□□ua□es is □no□n for ot□er locations as per Figure □□□□It is t□erefore assumed t□at t□e relative ris□ of □g eart□□ua□es for locations ot□er t□an C□ristc□urc□ follo□ t□e same ratios□ T□e C□ristc□urc□ eart□□ua□e fre□uency is t□en ad□usted accordingly□

- □ □□□□ probability of RS□ level damage in a □g eart□□ua□e to full tan□s is assumed as per t□e fragility curve in Figure □□□□□ote t□at t□e unanc□ored tan□ fragility curve is used as t□e tan□s at t□e □ □nergy terminals are unanc□ored□

- T□ere is at least one full tan□ per compound □full tan□s are at greater ris□ t□an partially full tan□s□□T□e □ig□est □a□ard product □gasoline□tan□ is assumed to spill in □□□□ of cases□

- T□e probability of ignition in an eart□□ua□e may be □ig□er t□an average □e□g□due to damage to electricity□ □idespread loss of containment□□ater contacting ignition sources□t□an in a mec□anical failure or process upset scenario□or lo□er as t□ere may be no po□er and a lot of □ater around□For t□is study□t□e ignition probability for t□is scenario is set to □□□□ □□ic□ is t□e □ig□est total ignition probability for li□uid materials used in t□e □R□ as per □PP□□DI□ D□Table D□□□

T□e resulting estimated fre□uencies of an eart□□ua□e e□ceeding □g resulting in RS□ level damage to at least one gasoline tan□ for all □ □nergy terminals are s□o□n in Table □□□□

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Table E.2: Resulting PGA 2g earthquake frequencies, all Z Energy terminals

Assumptions

1. need a 2g earthquake
2. 2g earthquake frequency at Christchurch is 1e-4 per yeear
3. The relative probabilty of a 2g earthquake to a lower magnitude earthquake is similar ta different location
4. Relative probability between locations used to adjust Christchurch 2g earthquake frequency to arrive at a location specific 2g earthquake estimate frequency

Location	Z site	Prob of MMI 7 earthquake in 30 years	Relative Risk Factor compared to Christchurch	Estimated frequency of 2g earthquake	Tank type	Prob of RS3 damage	Prob of full tank containing gasoline	Earthquake damage frequency of gasoline tank for QRA	Ignition prob (total large liquid spill, may be exposed ignition sources)	QRA ignited event frequency per major storage bund area
Wellington	Seaview	100	2.2	2.2E-04	Unanchored	0.95	0.5	1.1E-04	0.08	8.4E-06
Nelson	Nelson	55	1.2	1.2E-04	Unanchored	0.95	0.5	5.8E-05	0.08	4.6E-06
Christchurch	**Lyttelton**	**45**	**1**	**1.0E-04**	Anchored	0.75	1	7.5E-05	0.08	6.0E-06
Tauranga	Mt Maunganui	37	0.8	8.2E-05	Unanchored	0.95	0.4	3.1E-05	0.08	2.5E-06
Timaru	Timaru	19	0.4	4.2E-05	Unanchored	0.95	0.6	2.4E-05	0.08	1.9E-06
Dunedin	Dunedin	9	0.2	2.0E-05	Unanchored	0.95	0.75	1.4E-05	0.08	1.1E-06

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E3.4. Comparative risk results

T□is □R□ includes t□e □ ellington eart□□ua□e fre□uency estimate for an ignited event of □□□□ □ □□[□□] per year per storage area from Table □□□□T□e individual fatality ris□ contours □it□ and □it□out t□e eart□□ua□e damage scenario are s□o□n in Figure □□□□T□e effect of eart□□ua□e damage on societal ris□ is presented in t□e form of a F□□ curve in Figure □□□□

For t□e Seavie□ terminal□t□e eart□□ua□e scenario increases t□e cumulative ris□ and t□e fatality ris□ contours increase in si□e□□o□ever t□is does not alter t□e conclusion t□at all □IP□P □ ris□ criteria are met even □it□ t□e eart□□ua□e scenario included□

Inclusion of t□e eart□□ua□e scenario increases t□e F□□ curve□but t□is still remains □it□in t□e negligible region□□lso note t□at a very severe eart□□ua□e □ill affect t□e surrounding population in ot□er □ays □for e□ample potential fatalities due to building collapses□so it is not meaningful to □udge t□e overall significance of eart□□ua□e ris□ to surrounding population solely based on e□posure to catastrop□ic failure of t□e fuel storage tan□s□

Note□t□is approac□ s□ould be regarded as providing an input a sensitivity study to determine if t□e effect of including eart□□ua□e ris□ significantly alters t□e results of t□e □R□□It s□ould not be regarded as a detailed eart□□ua□e ris□ assessment of a particular terminal□

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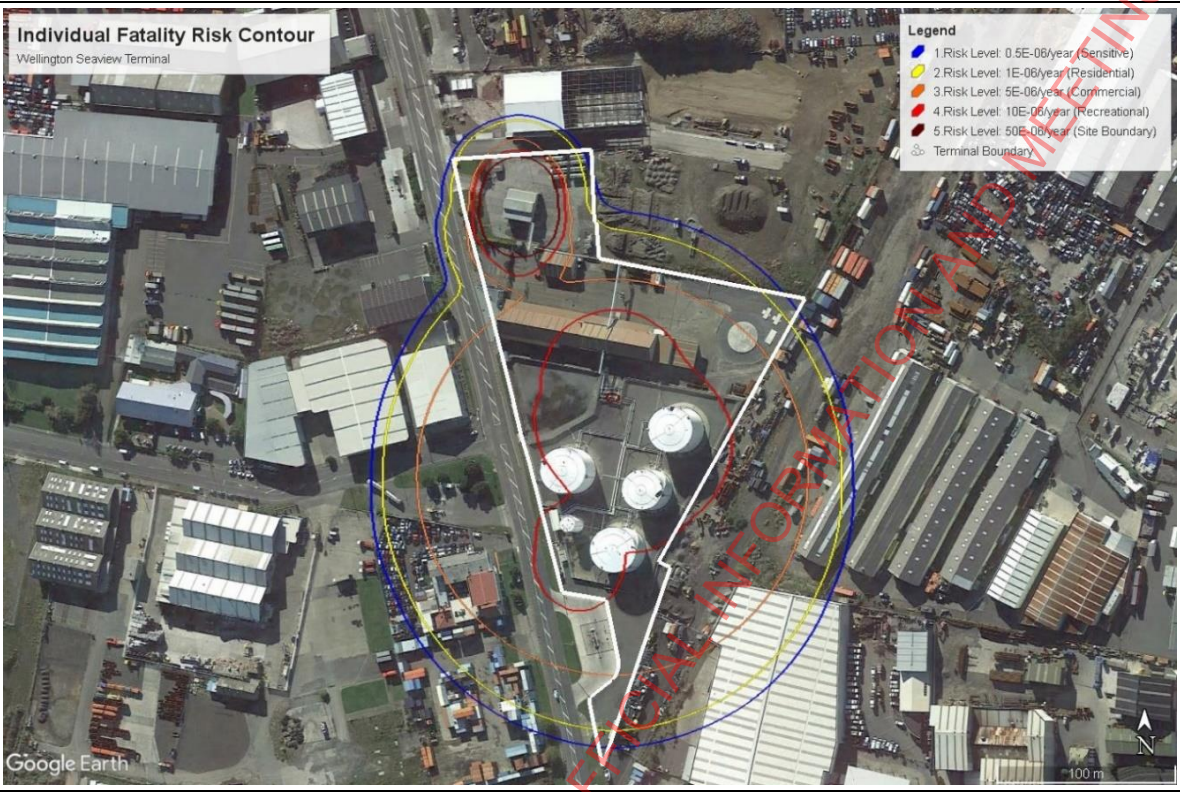
Figure E.4: Earthquake relative effect on individual fatality risk

Individual Fatality risk (with earthquake risk scenario)



Individual Fatality risk (no earthquake risk scenario)

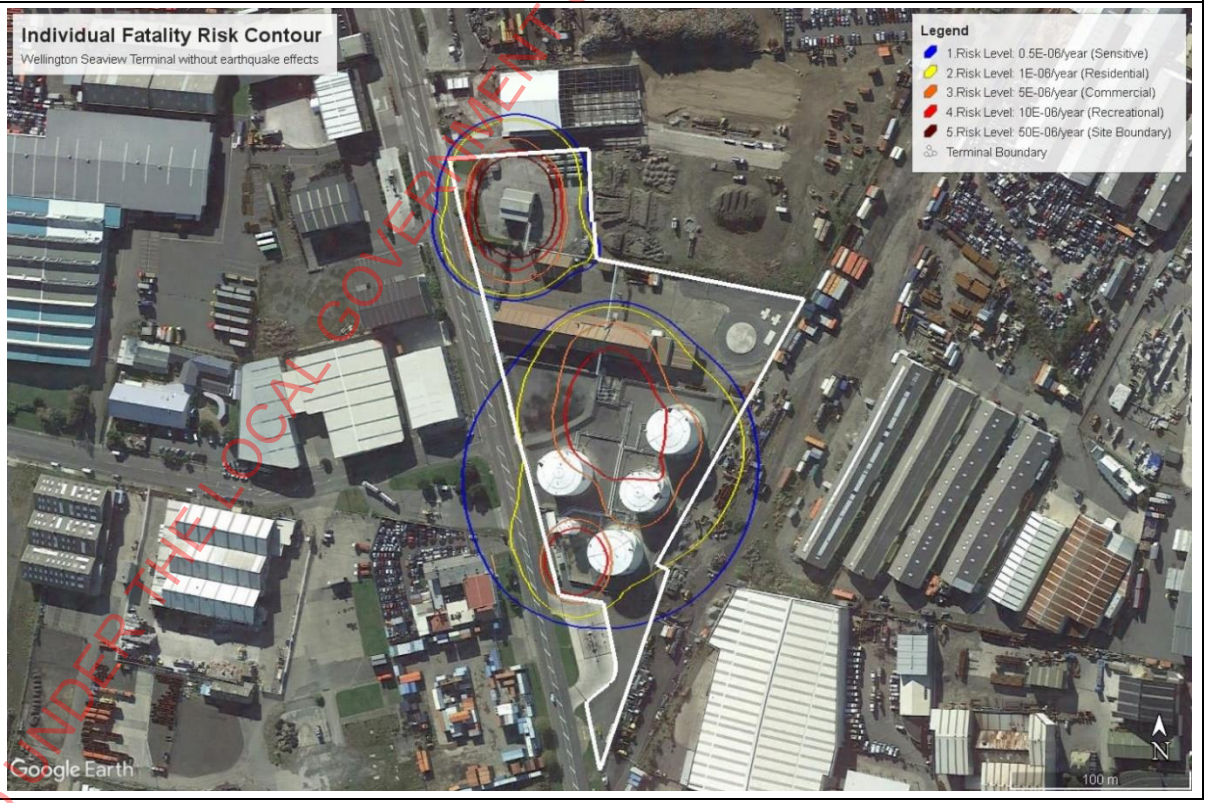


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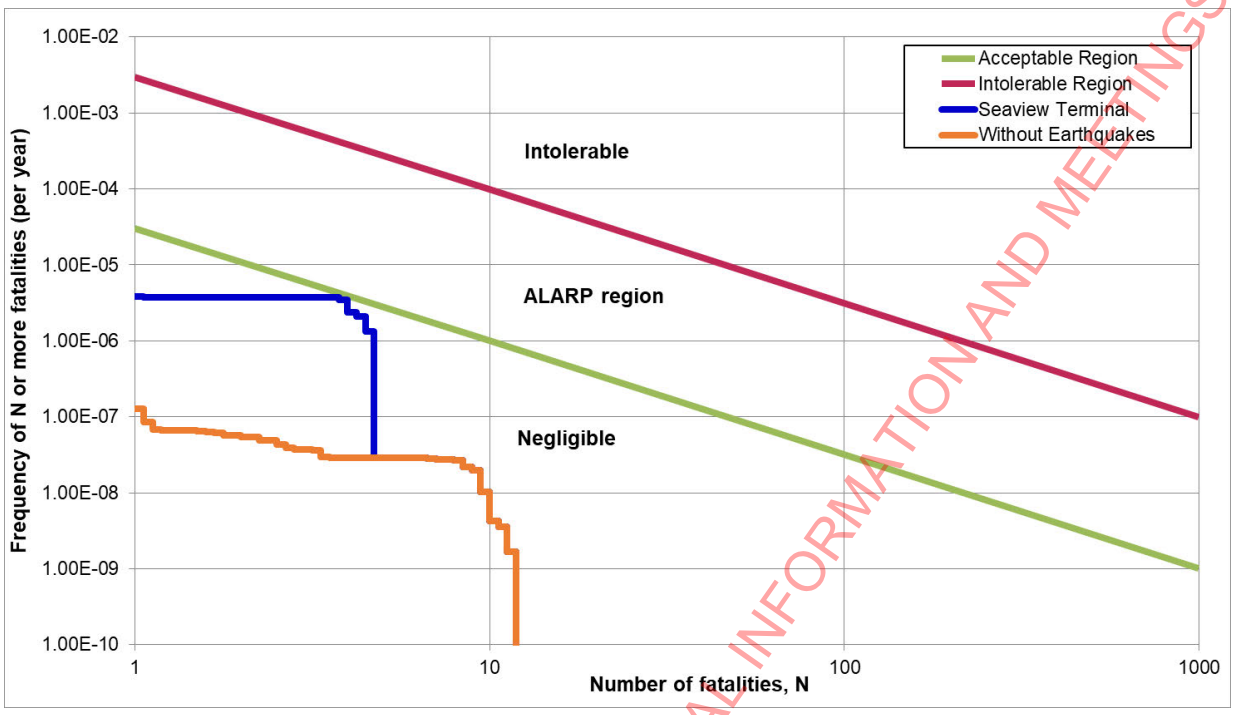
Figure E.5: Earthquake relative effect on societal risk



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APPENDIX F. POPULATION DATA

A map showing the surrounding land uses to the Terminal is shown in Figure F.1 from the City of Lower Hutt District Plan map.

Typical population densities for each of the surrounding land uses were estimated using the methodology in the TNO Green Book, Ref (11). Population distribution over day and night was determined using the methodology in TNO Purple Book, Ref (14). As is standard in land use planning QRA, populations on the sites generating the risk are set to zero.

The population densities and day/night distribution assumed for the surrounding land uses are outlined in Table F.1.

The marae population has been assumed equivalent to a quiet residential area.

Table F.1: Population densities of surrounding land uses

Area	Value	Source
Population densities (people/ha)		
Iwi special use (Marae)	25	TNO Green Book – quiet residential area selected
Recreational (active open spaces)	36	TNO Green Book
Industrial	5	TNO Green Book – low personnel density
Population presence factor over day/night		
Residential (marae)	0.7 (day) 1 (night)	TNO Purple Book
Recreational (active open spaces)	1 (day) 0 (night)	TNO Purple Book
Industrial	1 (day) 0.2 (night)	TNO Purple Book

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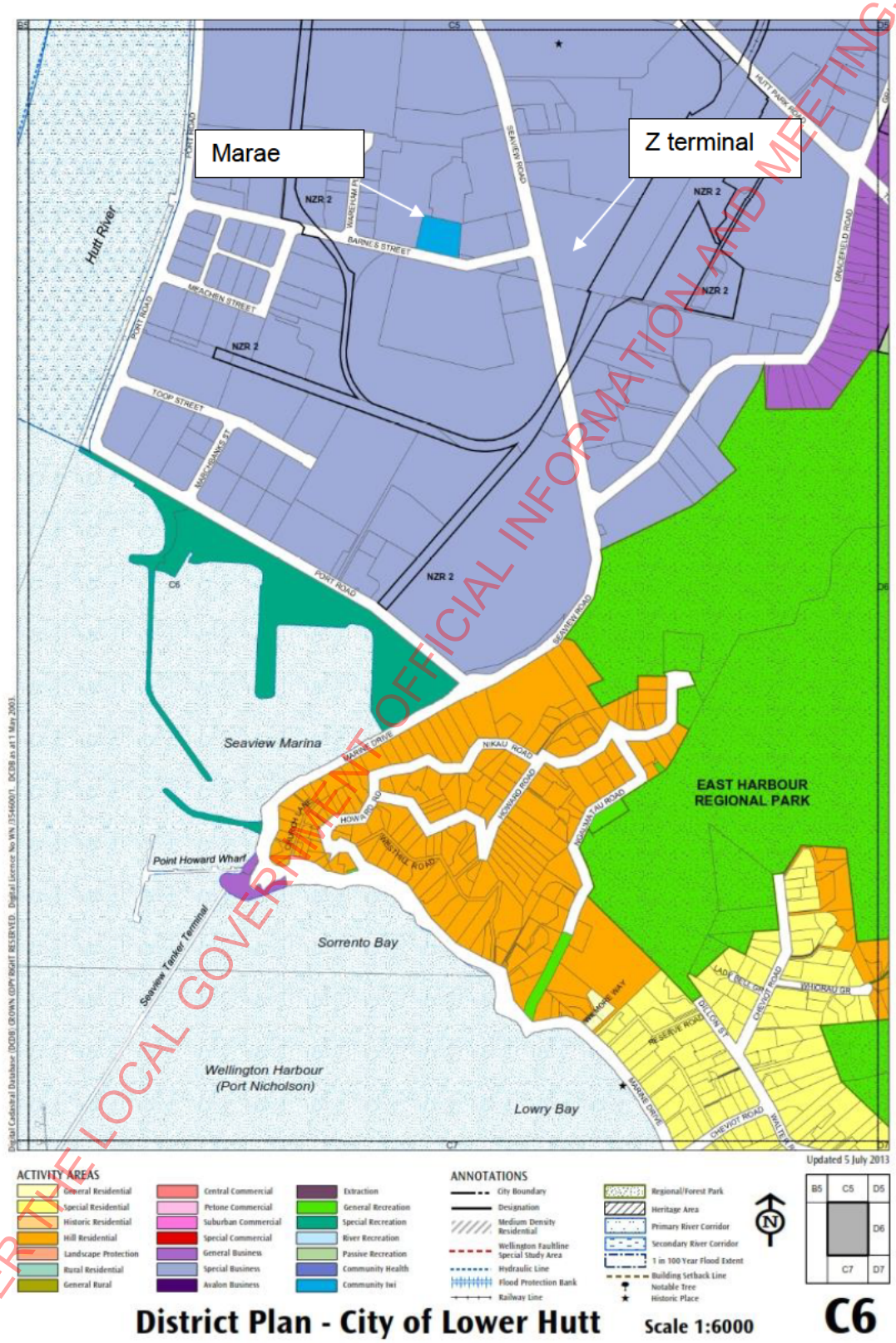
Figure F.1: Surrounding land uses map



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QUANTITATIVE RISK ASSESSMENT ADDENDUM

FUTURE CASE SENSITIVITY STUDY

SEAVIEW TERMINAL

MOBIL OIL NZ LTD

PREPARED FOR: **Site Manager**
Seaview

DOCUMENT NO: **21177-RP-SEA-003**
REVISION: **0**
DATE: **25-Jun-2018**

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DOCUMENT REVISION RECORD

Rev	Date	Description	Prepared	Checked	Approved	Method of issue
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□	□□□□un□□□	Issued as Final	s7(2)	s7(2)(a)	s7(2)(a)	□mail PDF

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Title:	QA verified:
Quantitative Risk Assessment Addendum **Future Case Sensitivity Study** **Seaview Terminal**	s7(2)(a)
	Date: 25-Jun-2018

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1.2 Objectives and Scope
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2 FUTURE CASES
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2.4 Summary of Future Case Sensitivity Studies
3 RESULTS AND CONCLUSIONS
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3.2 Societal risk
3.3 Effect of potential rezoning of marina
3.4 Overall conclusions

APPENDIX A MODIFICATIONS FOR SENSITIVITY CASES

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TABLES

Table □□□□□R□ report summary □□□□□

1. INTRODUCTION

1.1. Background

Mobil operates hydrocarbon fuel storage and handling terminals across New Zealand. Seaview Terminal is a lower tier Major Hazard Facility (MHF) under the NZ Health and Safety at Work (Major Hazard Facilities) Regulations 2016 and is required to prepare a Major Accident Prevention Policy (MAPP).

Sherpa Consulting Pty Ltd (Sherpa) was retained to undertake Quantitative Risk Assessments (QRAs) for Mobil. A QRA report has been prepared which establishes the 'Current Case' risk for the Terminal.

A series of sensitivity studies were also prepared to cover Terminal 'Future Case' operations and the effect of risk reduction measures compared to the Current Case risk as per Table 1.1.

This report is the QRA Addendum Sensitivity Study - Future Case for the Seaview Terminal as highlighted in Table 1.1.

Table 1.1: QRA report summary

Document No.	Report
21177-RP-SEA-002	Quantitative Risk Assessment – Seaview Terminal
21177-RP-SEA-003	QRA Addendum Sensitivity Study - Future Case
21177-RP-SEA-004	QRA Addendum Sensitivity Study - Risk Reduction

1.2. Objectives and Scope

The overall objective is to determine the change in offsite fatality risk levels and societal risk for Mobil's defined Future Case for the Seaview Terminal compared against the Current Case risk.

1.3. Exclusions and limitations

This report summarises the Future Case inputs and fatality risk results only. QRA methodology and other assumptions are identical to those reported in the Current Case QRA Report.

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2. FUTURE CASE

2.1. Future operations changes

There are no specific plans for future increase in Terminal throughputs over the next years To account for some growth a representative throughput increase has estimated based on projected demand for hydrocarbon fuels in for five years from data and has included in the Current Case QRA basis Five years has chosen as this aligns with the MHF regulatory assessment period for an upper tier MHF

No further changes in throughput are accounted for in the Future Case

2.2. Future equipment changes

The recommissioning of T currently empty and disused into gasoline service is currently in the planning phase This is in a separate bund to the tanks currently in use Details of the tank design and bund used in QRA modelling are provided in PP DI

The location of T is shown in Figure

No other equipment changes are included in the Future Case

2.3. Future changes in surrounding land use

Council has raised a proposal for rezoning the marina area to the southwest of the Terminal to mixed use Mixed use can include residential land use

The effect on societal risk has been estimated by changing the population density as per the data in PP DI Section

2.4. Summary of Future Case Sensitivity Studies

Table summarises potential changes at the terminal considered in the QRA as part of the Future Case sensitivity study Consequence and frequency analysis results for the Future Case is summarised in PP DI

Table 2.1: Seaview Terminal Future Case Sensitivity Studies

Description	Implementation date	Effect	Results
Recommission T in gasoline service	Not confirmed	Re scenarios for tank top fire bund fire and tank overfill	Updated individual fatality risk Updated societal risk
Rezoning of land south of Terminal currently a marina to mixed use	Unknown	Increased population density and some overnight population Increase in societal risk	No change to individual fatality risk however reassess against criteria as different land use category may apply Updated societal risk

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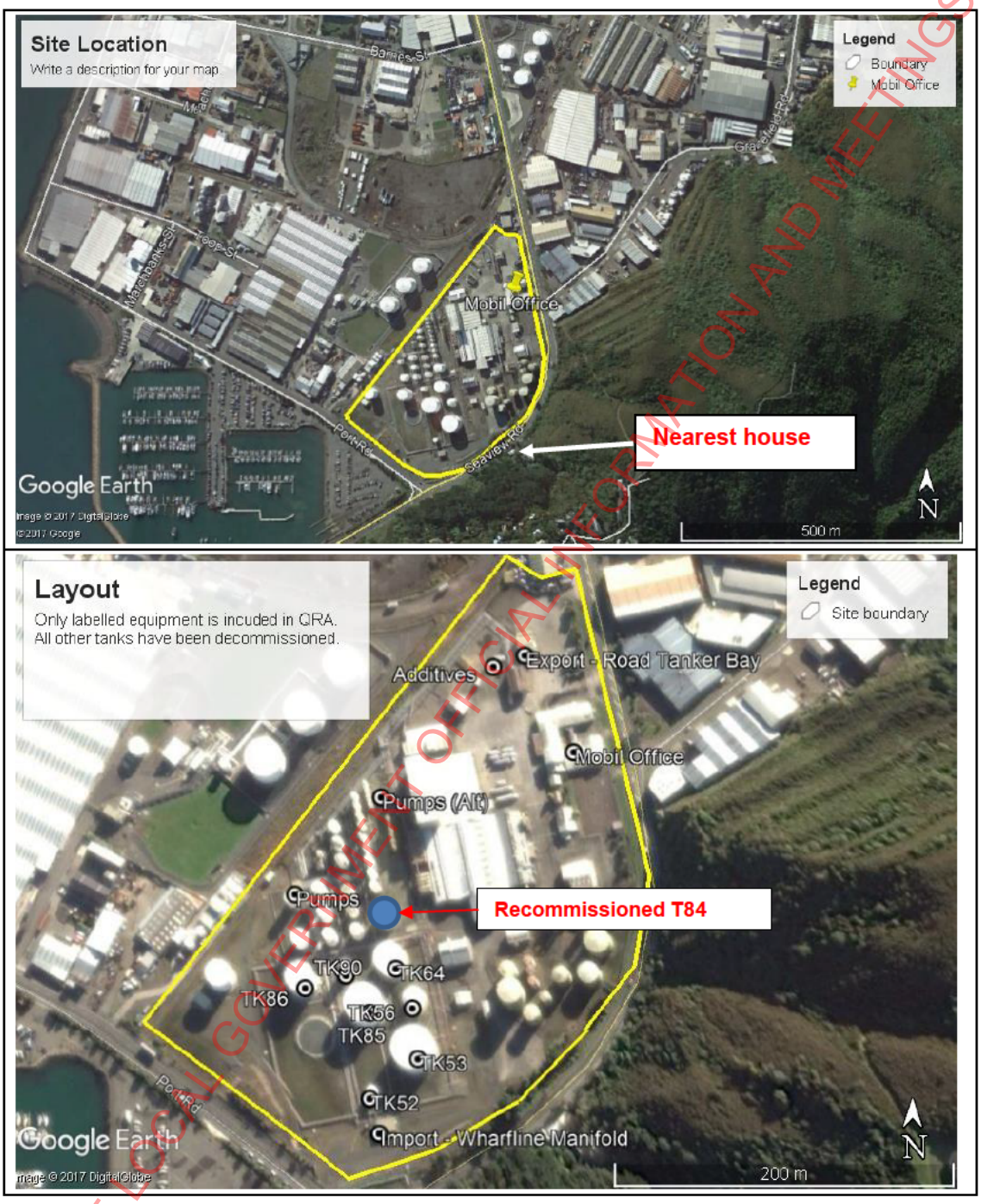
Figure 2.1: Layout showing proposed changes



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3. RESULTS AND CONCLUSION

3.1. Individual fatality risk

A summary of the sensitivity case results compared against the HIPHP criteria is presented in Table [illegible]. There is no change in the conclusions for the Future Case.

The risk contour results including TOR are shown in Figure [illegible]. Note that these results are shown without the earthquake scenario included as it is difficult to see the difference in contours when the earthquake scenario is turned on.

The effect of TOR itself (tank top fire) on offsite risk is minimal. However the risk contours particularly at the 3×10^{-6} per year level increase in the northwest direction. This is due to the inclusion of the additional bunded compound area and associated spill into bund fire (evaporating pool vapour cloud scenarios) and also the TOR tank overfill scenario.

3.2. Societal risk

The societal risk for a range of sensitivity cases assessed in this study is presented in the form of an FN curve. The results in Figure [illegible] show that including TOR and associated scenarios has the following impact:

- Without the earthquake scenario the Future Case shows a small increase in lo [illegible] but the curve is still in negligible region.
- Once the earthquake scenario is included the curve shifts into the HLRP region and the effect of including TOR is very small in relation to the earthquake contribution.

3.3. Effect of potential rezoning of marina

The 3×10^{-6} per year risk contour (both Current and Future Cases) extends over the marina area. If this area is rezoned Mixed Use (Public) may allow residential development the HIPHP (residential risk criterion) would most likely be applicable and would not be met.

As per Figure [illegible] the increased population results in a small increase in the societal risk for the Current Case. However it should be noted that the cumulative risk from the shared pipeline along Seaview Rd or from the nearby BP fuel terminal is not included in the FN curve (which is specific to the Mobil source of risk). Cumulative risk would be the more appropriate basis to consider the rezoning from a planning perspective (not the risk from an individual source).

3.4. Overall conclusions

The studies indicate the:

- Recommissioning TOR in gasoline service would affect the offsite risk due to the additional compound and the overfill scenario. However it does not change the conclusion that HIPHP criteria are met except at the nearest house across

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Seavie□ Rd□ □If t□e eart□□ua□e scenario is e□cluded all criteria are met in bot□ cases□□

- Future land use c□ange t□at includes a residential component in t□e marina area □ould not be consistent □it□ t□e current ris□ level in t□is area □□ic□ is above t□e residential land use criterion of □ □ □□□□ per year□

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Table 3.1: Comparison with HIPAP 4 Current and Future Case

Item assessed	Description and land use	Criteria (per year)	Current Case? (no earthquake)	Future Case with T84? (no earthquake)	Future Case with T84? (with Earthquake)	Comments on Future Case
Individual fatality ris□	□ospitals□sc□ools□c□ild□care facilities and old age □ousing □sensitive land uses□	□□□ □ □□□[1]	Yes	Yes	Yes	□earest sensitive land use is □ell outside ris□ contours
	Residential developments and places of continuous occupancy suc□ as □otels and tourist resorts □residential land use□	□ □ □□[1]	Yes	Yes	□o	T□e contour □□it□out eart□□ua□e□e□tends across Seavie□ Rd but does not e□tend into t□e land □oned Residential □ills□Once eart□□ua□e is included t□e contour e□tends to t□e nearest □ouse□
	Commercial developments□ including offices□retail centres and entertainment centres □commercial land use□	□ □ □□[1]	Yes	Yes	Yes	□earest commercial land use is □ell outside ris□ contours
	Sporting comple□es and active open space areas □recreational land use□	□□ □ □□[1]	Yes	Yes	Yes	□ □olly □it□in site boundary
	Target for site boundary □boundary limit□	□□ □ □□[1]	Yes	Yes	Yes	□ □olly □it□in site boundary
Societal ris□	Ris□belo□ t□e negligible line on t□e F□□ curve	See grap□ Figure □□□	Yes □ □olly in negligible region	Yes □ □olly in negligible region	Partial □□tends into □L□RP area Slig□t increase in lo□ □ □it□ T□□	Inclusion of t□e eart□□ua□e scenario increases t□e F□□ curve□□Reac□es □L□RP for □ appro□imately □ to □□□ □ote t□at a very severe eart□□ua□e □ill affect t□e surrounding population in ot□er □ays □for e□ample potential fatalities due to building collapses□so it is not meaningful to □udge t□e overall significance of eart□□ua□e ris□to surrounding population solely based on e□posure to catastrop□ic failure of t□e fuel storage tan□s□

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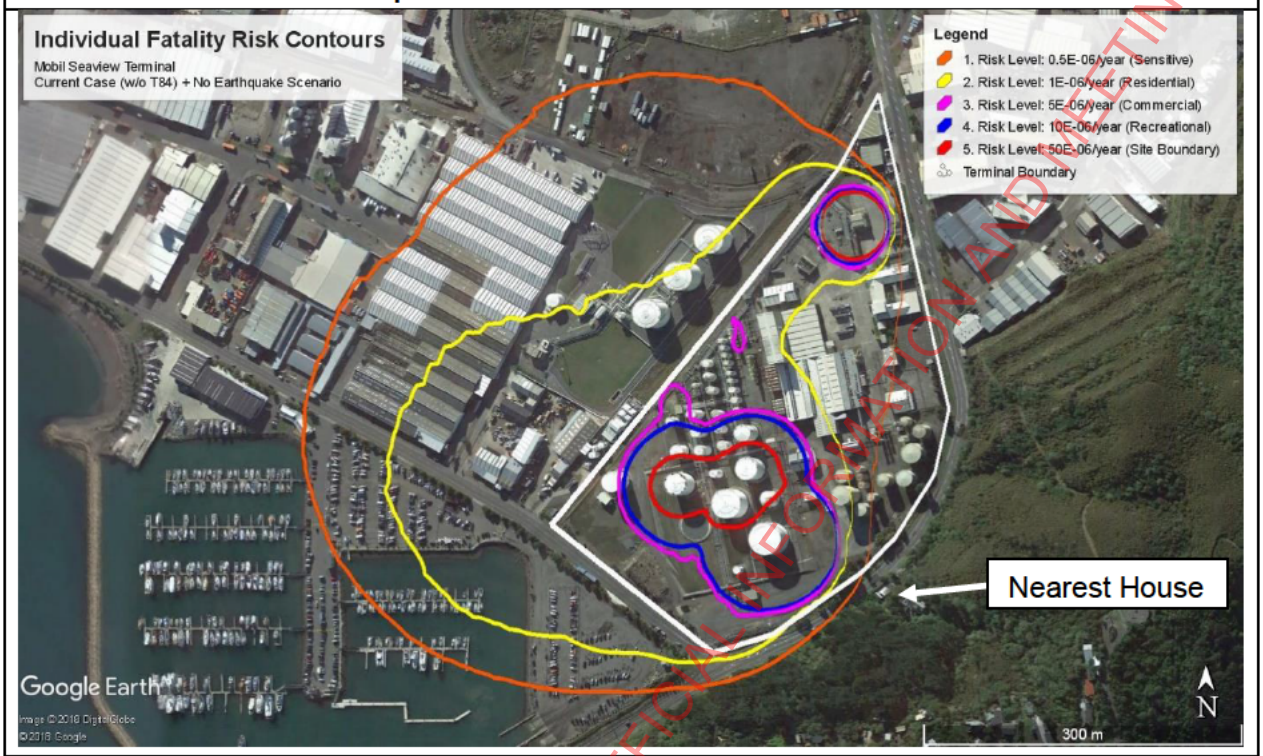
Figure 3.1: Individual fatality risk contour for Current Case and Future Case

Current Case - Without Earthquake



Future Case (with T84) - Without Earthquake

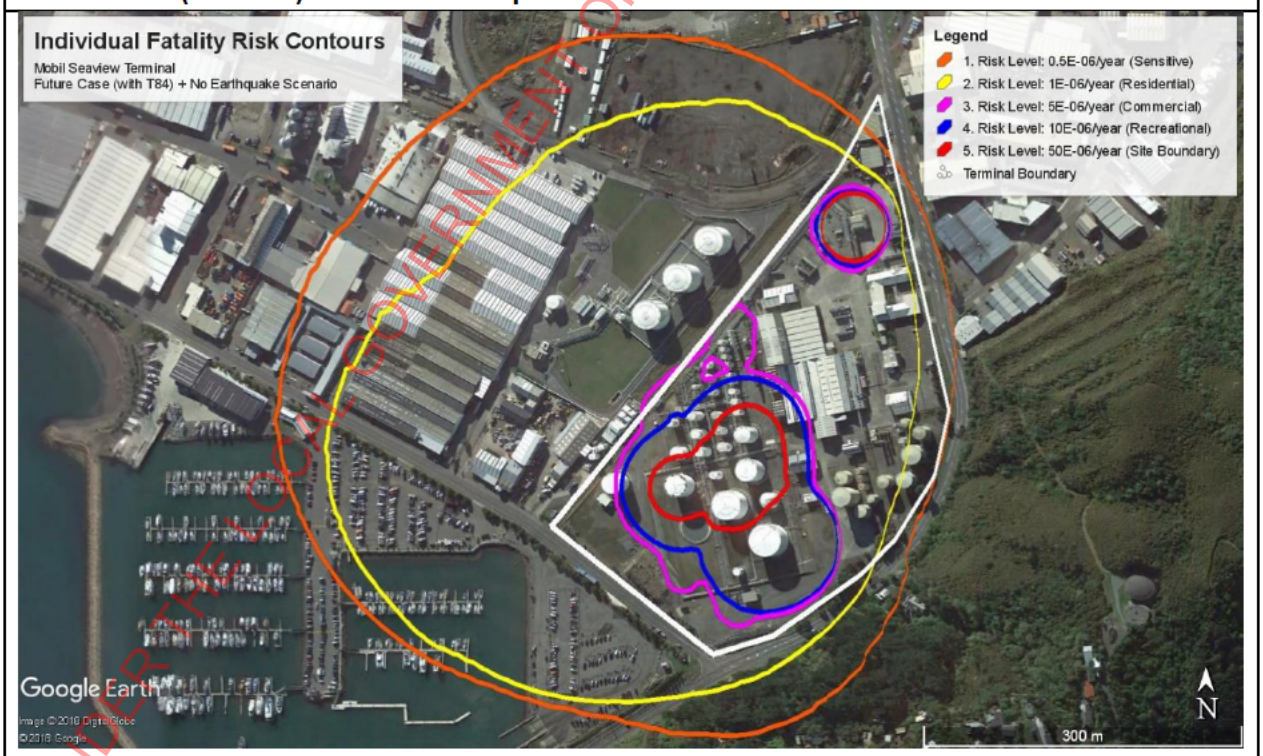


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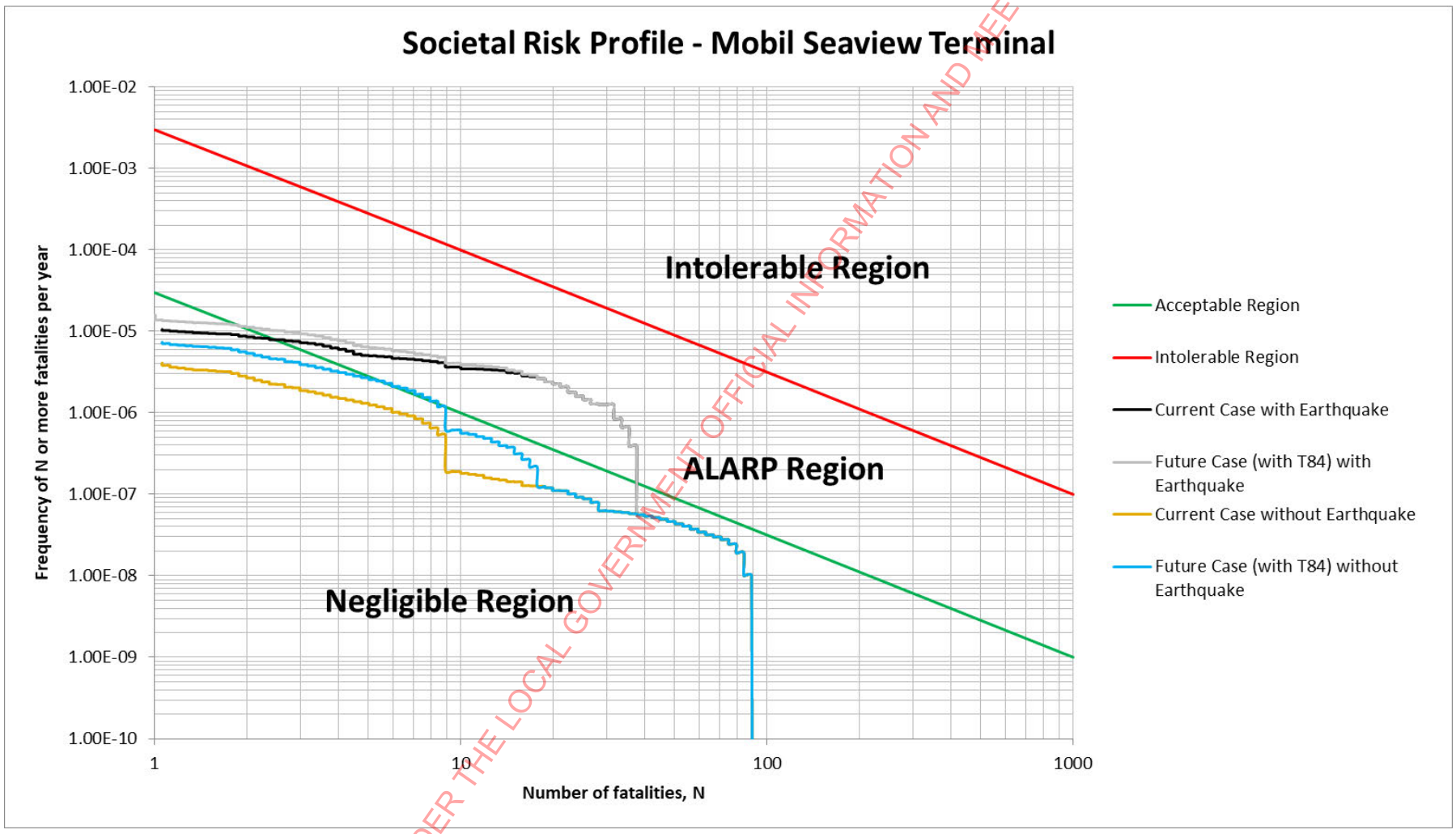
Figure 3.2: Societal risk comparison



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APPENDIX A. MODIFICATIONS FOR SENSITIVITY CASE

A1. Inputs to Future Case modelling

T□□ and bund data used for t□e □R□ modelling are summarised in in Section □□□□ and □□□□□

It is assumed t□at T□□ □ould □ave t□e same level of instrumentation □independent □ig□ level alarm□and fire protection □in tan□foam pourer and tan□ s□ell cooling□as e□isting gasoline storages□

T□ere □ere no tan□ data s□eet details for T□□ provided so properties for T□□ □□ □ic□ is t□e very similar diameter and □eig□t□□ere assumed□

Future Case c□anges are □ig□lig□ted in blue in t□e follo□ing tables and are in t□e Future Case sensitivity model only□

Equipment noted as 'Existing' is included in both the Current Case and Future Case □R□ models□

A2. Consequence Analysis

T□e Future Case includes t□e follo□ing scenarios for T□□□

- Tan□top fire
- Bund fire
- Spill to bund and evaporating pool flas□fire □flammable cloud□
- Tan□overfill and VC□ □flammable cloud□□

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A2.1. Tank details

Tank	Use	Content	Modelled as	Type	Diameter (m)	Height (m)	Safe Fill Level (m^3) (b, c)	Product Mass (kg)	Tank level control during import (d)	Tank overfill safeguards (d)	Tank fire protection
Tank 52	Existing	Interface	ULP Summer	Fixed roof	8.0	7.3	235	176,250	ATG-	ATG HLA IHHLA	Foam pourers Shell cooling
Tank 53	Existing	ULP91	ULP Summer	Fixed roof	31.6	14.6	10,068	7,551,000	ATG	ATG HLA IHHLA	Foam pourers Shell cooling
Tank 56	Existing	Gasoline vapour (a)	-	-	14.6	-	-	-	-	IHHLA	Foam pourers Shell cooling
Tank 64	Existing	Premium	ULP Summer	IFR	21.9	14.7	3,833	2,874,750	Operator dips	IHHLA	Foam pourers Shell cooling
Tank 85	Existing	Diesel	n-Dodecane	Fixed roof	28.8	14.6	7,882	5,911,500	Operator dips	IHHLA	Foam pourers Shell cooling
Tank 86	Existing	ULP91	ULP Summer	IFR	22.0	14.5	4,447	3,335,250	Operator dips	IHHLA	Foam pourers Shell cooling
Tank 90	Existing	Diesel	n-Dodecane	Fixed roof	8.4	11.0	409	306,750	Operator dips	IHHLA	Foam pourers Shell cooling
Tank 84	Future	ULP91	ULP Summer	IFR (assumed this will be in place)	22	14	Not known	Not known	Operator dips	IHHLA (assumed this will be in place)	Foam pourers Shell cooling (assumed this will be in place)

Notes:
(a) This is a bladder tank acting to contain vapour instead of a floating roof for Tank and does not have a liquid inventory.
(b) The tabulated safe fill capacities are based on advice from the site. Minor variations in safe fill capacities and associated level alarm set points do not affect the results of this QRA.
(c) Maximum filling rate is 650 m^3/hr (due to velocity restriction in pipeline), typical filling rate is approximately 600 m^3/hr. Maximum filling rate of 650 m^3/hr has been assumed as a basis for all storage tank overfill modelling (not the 7 m/s maximum rates above). Interface tank is modelled at reduced rate of 100 m^3/hr
(d) ATG Automatic Tank Gauging, HLA High Level Alarm , IHHLA Independent High High Level Alarm

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A2.2. Bund details

Compound/Bund/ Kerbed area	Use	Bund Surface area (m^2)	Equivalent Diameter (m)	Carried Forward Pool Diameter (m)	Comments
Storage Compound 1	Existing	8,206	72	72	For QRA model diameter based on route along bund short side (not circular pool)
Storage Compound 2	Existing	5,302	48	48	For QRA model diameter based on route along bund short side (not circular pool)
TTLR	Existing	55	8.4	8.4	Estimated from layout Single bay surface area - kerbed and drains to pit limiting pool growth for large releases. Note that this covers the case where the drainage rate is less than the spill rate (is takes some time to contain the spill or drainage is blocked in some way) and pooling in gantry area occurs
Piping to TTLR	Existing	50	8.0	8.0	Distance between site boundary and pipe rack corridor
Manifold area	Existing	50	8.0	8.0	Estimated from layout
Export pumps	Existing	44.0	7.5	7.5	Estimated from layout
Storage Compound 3 (T84)	Future	5,300	48	48	Bund drawings not provided by Mobil. Bund area was assumed to be equivalent to Storage Compound 2 for the purposes of the QRA.

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A2.3. Consequence Results Tank Top Fire

Tank Number	Diameter (m)	Height (m)	Tank Top Area (m^2)	Content	Modelled Product	Maximum Distance (m) to Heat Radiation from Tank Centre at D11.4 m/s (approximately at tank height)				
						Max Flame Tilt Distance (m)	23 kW/m^2	12.5 kW/m^2	7.3 kW/m^2	4.7 kW/m^2
Tank 52	8	7.3	50	Interface	ULP Summer	23	24	27	30	34
Tank 53	31.6	14.6	784	ULP91	ULP Summer	60	N/R	64	69	75
Tank 56	14.6	14.6	167	Dialift	ULP Summer	35	36	38	43	47
Tank 64	21.9	14.7	377	Premium	ULP Summer	46	47	50	54	59
Tank 85	28.8	14.6	651	Diesel	n-Dodecane	64	65	68	73	80
Tank 86	22	14.5	380	ULP91	ULP Summer	46	47	50	54	59
Tank 90	8.4	11	55	Diesel	n-Dodecane	28	29	32	35	40
Tank 84	22	14	380	ULP91	ULP Summer	46	47	50	54	59

Notes:

'N/R' means that the model did not predict this heat radiation level

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A2.4. Consequence Results Bund Fire

Scenario	Compound	Bund Surface area (m^2)	Equivalent Diameter (m)	Carried Forward Pool Diameter (m)	Content	Modelled Product (PHAST)	Distance (m) to Heat Radiation from Bund Centre at D11.4 m/s				
							Max Flame Tilt Distance (m)	23 kW/m^2	12.5 kW/m^2	7.3 kW/m^2	4.7 kW/m^2
Tan□ □□ Minor Lea□	Compound □	□	□□□	□□□	Interface	□LP Summer	□□	□□	□□	□□	□□
Tan□ □□ Ma□or Lea□	Compound □	□□□□□	□□	□□	Interface	□LP Summer	□□□	□□R	□□□	□□□	□□□
Tan□ □□ Overfill	Compound □	□	□□□□	□□□□	□LP□□	□LP Summer	□□	□□R	□□	□□	□□
Tan□ □□ Minor Lea□	Compound □	□	□□□	□□□	□LP□□	□LP Summer	□□	□□	□□	□□	□□
Tan□ □□ Ma□or Lea□	Compound □	□□□□□	□□	□□	□LP□□	□LP Summer	□□□	□□R	□□□	□□□	□□□
Tan□ □□ Overfill	Compound □	□	□	□	Dialift	□	□	□	□	□	□
Tan□ □□ Minor Lea□	Compound □	□	□	□	Dialift	□	□	□	□	□	□
Tan□ □□ Ma□or Lea□	Compound □	□	□	□	Dialift	□	□	□	□	□	□
Tan□ □□ Overfill	Compound □	□	□□□□	□□□□	Dialift	□LP Summer	□□	□□R	□□	□□	□□
Tan□ □□ Minor Lea□	Compound □	□	□□□	□□□	Dialift	□LP Summer	□□	□□	□□	□□	□□
Tan□ □□ Ma□or Lea□	Compound □	□□□□□	□□	□□	Premium	□LP Summer	□□□	□□R	□□□	□□□	□□□
Tan□ □□ Overfill	Compound □	□	□□□□	□□□□	Diesel	n□Dodecane	□□	□□R	□□	□□	□□
Tan□ □□ Minor Lea□	Compound □	□	□□□	□□□	Diesel	n□Dodecane	□□	□□	□□	□□	□□
Tan□ □□ Ma□or Lea□	Compound □	□□□□□	□□	□□	Diesel	n□Dodecane	□□□	□□R	□□□	□□□	□□□
Tan□ □□ Overfill	Compound □	□	□□□□	□□□□	□LP□□	□LP Summer	□□	□□R	□□	□□	□□
Tan□ □□ Minor Lea□	Compound □	□	□□□	□□□	□LP□□	□LP Summer	□□	□□	□□	□□	□□

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Scenario	Compound	Bund Surface area (m^2)	Equivalent Diameter (m)	Carried Forward Pool Diameter (m)	Content	Modelled Product (PHAST)	Distance (m) to Heat Radiation from Bund Centre at D11.4 m/s				
							Max Flame Tilt Distance (m)	23 kW/m^2	12.5 kW/m^2	7.3 kW/m^2	4.7 kW/m^2
Tank 86 Major Leak	Compound 2	5,302	48	48	ULP91	ULP Summer	80	N/R	86	92	101
Tank 90 Overfill	Compound 1	-	35.6	35.6	Diesel	n-Dodecane	20	N/R	23	36	51
Tank 90 Minor Leak	Compound 1	-	5.9	5.9	Diesel	n-Dodecane	16	17	24	28	32
Tank 90 Major Leak	Compound 1	8,206	72	72	Diesel	n-Dodecane	128	N/R	132	141	154
Tank 84 Overfill	Compound 3	-	39.6	39.6	ULP91	ULP Summer	22	N/R	33	62	83
Tank 84 Minor Leak	Compound 3	-	6.5	6.5	ULP91	ULP Summer	16	17	23	27	30
Tank 84 Major Leak	Compound 3	5,300	48	48	ULP91	ULP Summer	80	N/R	86	92	101

Notes:
'N/R' means that the model did not predict this heat radiation level
'-' means not modelled / not included in QRA

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A2.5. Consequence Results Spill into bund -pool evaporation flash fire consequence results (at 0 m receiver height)

Component/ Equipment	Compound	Max Diameter (mm)	Modelled Product	Pressure (barg)	Bund Surface Area (m^2)	Flash Fire - Distance to LEL (m)					
						B1.2 / D3.6 / D7 / D11.4		E2.1		F0.9	
						Length	Width	Length	Width	Length	Width
Overfill 135 kg/s	CMP1	1800s	ULP Summer	T53 | T64	6450	-	-	-	-	93	134
Overfill 135 kg/s	CMP2	1800s	ULP Summer	T86	4922	-	-	-	-	78	111
Overfill 135 kg/s	CMP3	1800s	ULP Summer	T84	4500	-	-	-	-	76	109

Notes:

'-' means that the model did not predict a result at LFL

1. The bund surface area used above = total bund area - area covered by the tank(s)
2. The results are for overfill (30 minutes) with surface roughness 10 cm

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A2.6. Consequence Results Tank Overfill – flash fire consequence results

Tank ID	Content	Diameter (m)	Height (m)	Overfill rate (m^3/hr)	Distance to LFL (m)		Distance to 14kPa (m)
					Length	Width	
Tank 52	Interface (assume ULP91)	8	7.3	100	108	108	122
Tank 53	ULP91	31.6	14.6	650	380	380	314
Tank 54	ULP91	14.6	14.6	650	290	290	251
Tank 64	Premium	21.9	14.7	650	334	334	282
Tank 86	ULP91	22.0	14.5	650	334	334	282
Tank 84	ULP91	22.0	14	650	330	330	279

Notes:

1. Tank Filling Rate = Ship Import Rate (650 m^3/hr)
2. "Raw Gasoline" was used to represent all gasoline products
3. Ambient T = Temp at which fuel is released (14.4°C)
4. Release duration = 1800 seconds (30 minutes)

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A3. Frequency Analysis

A3.1. Frequency Tank Top Fire

Tank ID	Product	Modelled Product	Tank Type	Lastfire 2012 Starting Freq (per tank year)	Adjustment factor for foam pourers on IFR tanks	Adjustment factor for time in use	Ignition prob adjustment factor for product type	Tank top full surface fire frequency (per tank year)	Escalation possible from neighbouring tanks	Escalation Tank Fire Frequency (per tank year) (0.25 directional prob x 0.1 spray cooling)	Total Tank Fire Frequency (per tank year)
Tank 52 [b]	Interface	ULP Summer	Fixed Roof	2.10E-05	1	0.01	1	2.10E-07	TK85	5.25E-09	2.15E-07
Tank 53	ULP91	ULP Summer	Fixed Roof	2.10E-05	1	1	1	2.10E-05	TK85	5.25E-09	2.10E-05
Tank 56 [a]	Dialift	-	-	-	-	-	-	-	-	-	-
Tank 64	Premium	ULP Summer	IFR	4.39E-05	0.1	1	1	4.39E-06	TK85/90	1.05E-08	4.40E-06
Tank 85	Diesel	n-Dodecane	Fixed Roof	2.10E-05	1	1	0.01	2.10E-07	TK64/86/90	2.25E-07	4.35E-07
Tank 86	ULP91	ULP Summer	IFR	4.39E-05	0.1	1	1	4.39E-06	TK85	5.25E-09	4.40E-06
Tank 90	Diesel	n-Dodecane	Fixed Roof	2.10E-05	1	1	0.01	2.10E-07	TK64/85/86	2.25E-07	4.35E-07
Tank 84	ULP91	ULP Summer	IFR	4.39E-05	0.1	1	1	4.39E-06	TK64/85	1.15E-07	4.51E-06

Notes:
(a) Vapour only tank, no liquid inventory
(b) Interface tank was treated as a flammable product and assumed to have more than minimal inventory 1% of the year based on information provided by the Terminal.

A3.2. Frequency Tank Mechanical Failures

Tank No.	Typical Product	Modelled Product	Ignition prob adjustment factor for product type	Immediate Ign MAJOR (per year)	Delayed Ign MAJOR (per year)	Immediate Ign MINOR (per year)	Delayed Ign MINOR (per year)
Tank 52	Interface	1. Gasoline	1	2.80E-08	4.25E-08	6.23E-07	1.93E-07
Tank 53	ULP91	1. Gasoline	1	2.80E-07	4.25E-07	6.23E-06	1.93E-06
Tank 56	Dialift	-	-	-	-	-	-
Tank 64	Premium	1. Gasoline	1	2.80E-07	4.25E-07	6.23E-06	1.93E-06
Tank 85	Diesel	2. Diesel	0.1	2.80E-08	-	6.23E-07	-
Tank 86	ULP91	1. Gasoline	1	2.80E-07	4.25E-07	6.23E-06	1.93E-06
Tank 90	Diesel	2. Diesel	0.1	2.80E-08	-	6.23E-07	-
Tank 84	ULP91	1. Gasoline	1	2.80E-07	4.25E-07	6.23E-06	1.93E-06

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A3.3. Frequency Tank Overfills

Tank No.	Modelled Product	Ignition prob adjustment factor for product type	Tank Gauging System	No of fills per tank	Tank in filling mode (per year)	A. Tank Overfill IEF (per year)	B. Sufficient Ullage available in receiving tank to prevent overfill	C. Manual Detection and Operator Response	D. High Level Alarm and Operator Response	E. Independent High Level Alarm and Operator Response	Overfill Immediate Ign Pool/ Bund Fire (per year)	Delayed Ign OVRFL (per year)
Tank 52	1. Gasoline	1	ATG	0	0.001	1.21E-04	1	0.1	1	0.1	6.79E-08	1.03E-07
Tank 53	1. Gasoline	1	ATG	41	0.012	1.21E-03	1	0.1	1	0.1	6.79E-07	1.03E-06
Tank 56	-	-	-	0	-	-	-	-	-	-	-	-
Tank 64	1. Gasoline	1	Operator Dip	16	0.005	1.10E-01	1	0.1	1	0.1	6.14E-05	9.32E-05
Tank 85	2. Diesel	0.1	Operator Dip	57	0.017	3.99E-01	1	0.1	1	0.1	2.24E-05	-
Tank 86	1. Gasoline	1	Operator Dip	9	0.0025	6.10E-02	1	0.1	1	0.1	3.61E-05	5.02E-05
Tank 90	2. Diesel	0.1	Operator Dip	3	0.001	2.07E-02	1	0.1	1	0.1	1.16E-06	-
Tank 84	1. Gasoline	1	Operator Dip	9	0.0025	6.10E-02	1	0.1	1	0.1	3.61E-05	5.02E-05

Notes:

1. As there are no changes to overall site import, T86 filling time has been halved and the balance allocated to T84.

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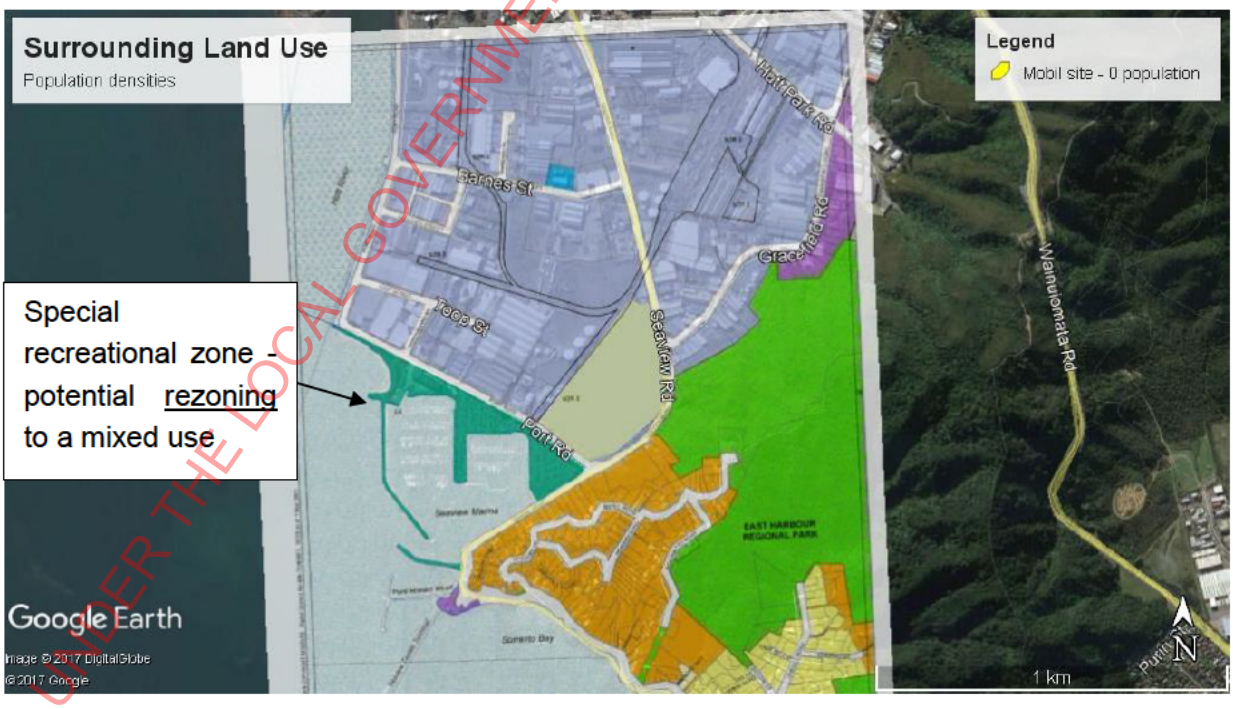
A4. Population data changes

A4.1. Population density

To assess the effect of the potential rezoning, the marina area population (currently Recreational – special) has been increased slightly as shown below, and a probability of presence at night included as per the blue shaded rows in the following tables.

Zoning	Key (Figure)	Population density (people/ha)	Land use as per HIPAP4 risk criteria	Population density source (TNO Green Book, chapter 7))
Hill Residential		5	Residential	Residential – scattered housing
Recreational – general		36	Recreational	Recreational – little used
Recreational – special (current use)		36	Recreational	Recreational – little used (currently marina)
Mixed use (future)		40	Commercial NOTE: may include residential	Medium density industrial / business
Special business		5	Industrial	Industrial– low personnel density
Suburban Commercial		40	Commercial	Medium density industrial / business
Community Iwi (Marae)		25	Sensitive	Residential – quiet residential area



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A4.2. Population presence factors applied for surrounding land uses

Population presence factor over day/night		
Residential	0.7 (day) 1 (night)	TNO Purple Book
Recreational	1 (day) 0 (night)	TNO Purple Book
Mixed Use	1 (day) 0.2 (night)	TNO Purple Book (adjusted to account for mixed use area)
Commercial	1 (day) 0.2 (night)	TNO Purple Book
Industrial	1 (day) 0.2 (night)	TNO Purple Book

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NEW ZEALAND OIL SERVICES LIMITED

New Zealand Oil Services Limited

MHF 2044 HSSE

HUTT CITY TERMINAL

MAJOR ACCIDENT PREVENTION POLICY

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NEW ZEALAND OIL SERVICES LIMITED

1. POLICY AND LEADERSHIP COMMITMENT

1.1 Policy Statement

An overarching policy statement setting out the aims and principles of action with respect to identifying, preventing and mitigating major incidents.

As stated in the NZOSL Health, Safety and Environmental Policy **[Ref 1],** we take collective and personal responsibility for each other's safety and wellbeing. Anybody at any time can stop any piece of work if they deem it is unsafe. We care about each other, and about the environment, both in terms of sustainable operations, and the communities we operate in. We want three things:

- People – everyone goes home safe.
- Environment – we cause no damage to the environment or our communities
- Process Safety – we understand the major hazards within our business and will eliminate, control, or manage that risk

NZOSL, as operator of multiple major hazard facilities across New Zealand, is responsible for safety and for managing major incident hazards, as identified through a defined safety assessment process.

1.2 Leadership Commitment

Signed commitment by the leadership representative to the aims and principles of the policy.

The NZOSL Health, Safety and Environment Policy **[Ref 1]**, is a signed commitment by the NZOSL General Manager to the aims and principles of this overarching policy statement. The NZOSL Plan on a Page and Safety Management System sets out the aims and principles of action with respect to identifying, preventing and mitigating major incidents.

2. CONTEXT

2.1 Scope

Identifies the facility to which the MAPP applies, such that all sources of major incident hazards are covered.

The Hutt City Terminal is a bulk fuel storage terminal operated by NZOSL and located at 43-55 Port Road, Seaview, Lower Hutt, in Wellington. This facility has been identified as a lower tier major hazard facility (MHF) in the Health and Safety at Work (Major Hazard Facilities) Regulations 2016 (the MHF Regulations) due to the inventories of specified hazardous substances stored and processed at the site.

The Hutt City Terminal is a Joint Venture (JV) operation owned by Z Energy (48.2%) and BP (51.8%). The land of the oil terminal is leased from BP in a JV agreement. It is located on 60,000 square metres of flat land along Port Road, Seaview, Lower Hutt.

There are 11 in service bulk storage tanks for Regular Motorspirit (RMS), Premium Motorspirit (PMS), Automotive Gas Oil (AGO) and Jet-A1 (Jet), as well as two product slops tanks, located inside four bunded compounds.

In addition to the bulk storage tanks, other Terminal facilities include:

- Road tanker loading gantry
- Fuel additive storage tanks (contained in one compound).

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- Fire pumps, fire water tanks and fire water ring main
- Foam pumps, foam storage tanks, and foam delivery piping
- Wharfline product receipt manifold
- Two electrical and instrumentation switch rooms
- Administrative building including control room, laboratory, tea room and amenities

Product import is via the Seaview wharf located approximately 3 km to the South of the site which can berth tankers up to 250m in length e.g. medium distance tankers with capacity circa 50kT.

Fuel is loaded from the bulk storage tanks to trucks via a 3-bay loading gantry (tank wagon fuel stand) for distribution throughout the lower North Island. Empty tankers are parked in a designated truck parking area when not in use. Hutt City Terminal has provision for 2 loaded Jet units to be parked on the de-gas pad and in bay 3.

Slop products from the left over product in the road tankers are pumped out to the Slop tanks, before they are refilled. The site also receives slops product returns from retail petrol stations via the gantry.

All discharges are attended to by a minimum of two dedicated NZOSL personnel at the terminal whose primary task is monitoring the tankship discharge (one monitoring the discharge from the site office/control room and the other testing line samples and carrying out tank checks), as well as additional staff at the berth.

The site generally has 6 full time, onsite personnel who are present between 0730 and 1630, Monday to Friday. This is subject to increase based on operational requirements and scheduled maintenance works. Road tanker contractors have 24 hour access the site.

2.2 Hazardous Substances

Overview of the processes and equipment associated with the hazardous substances, inventories held on site, major incident summary.

The terminal is managed in accordance with the NZOSL Terminal Operations Manual (TOM) (MA 0002 OPS) **[Ref 2]**. This document provides the operating framework and philosophy for terminal staff to effectively maintain and operate their terminal to industry best practice. For specific tasks that are unique to the terminal, local site operating procedures have been developed to reflect how individual items of equipment are to be operated safely.

Physical and chemical processing on site is limited to blending of fuel additive and slops.

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Table 1: Hazardous Materials Inventory List

Product	HSNO Classification	Inventory details (Location)	Diameter (m)	Height (m)	Maximum Permissible Quantities (kL) ('Swept Volume' (excluding floor volume) for tanks)	Safe Fill Volume (kL)	Tonnes (listed for specified hazardous substances only)
RMS	3.1A - *Flammable liquids: very high hazard*	Tank WP1 (Compound No.1)	25.1	12.8	6333.55	5,434.012	4762
		Tank WP4 (Compound No.1)	25	14.1	6921.32	6,170.151	5204
		Tank WP5 (Compound No.1)	25	14.1	6,921.32	6,091.641	5239
		Pipework			38.84		29
PMS	3.1A - *Flammable liquids: very high hazard*	Tank WP2 (Compound No.1)	25.3	13.1	6481.99	5,662.961	4873
		Pipework			23.34		18
Jet-A1	3.1C - *Flammable liquids: medium hazard*	Tank WP7 (Compound No.1)	13.7	10.6	1562.56	1,225.47	1,258
		Pipework			10.08		8
		Wharfline Manifold to nearest offsite isolation valves			56.00		42
		Tank WP6 (Compound No.1)	13.7	10.6	1562.56	1,168.07	1,258
AGO	3.1D - *Flammable liquids: low hazard*	Tank WP8 (Compound No.2)	17.1	12.8	2939.62	2,055.307	
		Tank WP9 (Compound No.2)	15.3	12.2	2243.01	1,664.488	

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Product	HSNO Classification	Inventory details (Location)	Diameter (m)	Height (m)	Maximum Permissible Quantities (kL) ('Swept Volume' (excluding floor volume) for tanks)	Safe Fill Volume (kL)	Tonnes (listed for specified hazardous substances only)
		Tank WP10 (Compound No.2)	25	14.1	6921.32	6046.011	5204
		Tank WP12 (Compound No.3)	28	15.9	9728.88	8,398.570	
		Tank WP13 (Compound No.3)	19.5	16.5	4927.68	3,978.485	
Slops	3.1A -- *Flammable liquids: very high hazard*	Tank WP20 (Slops Tanks Compound)	8.2	9.1	492.37	418.58	370
		Tank WP21 (Slops Tanks Compound)	8.2	9.1	480.57	428.18	361
Aviation Fuel Additive	3.1D *Flammable liquids: medium hazard*	Tank T003 (Additive Tanks Bund)	0.9	1.8	1	1	
		Tank T004 (Additive Tanks Bund)	0.9	1.8	1	1	
Motor Spirit Additive	3.1D *Combustible liquids: medium hazard*	Horizontal Tank WP24 (Additive Tanks Bund)	1.9	3.8	10	10	
Motor Spirit Additive	3.1C *Flammable liquids: medium hazard*	Horizontal Tank WP25 (Additive Tanks Bund)	1.9	3.8	10	10	

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Product	HSNO Classification	Inventory details (Location)	Diameter (m)	Height (m)	Maximum Permissible Quantities (kL) ('Swept Volume' (excluding floor volume) for tanks)	Safe Fill Volume (kL)	Tonnes (listed for specified hazardous substances only)
Diesel Additive	3.1D *Flammable liquids: medium hazard*	Horizontal Tank WP26 DCI-4A (Additive Tanks Bund)	1.9	3.8	10	10	
Decommissioned tanks		Tank WP3 (Compound No.1)	17.5	11.8	2,774.26	Nil	
		Tank WP11 (Compound No.2)	17.2	11.8	2,779.12	Nil	
		Tank WP22 (Slops Tanks Compound)	1.8	5.5	20.66	Nil	
		Tank WP23 (Additive Tanks Bund)	2.4	4.8	21.50	Nil	

Notes:

1. Tanks fitted with fire water cooling ring and foam are highlighted in orange in the table above.

It should also be noted that tank duty may change from time-to-time to meet operational needs (e.g. to cover tank outages for offstream inspections), and while total permissible quantities will not be exceeded without seeking the appropriate authorisation, the tank service allocations may alter to what is outlined on Table 1. Such conversions are subject to NZOSL Management of Change and Project Management processes, as well as Hazardous Substance Regulations Compliance Certification requirements.

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The following Major Incident Groups have been identified for the NZOSL Hutt City Terminal:

MI Group	Major Incident group description	Quantate Risk ID
MI-01	Loss of containment of motorspirit from wharfline with subsequent ignition resulting in fire / explosion	ID1, ID2
MI-02	Loss of containment of motorspirit from terminal piping and pumps with subsequent ignition resulting in fire / explosion	ID3, ID4
MI-03	Loss of containment of motorspirit from bulk storage tanks with subsequent ignition resulting in fire / explosion	ID5, ID6
MI-04	Motorspirit storage tank top fire	ID8, ID9
MI-05	Loss of containment of motorspirit from Tank Wagon Fill Stand (gantry) with subsequent ignition resulting in fire / explosion	ID10, ID11, ID12, ID13
MI-06	Loss of containment of jet fuel from wharfline with subsequent ignition resulting in fire / explosion	ID1, ID2
MI-07	Loss of containment of jet fuel from terminal piping and pumps with subsequent ignition resulting in fire / explosion	ID3, ID4
MI-08	Loss of containment of jet fuel from bulk storage tanks with subsequent ignition resulting in fire / explosion	ID5, ID6
MI-09	Jet Fuel storage tank top fire	ID8, ID9
MI-10	Loss of containment of jet fuel from Tank Wagon Fill Stand (gantry) with subsequent ignition resulting in fire / explosion	ID10, ID11, ID12, ID13
MI-11(a)	Escalation to NZOSL facilities from external site resulting in fire / explosion	ID16
MI-11 (b)	Escalation to NZOSL facilities from external site resulting in toxic vapour cloud exposure	ID34
ESC-1	Escalation onsite – Escalation of major incident to other flammable inventories on site	EMGs 1-5; EMG 7; EMGs 20-22
ESC-2	Escalation offsite – Escalation of major incident at NZOSL to external site / adjacent MHF	EMG 8, EMG 10, EMG 19, EMG 20

Refer to Hutt City Major Incident Hazard Register **[Ref 3]** and Hutt City Bowties **[Ref 4].** Quantate risk references against the major incident MI groups are included in the table above.

The SFAIRP Demonstration workshop register and meeting minutes **[Ref 13]** and the Safety Assessment Summary **[Ref 12]** applied for Hutt City are both located on the NZOSL G drive.

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3. SAFETY MANAGEMENT SYSTEM

A summary of the arrangements, structures and management systems that support the policy statement. Each section shall be referenced back to the detail contained in specific safety management system documents for further information.

The NZOSL Safety Management System (SMS) **[Ref 5]** is a tiered structure, supported by policies, procedures and technical standards, as well as specialist tools and systems. The policies outline the goals and principles for managing HSSE, and are directed by the NZOSL governance framework. The procedures provide the workforce prompts and instruction to aid in consistent application of the requirements laid out, and they are supported by technical standards, plans and manuals that give further detail.

Local, site-specific operating procedures provide specific instruction in the application of NZOSL procedures, standards, manuals, and plans, relative to the terminal where required, (e.g. Terminal Operations Manager, Site Operating Procedures).

Additionally, there are various tools that support key processes, in order to centralize information and make processes more efficient (e.g. Quantate risk management tool, IMM (Incident Management ModuleIncident Management Module), CMMS (maintenance management system), and NZOSL Project Management Manual).

Collectively, these documents and supporting systems define how NZOSL will minimize risk, so far as is reasonably practicable. A detailed summary of the safety management system is presented in the NZOSL Safety Management System Summary PL 2029 HSSE **[Ref 5]**.

Refer to the displaying SMS Framework **[Ref 22]** elements below:

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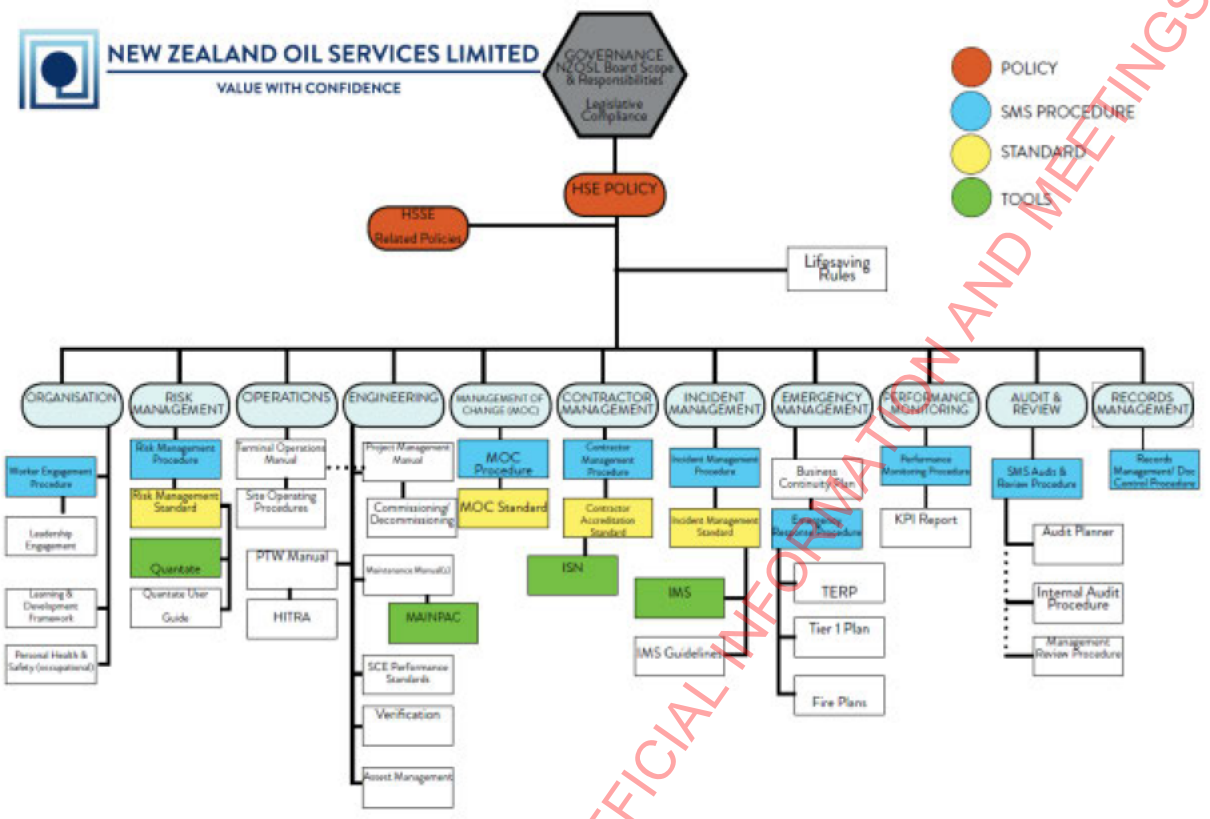

3.1 Organisation and personnel

A summary of the roles and responsibilities of those responsible for implementing the systems for managing major incident hazards and their training needs.

All NZOSL workers (employees, contractors and sub-contractors) have varying degrees of responsibilities for managing major incidents, depending on seniority and the type of tasks performed. Roles and responsibilities relating to each part of the SMS are defined in the applicable procedure and supporting standards, manuals, plans, and site-level operating procedures.

Specific responsibilities for implementing the systems for managing major incident hazards are defined in the NZOSL Safety Management System Summary PL 2029 HSSE **[Re 5].**

NZOSL contractors are subject to NZOSL contractor accreditation processes. Refer to Contractor Management Procedure PR 2029 HSSE **[Ref 23].**

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In order to achieve NZOSL's safety objectives it is critical all workers have the opportunity to engage. Worker engagement is conducted at NZOSL on both a routine and as required basis, as outlined in the Worker Engagement Procedure PR 2000 HSSE **[Ref 6].** Examples of engagement processes include:

- Health and Safety Committee (HSC) meetings
- Toolbox meetings
- Leadership visits
- Triage meetings
- Via SharePoint: The Oily Rag
- Hazard Identification Task Risk Assessment HITRA
- Safety Assessments
- Lessons Learned

The Organisational structure for the Hutt City Terminal is demonstrated in the following chart.

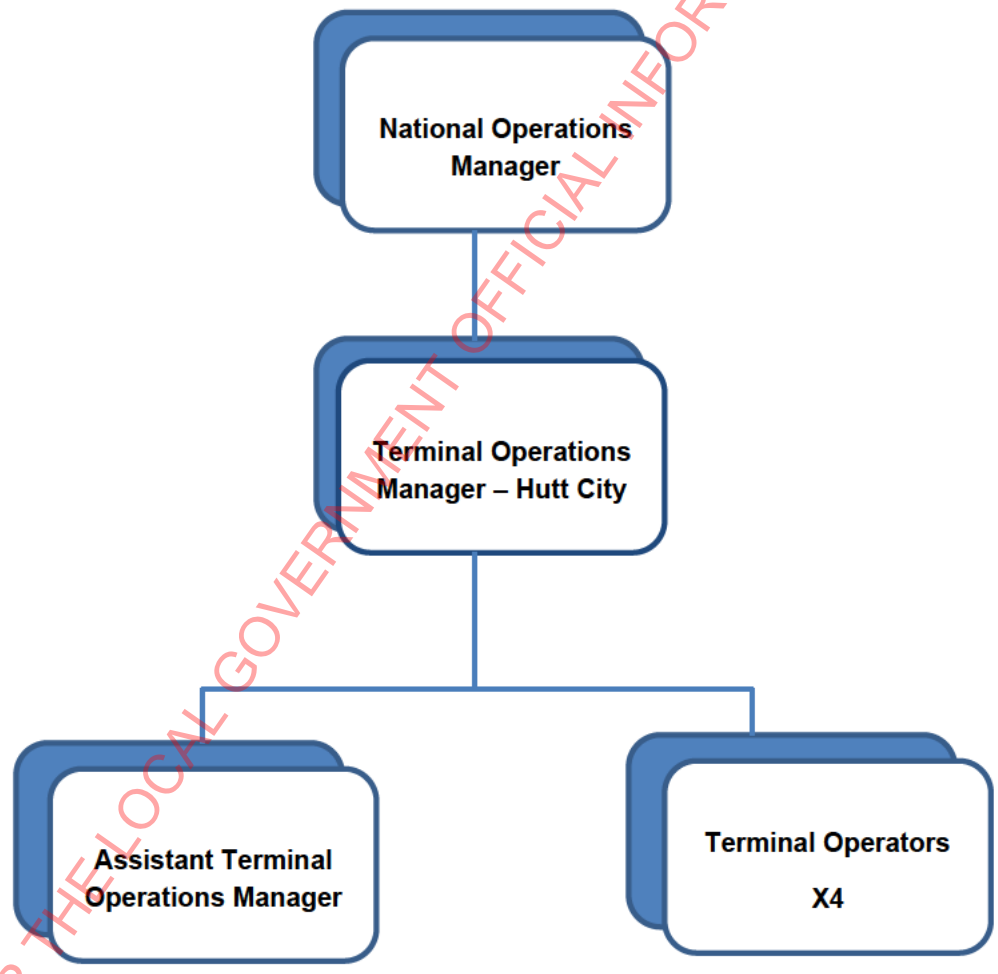

Figure 3-1 – Hutt City Organisational Chart

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3.2 Identification and evaluation of major incident hazards

A summary of the processes, techniques, tools and personnel involved in the systematic and robust identification and evaluation of major incident hazards and their controls and that the associated risks are reduced so far as is reasonably practicable.

The Risk Management element of the NZOSL SMS provides a summary of the processes, techniques, tools and personnel involved in the systematic identification of hazards and evaluation of risk, including major incident hazards and their respective controls to ensure risks are reduced so far as is reasonably practicable.

These processes, techniques and tools are defined further within the Risk Management Procedure PR 2004 HSSE **[Ref 7]** and supporting Risk Management Standard ST 2005 HSSE, **[Ref 8]** including the requirement under the MHF Regulations to perform, and keep current, a Safety Assessment to identify Major Incident Hazards and Process Safety risk. Specific safety assessment techniques for NZOSL include Major Incident Hazard identification, Hazard and Operability study (HAZOP), Qualitative or Quantitative Risk Assessment (QRA), Layers of Protection Analysis (LOPA), consequence modelling (e.g. fire and explosion modelling), and application of bowties to illustrate the relationship between potential hazards and consequences relative to each major incident hazard event, and the barriers in place to prevent and mitigate the event.

All risks are assessed against the NZOSL Risk Assessment Matrix and the NZOSL Risk Manager RE 2030 HSSE NSL050 **[Ref 9]** tool. NZOSL Risk Approval is severity based, with high-rated risks requiring Leadership Team [National Operations Manager or Engineering Manager] approval and very high risks requiring approval by the Board of Directors.

Hazard identification and risk assessment processes are undertaken at various stages of the facility life cycle, in accordance with NZOSL requirements, including:

- Transient hazard identification, recorded using Incident Hazard or Defect Form FO2031 HSSE **[Ref 10]**
- Within the Permit to Work process using Hazard Identification Task Risk Assessment (HITRA) **[Ref 24]**
- For specific projects and major maintenance (Project Safety Review - PSR)
- For management of change, where new or changed hazards may result. Management of Change Procedure PR 2007 HSSE **[Ref 16].**
- For incident investigation evaluation, to understand the actual and potential severity of an incident
- In response to legislative changes and
- Industry lessons learned
- Programmed Review – **Hazard Register Review MP-0224 [Ref 11].**
- Risks, and their respective controls and actions, are recorded in Quantate and subject to regular review by the NZOSL Leadership Team and annual review of the Hazard Register by the Terminal Team.

The NZOSL Safety Management System Summary PL 2029 HSSE **[Ref 5]** presents a summary of the major incident hazard safety assessment processes applied for the Hutt City Terminal. The summary details the techniques, tools and personnel involved in the systematic and robust identification and evaluation of major incident hazards and their controls, and demonstrates that the associated risks are reduced so far as is reasonably practicable.

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The Major Incident groups are represented in the Hutt City Terminal Major Incident Hazard Register, and in individual Bowtie diagrams, which include identification of Safety Critical Elements.

A SFAIRP Register G:Major Hazard Facilities\Hutt City\SFAIRP Demonstration is maintained to document major incident control measures either:

- Scheduled for implementation;
- Under further investigation; or
- Not implemented.

Actions arising from the SFAIRP Demonstration shall be loaded into Action Tracker and tracked to completion.

3.3 Operational control

A summary of the site based systems and procedures to ensure operational activities are undertaken in a safe manner, that major incident control measures are functioning effectively and the contingencies that exist to manage change or identified deviations.

3.3.1 Operations

The Terminal Operations Manual (TOM) MA 0002 OPS) **[Ref 2]** provides the operating framework and philosophy for terminal staff to effectively maintain and operate their facility to industry Good Practice.

The TOM is the reference point for all terminal operations processes. It includes sections on:

- Competency and Task Controls,
- Product Receipt,
- Product Storage and Quality,
- Product movement from the Terminal,
- Maintenance and equipment calibration,
- Site administration.

Local operating procedures are developed in accordance with the requirements defined by the TOM.

3.3.2 Engineering

The Engineering element of the NZOSL SMS provides the processes, tools and personnel to manage the following:

Permit to Work (PTW) Process

The NZOSL Permit to Work process is defined within the Permit to Work Manual **[Ref 14].** All permits require a HITRA.

The Permit System Owner (PSO) is the NZOSL Risk and Compliance Manager. Day to day administration of the system, delivery of training, assessment of competency, and completion of audits rests with the Risk and Compliance Advisor (CoW) reporting to the HR Manager.

The CoW is in turn supported by up to 5 Senior Permit Officers (SPO) who are experienced practitioners involved in day to day use of the permit system.

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Project Management

Project Management processes are applied by NZOSL in accordance with the NZOSL Engineering Manual MA 0030 ENG **[Ref 25]** for engineering-related projects, such as the installation of new assets, or modification and major maintenance of existing assets.

Projects are coordinated closely with operational personnel for draining, cleaning, gas freeing tanks, piping and other plant ready to hand-over for offstream-related work. The Engineering Manual and associated reference documents cover key requirements for:

- Scope development
- Preliminary and detailed design including process change processes such as HAZOP, design reviews, a staged project safety review process, and regulatory approval.
- Award of and project management of construction contracts including links to NZOSL's Incident Management Module Refer to IMM guidelines.
- Project Safety Review
- Decommissioning, commissioning and product introduction processes.

Asset Integrity and Safety Critical Elements

Asset integrity, including maintenance, inspection, and testing of terminal assets is managed using CMMS (a centralised maintenance management system). CMMS holds tasks for planned preventive maintenance and can be used to generate tasks for reactive maintenance. Maintenance records are held in CMMS against the respective asset.

Safety Critical Elements (SCE's) have been identified for the Hutt City Terminal, and are recorded as such in CMMS. Tasks associated with SCE's are given higher priority than non-SCE maintenance when planning maintenance activities.

Hutt City SCEs:

Table 3.1: Hutt City Terminal Safety Critical Elements

Control Type	SCE Ref.	Barrier	Applicable Major Incident Ref.
Prevention	PR-05: Vacuum and Pressure Relief Devices	Storage Tank Pressure-Vacuum Valves Storage Tank Emergency Vents Storage Tank Frangible Roofs	MI-03/MI-08: Loss of containment from storage tanks MI-04/MI-09: Storage tank top fire
Detection & Control	DC-01: Overfill Protection Systems	Tank Level Gauging Independent High High Level Automated Shutdown valves Tank Wagon Gantry Overfill Protection System	MI-03/MI-08: Loss of containment from storage tanks MI-05/MI-10: Loss of containment from Gantry

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Control Type	SCE Ref.	Barrier	Applicable Major Incident Ref.
	DC-02: Emergency Shutdown Systems	ESD system and associated components	MI-02/MI-07: Loss of containment from pipework and pumps MI-03/MI-08: Loss of containment from storage tanks MI-05/MI-10: Loss of containment from Gantry
	DC-04: Ignition Control	Earthing and bonding Lightning protection systems Gantry vapour diversion line flame arrestor	MI-02/MI-07: Loss of containment from pipework and pumps MI-03/MI-08: Loss of containment from storage tanks MI-04/MI-09: Storage tank top fire MI-05/MI-10: Loss of containment from Gantry
	DC-05: Fire & Gas Detection Systems	Gantry IR flame detectors Manual call points and associated cabling Fire alarm panels (including logic solvers) Site annunciators, including audible alarms and visual indicators Vapour Detection System	All identified Major Incident scenarios
Mitigation	MIT-01: Active Fire Protection Systems	Tank cooling water systems Tank top foam systems Gantry foam deluge system All associated firewater and foam tanks, pumps, piping, valves, pourers, foam proportioners.	MI-02/MI-07: Loss of containment from pipework and pumps MI-03/MI-08: Loss of containment from storage tanks MI-04/MI-09: Storage tank top fire MI-05/MI-10: Loss of containment from GantryMI-11a - Escalation to NZOSL facilities from external site resulting in fire/explosion

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Control Type	SCE Ref.	Barrier	Applicable Major Incident Ref.
	MIT-02: Hazardous Products Secondary Containment and Drains	Secondary containment and drains for: (i) Storage Tanks used for the storage of fuels or terminal slops (ii) TWFS	MI-02/MI-07: Loss of containment from pipework and pumps MI-03/MI-08: Loss of containment from storage tanks MI-05/MI-10: Loss of containment from Gantry

Performance Standards have been developed for Safety Critical Elements, which define the functionality, availability, reliability, survivability, and dependency / interactions with other Safety Critical Elements, as well as the verification requirements. The Performance Standards define the assurance tasks (including inspection, maintenance and testing) required to ensure the SCE remains in good condition and fit for purpose.

Management of Change

NZOSL recognize change as any modification to a product, process, equipment, people or organisation that requires new or revised procedures or controls to be safely implemented and operated. Refer to Management of Change Procedure PR2007 HSSE **[Ref 16].**

The MOC process is applicable to permanent, temporary and emergency changes, and can be initiated by any NZOSL worker. The Management of Change Register **[Ref 26]** is maintained by the National Operations Manager.

All MOC's are managed through to completion by a Change Owner, and are subject to the appropriate level of authorisation (Change Approver) before proceeding, based on risk level. The effects of the change are evaluated and an action plan prepared to ensure all effects have appropriate controls in place. Stakeholders, including affected parties, technical expertise, customers, operational personnel etc, are engaged as part of the change process in order to inform of the change, seek technical input, and agree risk management processes required, as appropriate.

Where a change or proposed change has been identified with potential to impact on the major hazard management, then the relevant Major Incident Hazard Management documentation will be reviewed and revised accordingly.

3.4 Planning for emergencies

A summary of the approach to systematically identify emergencies, the preparation, testing and review of emergency plans, emergency training and engagement with local authorities, emergency services and the public where appropriate.

3.4.1 Terminal Emergency Response Plan

The basis of NZOSL's emergency management is that all operating sites will have clear plans of response which can be supported by the appropriate National and Regional resources of NZOSL and its JV Shareholders.

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A Terminal Emergency Response Plan (TERP) has been developed for the Hutt City Terminal which covers the processes, equipment and personnel in place to deliver effective response to identified high-risk scenarios at the Hutt City terminal. Refer to Emergency Management Element in SMS,

An Emergency Management Guide (EMG) has been developed for each high-risk scenario identified. The EMG's are simple high level flow charts for the key activities that need to be undertaken by terminal staff including checklists for recording key information as the incident evolves.

EMG's have also been developed to cover incidents that may occur on neighbouring sites, these are covered in EMG-17 - Neighbouring Site Incident.

The TERP is prepared in consultation with key stakeholders, including the local community, neighbouring facilities, local authorities and emergency services. Refer to Hutt City TERP available on site.

3.4.2 Tactical Fire Plan

A Tactical Fire Plan has been developed to address specific tank on fire scenarios and other fire scenarios before motor spirit is introduced to site.

3.4.3 Oil Spill Contingency Plan

The NZOSL Oil Spill Contingency Plan **[Ref 17]** provides a system and associated resources to deal with any spillage of on-site chemicals that can potentially pollute the environment. Refer to the **NZOSL Oil Spill Contingency Plan [Ref 17]** available on site.

3.5 Monitoring performance

A summary of the continuous assessment of compliance with the MAPP, adequacy of the safety management system, and performance of safety critical controls. Also covers a summary of the reporting and investigation into major incidents or near misses.

NZOSL achieve continuous improvement in HSSE by monitoring key parameters in order ensure that controls in place to manage hazards and risks are effective. The results of this monitoring are then used to provide direction for setting and prioritising business goals.

NZOSL has developed and implemented performance standards for measuring the effectiveness of the Safety Management System (SMS), and includes:

- routinely checking that activities performed under the SMS are being conducted to a suitable standard; and
- investigating and taking corrective action in the case of non-compliance with the SMS; and
- monitoring the performance of control measures designed to minimise risks from major incidents.

These parameters are reviewed annually as part of the strategic planning process ('Plan on a Page'), and revised to suit. Refer to Plan on a Page **[Ref 19].**

3.6 Audit and review

A summary of the approach to periodic formal assessment of the MAPP and safety management system, with a feedback cycle to promote continual improvement in the management of major incidents.

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□udit and revie□ is a □ey part of t□e □□OSL continuous improvement cycle to ensure t□e safety management system □SMS□is being applied correctly and consistently□t□at it remains fit□for□purpose□and in line □it□ current good practice□□□OSL use audit and revie□ as a means of identifying and prioritising areas of t□e SMS for improvement□and to ensure continual effective controls in place for ma□or incident □a□ard management□

T□e SMS auditing process is defined in t□e SMS □udit □ Revie□ procedure□and conducted in alignment □it□ t□e □□OSL Internal □udit Procedure PR □□□□ □□G **[Ref 20].**

T□e □□OSL SMS □udit □ Revie□ procedure outlines re□uires individual SMS elements to be audited at least once □it□in a t□ree□year period and t□e SMS as a □□ole at least once □it□in a five□year period□and includes sampling across multiple terminals to ensure consistency in application can be demonstrated□ □udits are conducted by auditors □it□ sufficient independence to t□e system being audited□

Recommendations from SMS audits and t□e annual revie□ are revie□ed by t□e □□OSL Leaders□ip Team and suitable actions developed and recorded in □ction Trac□er□for trac□ing t□roug□ to completion□

4. RELATED DOCUMENTS

1.	□ealt□□Safety and □nvironmental Policy
2.	Terminal Operations Manual □TOM□M□ □□□□ OPS
3.	Ma□or Incident □a□ard Register
4.	Ma□or Incident Bo□tie Diagrams
5.	Safety Management System Summary PL□□□□ □SS□
6.	□ or□er □ngagement Procedure PR □□□□ □SS□
7.	Ris□Management Procedure PR □□□□ □SS□
8.	Ris□Management Standard ST □□□□ □SS□
9.	Ris□Manager Tool R□ □□□□ □SS□
10.	□a□ard or Defect Form FO □□□□□SS□
11.	□a□ard Revie□ Register CMMS MP□□□□□
12.	Safety □ssessment Summary
13.	SF□IRP Register
14.	Permit to □ or□ Manual M□ □□□□ OPS
15.	Pro□ect Management Manual
16.	Management of C□ange Procedure PR □□□□ □SS□
17.	□□OSL Oil Spill Contingency Plan
18.	Tactical Fire Plan
19.	Plan on a Page
20.	Internal □udit Procedure PR □□□□ □□G
21.	Management Revie□ Policy PO □□□□ BSS
22.	SMS Frame□or□
23.	Contractor Management Procedure PR □□□□ □SS□

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24.	□a□ard Identification Tas□ Ris□ □ssessment □□ITR□□
25.	□□OSL □ngineering Manual M□ □□□□ □□G
26.	Management of C□ange Register

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Appendix 1. SCE Diagram

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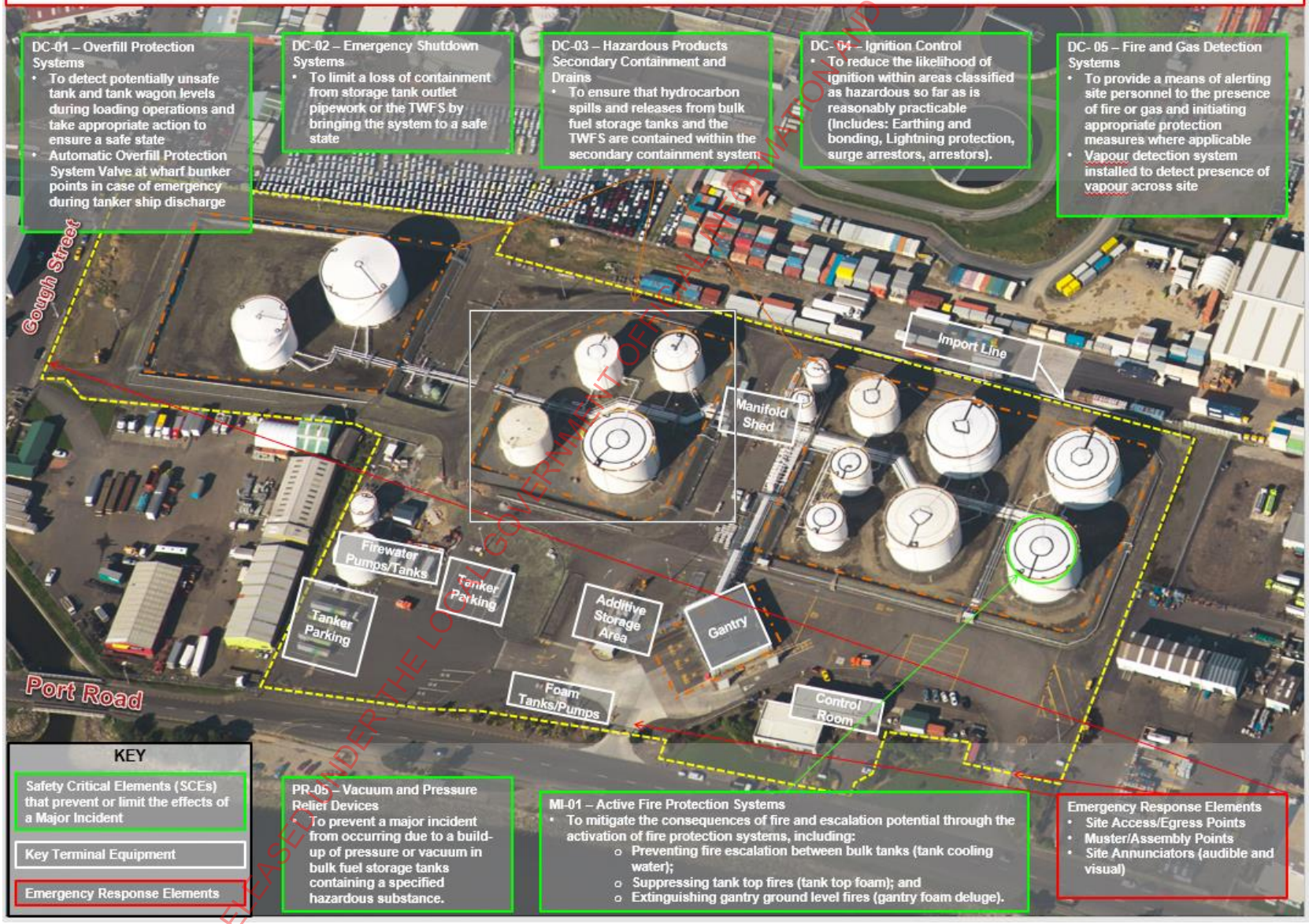
Safety Critical Elements for NZOSL Hutt City Terminal



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Appendix 2. Guidance extracts for Health and Safety at Work (Major Hazard Facilities) Regulations 2016 and Worksafe Good Practice Guidelines: MAPP and Safety Management Systems

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Health and Safety at Work (Major Hazard Facilities) Regulations 2016

Subpart 2—Duty of lower tier major hazard facility operators

36 (1) *The operator of a lower tier major hazard facility must—*
(a) prepare and retain a major accident prevention policy for the facility; and
(b) implement the policy before the facility commences operations.

(2) *The purpose of the policy is to prevent the occurrence of* ***major incidents*** *and limit their consequences to persons at or near the facility by appropriate means, structures, and management systems.*

(3) *The major accident prevention policy must—*
(a) include measures that are proportionate to any ***major incident hazards*** *presented by the facility; and*
(b) describe the operator's overall goals and principles of action in relation to the control of ***major incident hazards****; and*
(c) be in writing.

(4) *The operator must* ***implement*** *the major accident prevention policy* ***by establishing a safety management system that satisfies the requirements specified in Schedule 5****.*

(5) *The operator must, when preparing or revising a major accident prevention policy and when establishing and implementing the safety management system,* ***engage with workers at the facility****, in accordance with regulation 65.*

35 *(1) The operator of a major hazard facility must* ***review and, as necessary, revise*** *the following (as relevant), in accordance with this regulation:*
(c) the ***major accident prevention policy***

Good Practice Guidelines – Major Hazard Facilities: MAPP and Safety Management Systems, July 2016, Worksafe NZ

3.2 Developing a Major Accident Prevention Policy

'A MAPP is not a mini safety case but a high level policy document referring to detailed documentation within the SMS. Within the SMS's hierarchy of documentation, at the top the MAPP sets out the policy and principles of major hazard prevention.'

'The MAPP does not need to contain a detailed description of your SMS. However, it should give enough detail to show you have systems in place to cover all the aspects listed later in the section 'What should go in your MAPP?'.

'WHAT SHOULD GO IN YOUR MAPP?

The MAPP should contain information on the

following areas:

- *organisation and personnel*
- *identification and evaluation of major*
- *incident hazards*
- *operational control*
- *planning for emergencies*
- *monitoring performance*
- *audit and review.'*

'In summary, the MAPP will include:

- *your policy setting out your aims and principles of action about the identifying, preventing and mitigating major incidents;*
- *a description of your SMS for achieving the stated aims*
- *a commitment to continual improvement.*

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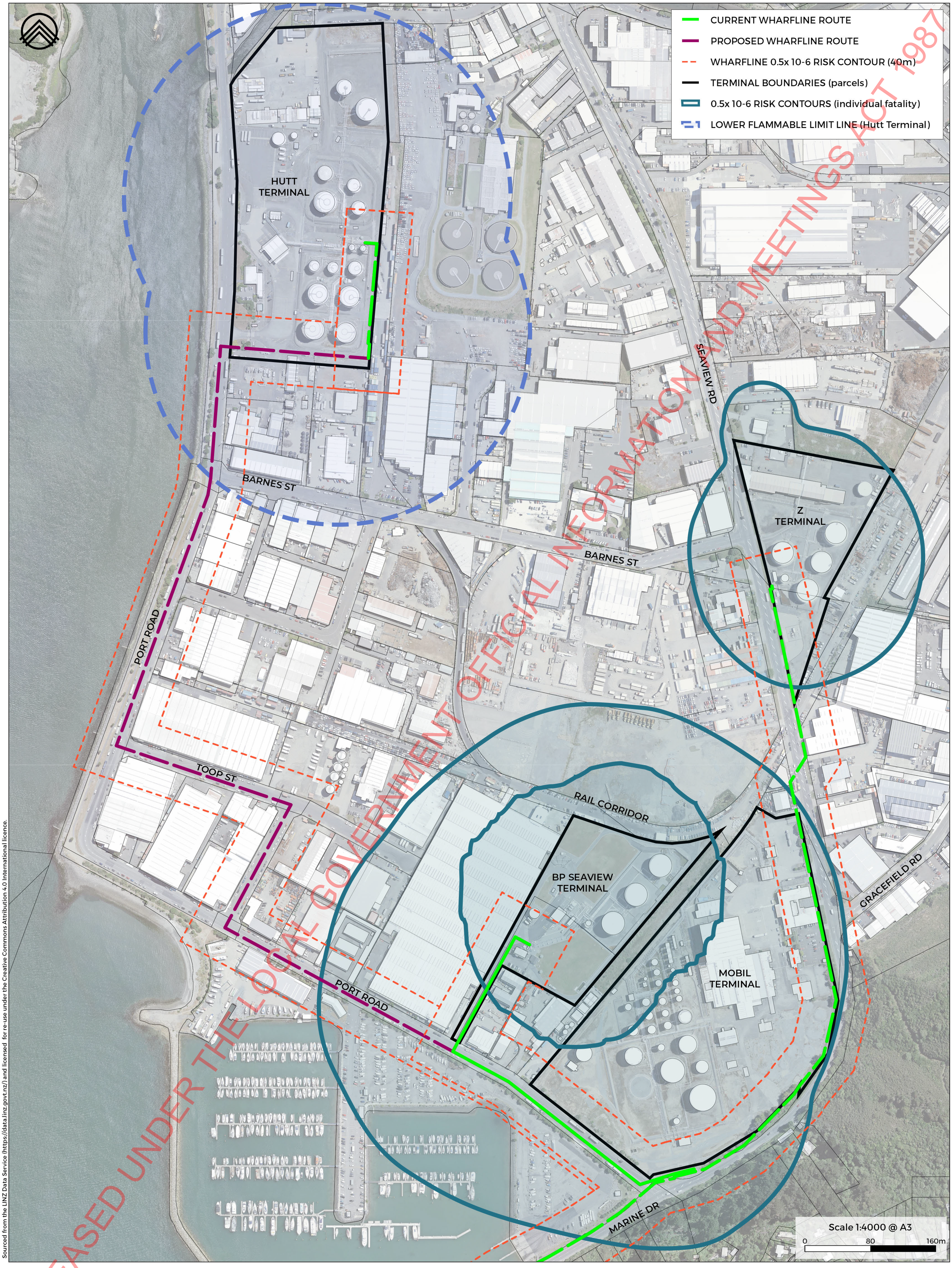

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SLR

810.V16188.00001 - Hutt City District Plan Review (OIEWG)

SEAVIEW WHARFLINE AND TERMINAL RISK CONTOURS

Figure prepared for HCC by SLR Consulting.

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4.1 Hazardous substances

4.1.1 Introduction

a. This introduction is to assist the lay reader to understand how this chapter works and what it applies to. It is not an aid to interpretation in a legal sense.

b. This chapter seeks to manage the residual risks associated with the storage, use, or disposal of hazardous substances, this includes the minimisation of reverse sensitivity effects, and avoidance of sensitive activities being located within a defined Risk Management Area. The defined Risk Management Area is located in Woolston, the extent of which is illustrated on Planning Map 47A.

c. The objectives, policies and rules in this chapter provide for the storage, use, or disposal of hazardous substances as a permitted activity throughout the District, subject to provisions in other chapters. The exception to the permitted activity status is the inclusion of two non-complying activities. The first relates to new storage or use of hazardous substances with explosive or flammable properties within close proximity to National Grid transmission lines and some electricity distribution lines. The second is for sensitive activities locating within the defined Risk Management Area.

d. Plan users should be aware that certain activities which comply with the rules regulating hazardous substances under the District Plan may still require consent from the Canterbury Regional Council (CRC).

e. The provisions in this chapter give effect to the Chapter 3 Strategic Directions Objectives.

4.1.2 Objectives and Policies

4.1.2.1 Objective - Adverse environmental effects

a. The residual risks associated with the storage, use or disposal of hazardous substances in the district are managed to acceptable levels to not adversely affect people, property and the environment while recognising the benefits of facilities using hazardous substances.

4.1.2.1.1 Policy - Location of new facilities using, storing or disposing of hazardous substances

a. Locate new facilities using, storing, or disposing of hazardous substances on appropriate sites to ensure that any residual risks to strategic infrastructure are managed to acceptable levels.

4.1.2.1.2 Policy - Identifying and managing individual and cumulative effects of facilities using, storing, or disposing of hazardous substances

a. Identify the individual and cumulative effects associated with facilities using, storing or disposing of hazardous substances and manage residual risks to people, property and the environment to acceptable levels.

4.1.2.2 Objective - Risk and reverse sensitivity effects

a. Sensitive activities are established at suitable locations to minimise reverse sensitivity effects on and avoid unacceptable risks from established facilities using, storing or disposing of hazardous substances.

4.1.2.2.1 Policy - Establishment of sensitive activities

a. The establishment of sensitive activities in close proximity to existing major facilities using, storing or disposing of hazardous substances shall be:

   i. avoided in the first instance when that facility or area includes strategic infrastructure or where the sensitive activity may be exposed to unacceptable risk; and

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ii. minimised, to allow such facilities to carry out their operations without unreasonable reverse sensitivity constraints.

4.1.2.2.2 Policy - Woolston Risk Management Area

a. Avoid sensitive activities locating within the Woolston Risk Management Area where these have the potential to be exposed to unacceptable risk and/or may otherwise constrain the development, operation, upgrading or maintenance of bulk fuel and gas terminals.

Advice note:

1. The Woolston Risk Management Area is shown on Planning Map 47A.

4.1.2.3 Objective - Acceptable slope stability risks in relation to hazardous substances

a. Residual risks of adverse effects from the use, storage, or disposal of hazardous substances are managed to acceptable levels in areas affected by slope instability.

4.1.2.3.1 Policy - Risks and adverse effects within areas affected by natural hazards

a. Design, construct and manage any proposal involving use, storage or disposal of hazardous substances within areas affected by slope instability to ensure residual risks are managed to acceptable levels.

4.1.3 How to interpret and apply the rules

a. The following rules apply to activities that involve the use, storage, and disposal of hazardous substances, and sensitive activities located within a defined Risk Management Area.

b. There are regional rules applicable to the contamination of land, air and water associated with the storage, use, and disposal of hazardous substances. Certain activities which comply with the rules regulating hazardous substances under the District Plan may still require consent from the Canterbury Regional Council (CRC).

c. The activity status tables and standards in the following chapters also apply:

5 Natural Hazards
6 General Rules and Procedures
7 Transport
8 Subdivision, Development and Earthworks
9 Natural and Cultural Heritage
11 Utilities and Energy
12 Papakāinga/Kāinga Nohoanga Zone
13 Specific Purpose Zones
14 Residential
15 Commercial
16 Industrial
17 Rural
18 Open Space

4.1.4 Rules - Hazardous substances

4.1.4.1 Activity status tables - Hazardous substances

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4.1.4.1.1 Permitted activities

a. The activities listed below are permitted activities if they meet the activity specific standards set out in this table.

b. Activities may also be non-complying as specified in Rule 4.1.4.1.5.

Activity		Activity specific standards
P1	The use, storage or disposal of any hazardous substance (unless otherwise specified in this plan).	Nil

4.1.4.1.2 Controlled activities

There are no controlled activities.

4.1.4.1.3 Restricted discretionary activities

There are no restricted discretionary activities.

4.1.4.1.4 Discretionary activities

There are no discretionary activities.

4.1.4.1.5 Non-complying activities

a. The activities listed below are non-complying activities.

Activity

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NC1	a. Any new storage or use of hazardous substances with explosive or flammable properties within: i. 10 metres of the centre line of a 66kV National Grid transmission line or a 66kV electricity distribution line; or ii. 5 metres of the centre line of a 33kV electricity distribution line; or iii. 12 metres of the centre line of a 110kV or 220kV National Grid transmission line. b. For the purpose of (a), the definition of hazardous substances excludes the following activities, facilities and quantities: i. storage of substances in or on vehicles being used in transit on public roads; ii. installations where the combined transformer oil capacity of the electricity transformers is less than 1,000 litres; iii. fuel in mobile plant, motor vehicles, boats and small engines; iv. gas and oil pipelines and associated equipment that are part of a utility; v. retail activities selling domestic scale usage of hazardous substances, such as supermarkets, trade suppliers, and pharmacies; vi. the accessory use and storage of hazardous substances in minimal domestic scale quantities; vii. fire-fighting substances, and substances required for emergency response purposes on emergency service vehicles and at emergency service facilities; viii. activities involving substances of Hazardous Substances and New Organisms (HSNO) sub-classes 1.4, 1.5, 1.6, 6.1D, 6.1E, 6.3, 6.4, 9.1D and 9.2D unless other hazard classification applies; ix. the temporary storage, handling and distribution of national or international cargo containers; x. waste treatment and disposal facilities (not within High Flood Hazard Management Areas and Flood Management Areas), and waste in process in the Council's trade waste sewers, municipal liquid waste treatment and disposal facilities (not within High Flood Hazard Management Areas and Flood Management Areas) which may contain hazardous substance residues; xi. vehicles applying agrichemicals and fertilisers for their intended purpose.
NC2	a. Any sensitive activity located within the Woolston Risk Management Area. Advice note: 1. The Woolston Risk Management Area is shown on Planning Map 47A.

4.1.4.1.6 Prohibited activities

There are no prohibited activities.

4.1.5 Other methods

a. Education will be used to promote public awareness about the costs and benefits of hazardous substances and associated facilities, to encourage resource users to take responsibility for their own health and safety, and for management of the effects of their activities on the public and the environment.

b. Industry Codes and New Zealand Standards and Guidelines will be utilised in some circumstances to provide the basis for controls on the use of hazardous substances.

c. Develop specific guidelines to assist operators of facilities using, storing, or disposing of hazardous substances in

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achieving compliance with relevant management requirements.

d. Preparation and operation of site management systems and emergency plans to avoid or mitigate the risk of hazardous substances escaping into the environment.

e. Promotion by government and local government of "Cleaner Production" and recycling principles, including methods and processes to improve operating efficiency and minimise the release of hazardous substances, or the use of alternative non-hazardous substances or technologies.

f. Waste Disposal Guidelines will be used for the disposal of hazardous waste to Local Authority approved facilities to protect human health and the receiving environment from potential adverse effects. Advice may be given on pre-treatment requirements or alternative methods of disposal for non-acceptable wastes.

g. Liaise with parties involved with hazardous substance use, such as the Canterbury Regional Council and adjoining territorial authorities, WorkSafe New Zealand, Ministry of Health, Ministry for the Environment, the Environmental Protection Authority (EPA), the New Zealand Police and owner/operators who use hazardous substances, to allow more effective risk management coordination.

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E29. Emergency management area – Hazardous facilities and infrastructure

E29.1. Background

For t□e purposes of t□is section□t□e identified □a□ardous facilities and infrastructure are t□e □ iri Oil Terminal□□ iri LPG Depot and t□e □ig□ pressure Refinery to □uc□land petroleum pipeline□

T□is section provides a frame□or□ to manage t□e ris□ of adverse effects on activities located in pro□imity to e□isting □a□ardous facilities and infrastructure□

□a□ardous facilities and infrastructure pose a ris□ to surrounding land uses and can result in emergency events□T□ese are events of lo□ probability but □ig□ potential □arm to people and damage to property□T□ey may include vapour cloud e□plosions□large fires or t□e release of to□ic gas □□ic□ could cause blast overpressure□fragments□□eat radiation or poisoning□

Restricting or managing t□e encroac□ment of land uses in pro□imity of certain e□isting □a□ardous facilities and infrastructure may be necessary to ensure t□at ris□ to t□ose land uses is appropriately managed□ T□is is also to ensure t□at t□e operation and potential e□pansion of t□e facilities and infrastructure is not compromised by surrounding incompatible or conflicting land uses□Incompatible activities may create a lo□er t□res□old of acceptable ris□ in t□e receiving environment and generate reverse sensitivity effects□Some of t□ese □a□ardous facilities and infrastructure are critical to t□e functioning of □uc□land and □e□ □ealand□

T□e provisions for emergency management areas □ave t□o related elements t□at may be relevant to t□e activity□

- an inner emergency management area applies to t□e area closest to t□e facility□ and is sub□ect to t□e greatest potential effects from emergency events□In addition to t□e preparation of emergency management plans□building design elements must be considered for all buildings □it□in t□is area□and
- a □ ider □mergency Management □rea applies to an area around t□e inner emergency management area□□□ic□ re□uires t□e preparation of emergency management plans to ensure t□at activities operating □it□in pro□imity of t□e □a□ardous facilities and infrastructure are a□are of t□e ris□s and are suitably prepared□

T□e emergency management areas also restrict sensitive activities or incompatible land uses□including t□ose generating □ig□ populations of people□

Sensitive activities contain people intensive activities□or t□ose containing vulnerable populations t□at □ould re□uire a greater level of assistance in t□e case of an emergency scenario□□□ic□ are defined as “activities sensitive to □a□ardous facilities and infrastructure”.

PC 78 (see Modifications)

[new text to be inserted]

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E29.2. Objectives [rcp/dp]

(1) □ctivities sensitive to □a□ardous facilities and infrastructure are avoided in emergency management areas□

(2) T□e use and development of identified □a□ardous facilities and infrastructure are not unreasonably constrained by t□e establis□ment or e□pansion of sensitive and incompatible activities□

(3) T□e ris□ to activities in pro□imity to identified □a□ardous facilities and infrastructure is at a level acceptable to t□ose types of activities□

E29.3. Policies [rcp/dp]

(1) Identify emergency management areas around □a□ardous facilities and infrastructure □□ere t□is is □ustified on t□e basis of a □uantitative ris□ assessment□

(2) Manage t□e ris□ to activities □it□in t□e emergency management area for t□e □ iri Oil Terminal and t□e □ iri LPG Depot to acceptable levels and manage reverse sensitivity effects on t□e development and operation of t□e □ iri Oil Terminal and □ iri LPG Depot by□

(a) avoiding t□e establis□ment or e□pansion of activities sensitive to □a□ardous facilities and infrastructure□and

(b) limiting t□e establis□ment or e□pansion of incompatible activities□and

(c) re□uiring t□e preparation and implementation of a site emergency management plan□and

(d) re□uiring buildings □it□in t□e Inner □mergency Management □rea to consider □o□ layout reduces ris□ of □arm to people from an emergency event□

(3) Consider t□e ris□ to activities sensitive to □a□ardous facilities and infrastructure □it□in □□ metres of t□e boundary of designations □□□□ and □□□□ □Petroleum Pipeline) where the pipeline is constructed to a “thin wall” specification.

E29.4. Activity table

Table □□□□□□□ □ctivity table specifies t□e activity status of land use and development activities located □it□in t□e emergency management areas for t□e □ iri Oil Terminal s□o□n in Figure □□□□□□□ and Figure □□□□□□□ and t□e □ iri LPG Depot s□o□n in Figure □□□□□□□ pursuant to section □□□□of t□e Resource Management □ct □□□□□

Table □□□□□□□ and Standard □□□□□□□ do not apply to t□e □ig□ pressure Refinery to □uc□land petroleum pipeline□only Policy □□□□□□□□and Rule □□□□□□□□apply□

□ □ere more t□an one □uc□land□□ide or □one rule applies to t□e same activity□t□en t□e most restrictive status applies□

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Table E29.4.1 Activity table

Activity		Activity status
(A1)	Activities sensitive to hazardous facilities and infrastructure	Pr
(A2)	Activities not otherwise permitted in the Business – Heavy Industry Zone (except Emergency Services within the Business – Heavy Industry Zone)	NC
Development		
(A3)	New buildings within the Inner Emergency Management Area for the Wiri Oil Terminal (Figure E29.6.2) or Wiri LPG Depot (Figure E29.6.3)	C
(A4)	Alterations to buildings that increase the building platform area or building height within the Inner Emergency Management Area for the Wiri Oil Terminal (Figure E29.6.2) or Wiri LPG Depot (Figure E29.6.3)	C

E29.5. Notification

(1) Any application for resource consent for an activity sensitive to hazardous facilities and infrastructure (including controlled activities) located within 34m of the boundary of designations 6500 and 6501 (Petroleum Pipeline) where the pipeline is constructed to a "thin wall" specification will be subject to the normal tests for notification under the relevant sections of the Resource Management Act 1991.

(2) Any application for resource consent for an activity including controlled activities listed in Table E29.4.1 Activity table will be subject to the normal tests for notification under the relevant sections of the Resource Management Act 1991.

(3) When deciding who is an affected person in relation to any activity for the purposes of section 95E of the Resource Management Act 1991 the Council will give specific consideration to those persons listed in Rule C1.13(4) and including any person operating within the inner emergency management area.

E29.6. Standards

The following standards apply to all activities located within the wider emergency management area for the Wiri Oil Terminal shown in Figure E29.6.1 and the Wiri LPG Depot shown in Figure E29.6.3.

E29.6.1. Site Emergency Management Plan

(1) A Site Emergency Management Plan must either be prepared and completed in accordance with the template set out E29.9.1 Site Emergency Management Plan template (non-statutory) or otherwise prepared and completed by a suitably qualified expert (for example a fire safety engineer).

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(2) T□e Site □mergency Management Plan must be implemented and submitted to Council at least □□ □or□ing days prior to t□e proposed date of commencing any ne□ activity or any c□ange of activity□

Figure E29.6.1 Wider Emergency Management Area for the Wiri Oil Terminal

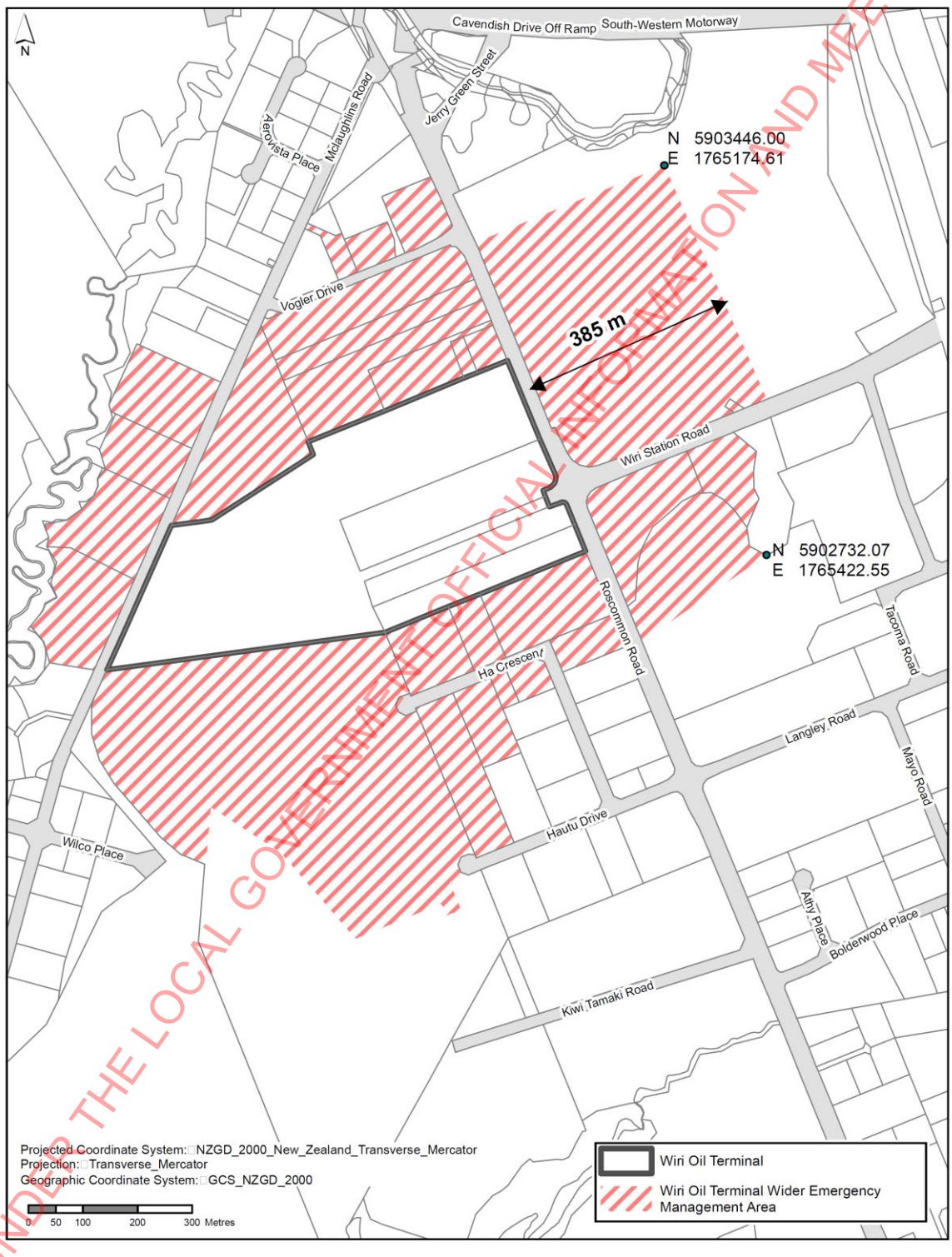

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Figure E29.6.2 Inner Emergency Management Area for the Wiri Oil Terminal

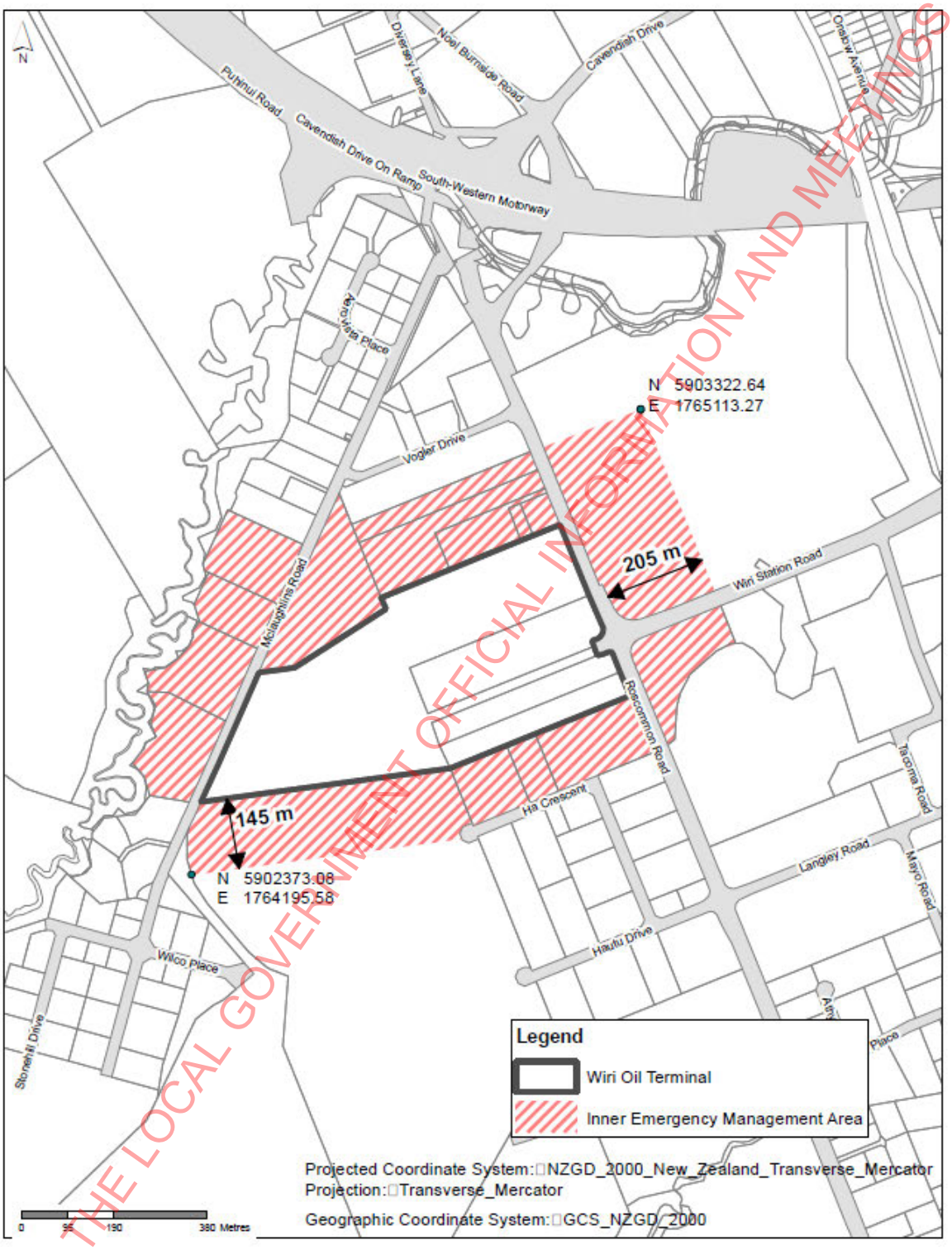

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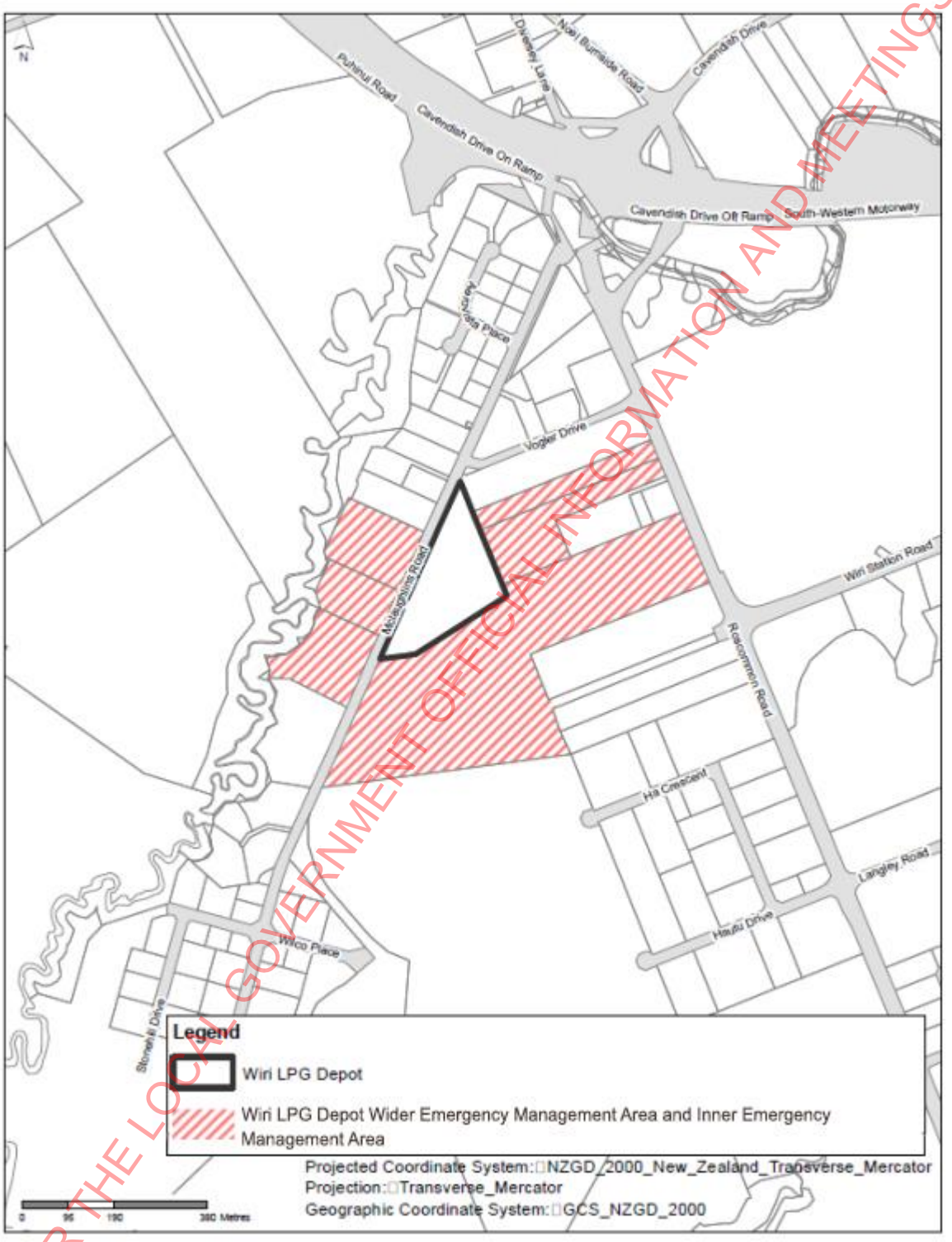
Figure E29.6.3 Wider Emergency Management Area and the Inner Emergency Management Area for the Wiri LPG Depot



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E29.7. Assessment – controlled activities

E29.7.1. Matters of control

T□e Council □ill reserve its control to all of t□e follo□ing matters □□en assessing a controlled activity resource consent application□

□□□ne□ buildings and alterations to buildings t□at increase t□e building platform area or building □eig□t □it□in t□e Inner □mergency Management □rea for t□e □ iri Oil Terminal □Figure □□□□□□□□or □ iri LPG Depot □Figure □□□□□□□□

□a□building layout and mitigation measures for ris□ management purposes□

E29.7.2. Assessment criteria

T□e Council □ill consider t□e relevant assessment criteria belo□ for controlled activities□

□□□ne□ buildings and alterations to buildings t□at increase t□e building platform area or building □eig□t □it□in t□e Inner □mergency Management □rea for t□e □ iri Oil Terminal □Figure □□□□□□□□or □ iri LPG Depot □Figure □□□□□□□□

□a□t□e e□tent to □□ic□ t□e design of buildings or alterations to buildings ensures t□e safety of occupants from an emergency event at t□e □a□ardous facility□T□e follo□ing design matters s□ould be considered□

□i□ layout of t□e buildings on t□e site □including t□e orientation of main building entrances□s□ould ma□imise t□e separation of □ig□er occupancy areas □suc□as offices□from t□e □a□ardous facility□

□ii□ t□e location of gla□ing in relation to t□e □a□ardous facility□□ □ere it is not practicable to locate □indo□s a□ay from t□e □a□ardous facility□ consideration s□ould be given to mitigation measures □suc□ as strengt□ened glass □protective films□to reduce ris□ of □arm to people□ and

□iii□t□e location of t□e emergency egress points to facilitate movement a□ay from t□e □a□ard □noting t□at fire egress doors may still be re□uired on t□e side of buildings facing t□e □a□ardous facility to meet building code re□uirements□□

□b□to ensure t□at operators of □a□ardous facilities are made a□are of pro□imate activities and potential reverse sensitivity effects□□ □et□er t□e application includes evidence of consultation □it□ t□e operator of t□e □a□ardous facility□including□

□i□ a copy of t□e application to t□e operator □□ □or□ing days prior to lodgement of t□e application □it□ t□e Council□

□ii□ details of t□e nature of t□e activities in t□e building or alteration□

□iii□ details of t□e number of staff□and

□iv□ details of t□e □ours of operation□

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E29.8. Assessment – restricted discretionary activities

E29.8.1. Matters of discretion

T□e Council □ill reserve its discretion to all of t□e follo□ing matters □□en assessing a restricted discretionary resource consent application□

□□□any activity t□at does not comply □it□ Standard □□□□□□□□

□a□t□e nature and e□tent of emergency management planning□

E29.8.2. Assessment criteria

T□e Council □ill consider t□e relevant assessment criteria belo□ for restricted discretionary activities□

□□□any activity t□at does not comply □it□ Standard □□□□□□□□

□a□refer to Policy □□□□□□□□□

E29.9. Special information requirements

T□ere are no special information re□uirements in t□is section□

E29.10. Site Emergency Management Plan Template (non-statutory)

□ame□□ddress		
Contact details	P□one □mail □ ebsite	Fa□
□mergency contacts	□ame Role P□one	Mobile
	□ame Role P□one	Mobile
Contact details of □a□ardous Facility □ Facilities	□ame Role P□one	Mobile
	□ame Role P□one	Mobile
Date Plan provided to □uc□land Council		
Date copy of Plan provided to □a□ardous Facility Operator□s		

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Date last updated and reprinted	
Date updated Plan provided to □uc□land Council	
Date updated Plan provided to □a□ardous Facility Operator□s	

□ote □

For t□e purposes of t□is □mergency Management Plan t□e term '□a□ardous Facility' means □delete any not relevant□□

- □ iri Oil Terminal
- □ iri LPG Depot

(1) Purpose

T□is plan applies in addition to □name of organisation□s□o□n building evacuation plan □□ic□ addresses incidents arising from its o□n operations□

T□is plan outlines □o□ □name of organisation□□ill respond to a potential emergency arising from t□e □a□ardous Facility and t□ereby partly satisfies t□e re□uirements and obligations of t□e Resource Management □ct □□□□ and □ealt□ and safety legislation□ Located □it□in t□e □a□ardous Facility □mergency Management □rea□t□e □name of t□e organisation□is in a location □□ere it may be sub□ect to suc□ emergency scenarios□

T□e □ey □a□ard at t□e □a□ardous Facility is t□e storage and □andling of large □uantities of flammable and combustible materials□T□ere are t□o particular potential emergency scenarios t□at could occur at t□e □a□ardous Facility □it□ t□e potential to impact offsite areas□

- flammable vapour cloud □it□ t□e ris□ of ignition and e□plosion□and
- □a□ardous substances fire □e□g□tan□ or bund fire at t□e □ iri Oil Terminal or LPG fire at t□e □ iri LPG Depot□□

(2) Site plan

□ copy of site plan s□o□ing location of on□site and off□site safe assembly areas and outside evacuation routes □to be attac□ed as □ppendi□ □□□

Safe assembly areas and evacuation routes □ave been selected and meet t□e follo□ing criteria□

- designated off□site assembly area as far as reasonably practicable from t□e □a□ardous Facility e□g□a minimum of □□□ metres from □ iri Oil Terminal site boundary or outside t□e Inner □mergency Management □rea of t□e □ iri LPG Depot□

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- t□e e□its and outdoor evacuation routes avoid cul□de□sacs and routes t□at ta□e any person closer to t□e □a□ardous Facility□T□e route□s□lead a□ay from t□e □a□ardous Facility□
- e□it points to be used s□ould be as far a□ay from t□e □a□ardous Facility as possible□
- avoid assembly area being ad□acent to large areas of gla□ing□and
- assembly area is preferably in an open area and or removed or remote from buildings□

(3) Notification (relevant only in relation to the Wiri Oil Terminal)

□ iri Oil Terminal provides a □arning□notification system in t□e event of an emergency scenario arising at t□e □ iri Oil Terminal□T□e □name of t□e organisation□ □ill facilitate and enable t□e notification system to be implemented on site□□lt□oug□ mitigation and □arning systems are in place at t□e Terminal□catastrop□ic failure of systems can never be ruled out and t□ere may be little or no prior □arning□

(4) Response actions (as appropriate):

- Receive notification of incident from t□e □a□ardous Facility or emergency services□
- □void operating any electrical s□itc□es□including lig□ts□alarms or any ot□er electrical appliances and systems□
- Leave immediately by t□e nearest safe e□it route a□ay from t□e □a□ardous Facility□
- □vacuate on foot in a direction a□ay from t□e □a□ardous Facility to t□e assembly area□
- Do not rubbernec□
- Do not operate a ve□icle□
- Report to t□e off□site safe□assembly area and building □ardens to reconcile staff and visitor □customer names and numbers□
- Do not leave t□e assembly area or re□enter t□e building until advised it is safe to do so by t□e Fire Service□

(5) Plan testing and evaluation

- Practise relevant drills suc□ as evacuation simulations□
- Ta□e part in sc□eduled □a□ardous Facility emergency e□ercise as re□uested□
- Fully document all e□ercises underta□en□
- □ddress any difficulties and problems encountered during e□ercises and update Plan as re□uired□

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(6) Plan review and updating

Revie□ and update t□e Plan at least annually and follo□ing any c□ange in circumstances

□e□g□p□ysical c□anges to building or on site activities□e□its or routes or personnel□□

(7) Attach Site Plan

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, 25 October 2024 10:30 am
To: Hamish Wesney; Stephen Davis
Cc: David Le Marquand; s7(2)(a)
Subject: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Hamish & Stephen,

Thanks Hamish for the phone discussion a couple of weeks ago.

As you'll recall, at the last meeting we had (23 August), there were some outstanding matters in relation to the draft district plan that we were going to look into and come back to Council on. We have now prepared a letter which addresses those outstanding matters. Apologies for the delay in getting this to you, it's been a busy past few weeks so we didn't get to this as quickly as we would have like to.

Recognising that Council is not willing at this stage to support the wharfline risk classification system / zone provisions approach at this stage, we have proposed an alternative method. This alternative method involves mapping a ' fuel transmission pipeline corridor', similar to the gas transmission pipeline corridor already in the draft plan and based on the sensitive activity risk setback (0.5×10^{-6}) for the wharfline which is identified as being 40m either side of the wharfline in the bp Risk Assessment Report. This approach, which would set up a policy framework avoiding sensitive activities in this corridor, is underpinned by risk management work undertaken and ensures that a framework is set up which reflects the clear RPS directives in relation to the need to protect / enable RSI. I am also providing Council with a drawing showing the location of this ' fuel transmission pipeline corridor', as well as the Shapefile for this.

Regarding the Hutt City Terminal QRA, we have been advised that the draft QRA is close to completion (potentially next week) so expect to be able to send this to HCC in the next few weeks, meeting the end of November deadline.

Finally, recognising that we have sent in various iterations of feedback (which I can appreciate could become hard to keep track of) I have quickly put together a word document summarising the Fuel Companies' feedback on the draft Huitt City District Plan to date. I hope that this assist Council.

Please see in this link the following FuelCo feeback - Hutt City District Plan (*I have enabled both of you access but please let me know if you can't access for some reason*):

- Letter from the Fuel Companies addressing outstanding / additional matters.
- Drawing showing the location of the ' fuel transmission pipeline corridor'.
- Bp Risk Assessment Report which speaks to the wharfline sensitive activity risk setback. I believe this was sent to Council a couple of years ago but I'm sending again in case you don't have it on file.
- Summary of FuelCo feedback to date.
- Shapefiles for the terminal risk contours and also the fuel transmission pipeline corridor. If there are still issues with importing these files to Council's GIS mapping system, it could be worth Council's GIS person making direct contact with SLR's landscape specialist Aimily Li (cc'd). Aimily's details are as follows:

s7(2)(a)
Landscape Architect - Landscape

O s7(2)(a)
M s7(2)(a)
E s7(2)(a)@slrconsulting.com

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Thanks again for these ongoing discussions and for providing the Fuel Companies with the opportunity to feedback on the plan at draft stage – we greatly appreciate it. Please don't hesitate to contact me if you have any questions or would like to discuss further.

Otherwise, I'll be in touch again soon with the QRA.

Kind regard
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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SLR Consulting New Zealand
□□□ Victoria Street □ est □uc□land □□□□□□e□ □ealand

□□ October □□□□

SLR Ref □o□□Draft □utt City District Plan Fuel Companies□Feedbac□ □Iteration □□v□□□

□ttention□□amis□ □ esney □ Step□en Davis
□utt City Council

Via email□
Step□en□Davis□ □uttcity□govt□n□
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SLR Pro□ect □o□□□□□V□□□□□□□□□□□

RE: Fuel Companies further feedback to Hutt City Council (HCC) in relation to the Draft Hutt City District Plan – Iteration 5

Dear □amis□ □ Step□en□

Requested amendments supported by HCC

T□e Fuel Companies □ave been providing feedbac□ to □utt City Council to assist □it□ its revie□ of t□e Operative □utt City District Plan□□ e understand t□at t□e proposed □utt City District Plan is sc□eduled for notification in early □□□□

On □□ □ugust □□□□□t□e Fuel Companies □David le Mar□uand and myself□met □it□ □utt City Council to discuss t□e feedbac□ provided to date□T□is letter addresses outstanding matters □ □uestions from □CC t□at □ere discussed during t□at meeting□

Port Road Drag Race

HCC was interested to understand whether the Seaview terminals have any operational procedures in place to address risks posed by the Port Road Drag Races.

□ e understand t□at t□e Port Road Drag Race is an event □eld annually on t□e stretc□ of Port Road bet□een Merc□ban□s Street and Toop Street□T□e event attracts a reasonable cro□d □a fe□ □undred people□□o gat□er in t□e reserve land bet□een Port Road and t□e □utt River to □atc□ t□e races□T□e □□OSL □utt City Terminal and bp Seavie□ Terminal are bot□ located on Port Road □o□ever belo□ t□ey do not ad□oin t□e segment of road on □□ic□ t□e drag race event occurs□Similarly□t□e e□isting □□arfline route does not currently run do□n Port Road so is no□□ere near t□is event□□s a result□it is unli□ely t□at t□e Port Road Drag Races present particular issues from a reverse sensitivity □residual ris□ perspective□ □ e are a□are t□at truc□ access to t□e sites is restricted during t□e event□□o□ever t□is is a general traffic safety matter rat□er t□an a ris□ matter□

□ □ile t□e proposed □□arfline route □ill run do□n Port Road□it avoids t□e corner of Port Road and instead runs do□n Merc□ban□s □Toop St□□Refer to Figure □ belo□□□□ e are not a□are of any ris□ management procedures currently being in place to address t□e Port Road Drag Races□□o□ever t□ere is a possibility t□at ne□ procedures □ill need to be implemented once t□e ne□ □□arfline route is completed□

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Temporary activities

HCC was interested to get the Fuel Companies' views on a temporary activity rule for the Seaview Marina Precinct.

□s detailed in previous feedbac□□activities occurring in t□e Seavie□ Marina Precinct need to be appropriately managed given its pro□imity to t□e industry □□arfline and t□at most of t□e terminals' risk contours □□e□t□e Ris□Management Overlay□encompass t□is area□□ey to t□is is ensuring t□at temporary activities □e□g□mar□ets□sporting events□are managed□as cro□ds of people congregating in pro□imity of t□is infrastructure poses potential residual ris□and reverse sensitivity issues□Permitting temporary activities in t□e Seavie□ Marina is particularly dangerous as t□is could lead to a scenario □□ere large cro□ds gat□er in immediate pro□imity of t□e □□arfline and fuel terminals□□it□ no re□uirement to consider □ address ris□management□

It is critical t□at land use activities surrounding t□e □□arfline are managed to ensure t□at future reverse sensitivity and ris□issues are avoided□□ □ilst enabling t□e continued safe and unimpeded operation of t□is regionally significant infrastructure □RSI□□

□ e t□erefore recommend that the following changes are made to the 'Temporary activities' c□apter of t□e draft plan □or alternatively similar relief could be soug□t in t□e Seavie□ Marina C□apter□□

TEMP-R1 Temporary activities

*All zones **excluding the Seaview Marina Precinct***

1. Activity status: Permitted

……

*All zones **excluding the Seaview Marina Precinct***

4. Activity status: Restricted discretionary

….

□

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Seaview Marina Precinct

5. Activity status: Restricted discretionary

Matters of discretion are restricted to:

1. Positive effects, including contribution to Lower Hutt's vibrancy, diversity, and prosperity; and

2. The matters of discretion in any standard not met (including TEMP-S4 if it is not met).

3. Management of residual risk effects and reverse sensitivity effects associated with nearby significant hazardous facilities and the Hutt City fuel transmission pipeline.

Regionally Significant Infrastructure

In a discussion subsequent to the meeting, Hamish (HCC) indicated that at this stage, the district plan does not contain any provisions addressing regionally significant infrastructure (RSI).

Per t□e Fuel Companies' previous feedback, a policy frame□or□is soug□t in t□e district plan to ensure t□at RSIs suc□ as t□e □utt City □ □arfline are protected and enabled□t□is is critical to □ave in place as a base minimum approac□ and to ensure consistency □it□ t□e □ ellington Regional Policy Statement □RPS□□

T□e □ ellington RPS □PC□ decisions version□□re□uires t□at district plans□

- *Recognise the benefits of RSI* □Policy □□Policy □□□□and
- *Enable the safe and efficient operation of RSI where it is protected from potential reverse sensitivity effects* □Policy □□□m□□□

T□is policy frame□or□ □□ □ic□ could be added to t□e Infrastructure C□apter□s□ould be accompanied by a definition of RSI □□ic□ is consistent □it□ t□e definition in t□e □ ellington RPS as amended t□roug□ PC□ □decisions version□□

'Expansion of SHF' Rule

The previous iteration of feedback from the Fuel Companies sought changes in relation to a rule around the expansion of Significant Hazard Facilities (SHFs). HCC was generally comfortable in principle with the changes sought by the Fuel Companies but wanted to ensure that this rule could be clearly and easily interpreted.

T□e □ey limitation of t□e draft plan's 'expansion of SHF' rule □□S□R□□is t□at it □ould re□uire resource consent for almost any activities regardless of scale or its potential residual ris□ implications□□ccordingly□t□e previous iteration of feedbac□from t□e Fuel Companies □dated □ □ugust □□□□□soug□t an amendment to ensure a permitted pat□□ay □as provided □□ere it did not pose a furt□er ris□□□ e □ave given t□is rule some furt□er t□oug□t□and consider t□at amending wording to apply the rule to 'additions and/or alterations 'is more appropriate□as follo□s□

Additions and/or alterations to existing significant hazardous facilities

1. The activity does not change the risk profile established by QRA of the significant hazard facility, as measured from the date of notification of this Plan.

□ □ttps□□□ □ □ g □ govt n □ assets□Plans □policies□byla□s□RPS□□□□□□□Decision□Docs□Decision□version□of□Proposed□C□ange □□and□Variation□□provisions□pdf

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All zones

Activity status: Permitted

To accompany t□e above pat□□ay□□e see□to ensure t□at an appropriate definition of S□F is provided (note this was sought in the Fuel Companies' original feedback on the draft plan)□ T□e follo□ing amendments □ould ensure t□at t□e definition is consistent □it□ t□at in t□e Proposed □apier District Plan□

Significant hazardous facilities:

Means any facility which involves one or more of the following activities:

…

3. The storage/use of more than ~~100,000~~ ***50,000*** *litres of petrol*

4. The storage/use of more than 100,000 litres of diesel

……

The definition does not apply to:

1. The underground storage of petrol and diesel at service stations and truck stops that is undertaken in accordance with HSNOCOP 44 Below Ground Stationary Container Systems for Petroleum – Design and Installation and HSNOCOP 45 Below Ground Stationary Containers Systems for Petroleum – Operation.

2. The distribution or transmission by pipelines of petroleum products.

3. Fuel installations and fuel servicing activities at airports.

4. The incidental use and storage (including for disposal) of hazardous substances for emergency service activities.

Incidentally□□e □is□to □ig□lig□t t□at t□e□ ellington RPS as amended t□roug□ PC□ □decisions version□□uses t□e term *major hazard facility* instead of *significant hazardous facility*□□n alternative approac□to t□e district plan□□□ic□ □ould ensure consistency □it□ t□e □ ellington RPS□□ould be to replace all references to *significant hazardous facility* □it□ *major hazard facility* and introduce a definition of *major hazard facility* consistent □it□ t□e RPS definition as follo□s□

Major hazard facility

Has the same meaning as the Health and Safety at Work (Major Hazard Facilities) Regulations 2016 - means a facility that WorkSafe has designated as a lower tier major hazard facility or an upper tier major hazard facility under regulation 19 or 20.

Natural Hazards Chapter

HCC were interested to get the Fuel Companies' further thoughts on the Natural Hazards Chapter of the draft district plan. In particular, whether appropriate exemptions were in place for minor works where there is no flooding risk.

T□e Fuel Companies provided feedbac□on t□e □atural □a□ards C□apter in t□e letter to □CC dated □ May □□□□□T□is addressed□

- □□ □a□ard sensitive activities definitions□□ e understand t□at □CC □ill amend definitions so t□at □a□ardous facilities and ma□or □a□ard facilities are classed as 'potentially hazard sensitive activities' as opposed to 'hazard sensitive activities'□per t□e Fuel Companies prior feedbac□□

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□□ □n amendment to Policy □□□P□to ensure t□at additions □alterations at industry sites located in t□e □ig□ □a□ard areas □ere enabled □□ere t□ere is an operational or functional need OR □□ere ris□to natural □a□ards is mitigated□so t□at t□ese necessary □or□s are not inadvertently pro□ibited□□CC is yet to confirm □□et□er it □ill ma□e t□is c□ange□

□□ □mendments to rules □□□R□□□□□R□□□□□□R□□□□□□R□□ to clarify t□at t□ey do not trigger consenting re□uirements for □or□s involving structures □□ic□ are in□erently resilient to flooding and overland flo□pat□ris□s □e□g□ne□ remote fill points□lig□t poles□ signage□rubbis□ storage units etc□□□□ e note t□at the draft plan's definition of building, □□ic□is consistent □it□t□e □ational Planning Standards building definition□is supported□ □CC is yet to confirm □□et□er it □ill ma□e t□ese c□anges□

□ e □ave given t□is matter furt□er t□oug□t and consider t□at t□e follo□ing sub□clause to rules □□□R□□□□□R□□□□□□R□□□□□□R□□ □ould ac□ieve Council's intent□

Where:

a. The activity does not result in new or additional gross floor area unless it relates to car parking, loading docks or spaces, vehicle access aisles, manoeuvring areas / ramps, or carwashes.

Sub□ect to amendments in line □it□ items □ and □ above t□e Fuel Companies generally support t□e □atural □a□ards c□apter and consider t□at it adopts a ris□□based approac□ □□ic□is consistent □it□t□e Proposed □ational Policy Statement for □atural □a□ard Decision Ma□ing □□PS□□□D□□

Reverse Sensitivity

HCC sought the Fuel Companies' views on a definition for 'reverse sensitivity'.

In □ppendi□B of its letter to □CC dated □□ May □□□□□t□e Fuel Companies soug□t t□at ob□ectives and policies □ere added to t□e Seavie□ Marina Precinct to ensure t□at reverse sensitivity effects and residual ris□effects □ere appropriately managed in t□e conte□t of t□e nearby fuel terminals and □utt City □□arfline□C□anges □ere also soug□t to provisions in t□e □eavy Industry □one□□CC is yet to confirm □□et□er it □ill ma□e t□ese c□anges□

□ e consider t□at the following definition of 'reverse sensitivity' would be appropriate:

Reverse sensitivity

means the potential for the operation of an existing lawfully established activity to be compromised, constrained, or curtailed by the more recent establishment or alteration of another activity which may be sensitive to the actual, potential, or perceived adverse environmental effects generated by the existing activity or structure.

Risk Management Framework Addressing the Hutt City Wharfline – Fuel Transmission Pipeline Corridor

We understand that HCC does not consider that the additional provisions are necessary in the Seaview Marina Precinct and Heavy Industry Zone to address the potential for impacting the wharfline's risk classification status. At this stage, we understand that there is no specific recognition of the wharfline in the district plan.

T□e Fuel Companies remain concerned t□at t□e Seavie□ Marina Precinct draft provisions are inappropriate from a ris□management perspective□T□e provisions enable a □ide range of activities □□ic□could significantly implicate t□e □□arfline□not only in terms of immediate

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operational □p□ysical control c□anges to it□but also conse□uential c□anges □□ic□ impact supply c□ain of fuel to t□e region and country□□t a minimum□it is critical to ensure t□at a consenting pat□□ay is re□uired for activities in t□e Seavie□ Marina Precinct□per t□e Fuel Companies previous iterations of feedbac□□Ot□er□ise□t□e Fuel Companies are concerned about t□e cumulative addition of a number of permitted activities in t□e SMP resulting in a □ig□ density of people□

□ e □is□ to again □ig□lig□t t□e fact t□at t□e □□arfline is regionally significant infrastructure and t□erefore needs to be protected □enabled□per t□e □ ellington RPS directives□

T□e Fuel Companies remain of t□e vie□ t□at it is appropriate to implement a district plan policy frame□or□ □□ic□ is underpinned by t□e wharfline's risk classification status□□o□ever□ if t□is approac□ is not supported by Council□an alternative met□od is to map a 'fuel transmission pipeline corridor' in t□e district plan based on t□e □□arfline's ris□ profile□similar to t□e gas transmission pipeline corridor already in place in t□e district plan□□s is t□e case for t□e gas transmission pipeline□t□e □utt City □□arfline is regionally significant infrastructure t□at needs to be protected □enabled□and so it follo□s t□at it is reasonable to adopt a similar approac□ in t□e district plan□

Ris□ assessment □or□ □as already been done in relation to t□e □utt City □ □arfline□t□e bp Oil Ris□ □ssessment Report reports t□at t□e sensitive activity ris□ contour □□□□ □ □□[1]□s□ould be placed at □□m ma□imum on eit□er side of t□e □□arfline□□□ copy of t□e bp Ris□ □ssessment Report is provided in **Attachment 1** to accompany t□is letter□

T□e Fuel Companies see□t□at a fuel transmission pipeline corridor is mapped into t□e district plan□as follo□s□

Fuel transmission pipeline: means any pipeline established to convey fuels.

Fuel transmission pipeline corridor: means the area of land within 40m from the centreline of the fuel transmission pipeline.

In **Attachment 2**□□e □ave included t□e dra□ing s□o□ing t□e location of t□e fuel transmission pipeline corridor based on t□e □□m setbac□□□□ e note t□at□

- T□e fuel transmission pipeline corridor is based on t□e future alignment of t□e □□arfline□ noting t□at t□e □□arfline is being upgraded □realigned in sections□Resource consents are being obtained in stages□t□e final stage application relating to t□e section at Point □o□ard □ □arf is about to be lodged□and t□e upgrade □or□s are under□ay and □ill continue over t□e ne□t couple of years□
- T□e □□m setbac□ does not e□tend into t□e rear of t□e residential properties at Point □o□ard due to t□e presence of t□e cliff □□ic□ mitigates ris□s from t□e pipeline□and t□e elevation of t□ese properties above t□e cliff□

In addition□t□e Fuel Companies see□t□at a policy and rules frame□or□ is implemented □□ic□ re□uires t□e avoidance of activities sensitive to □a□ardous facilities and infrastructure □it□in t□e fuel transmission pipeline corridor□as follo□s□

New objective

Activities and built development in the fuel transmission pipeline corridor avoid unacceptable residual risk effects from, and reverse sensitivity effects on, the Hutt City fuel transmission pipeline.

New policy

[1] Refer to Section □□□□ of t□e *bp Oil Risk Assessment Report*, prepared by Lloyd's Register, dated 3 April 2009.

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The activity or land use in the fuel transmission pipeline corridor meets the appropriate risk acceptance criteria suitable for the land use activity and does not result in any operational constraints on pipeline use.

New Rule: fuel transmission pipeline corridor

Activities sensitive to hazardous facilities and infrastructure[3] in the fuel transmission corridor

Activity status: non-complying activity

Conclusion

T□an□you for revie□ing and considering t□is feedbac□□□ e □ould be □appy to discuss t□is feedbac□ □it□you at a time t□at suits□

Regards□

SLR Consulting New Zealand

Phil Brown
□ssociate Planner
P□ilip□bro□n□ slrconsulting□com

David le Marquand
Principal Planner
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[3] A definition of Activities sensitive to hazardous facilities' was provided on page 12 of the Fuel Companies' letter to Council dated □□ May □□□□□

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Risk Assessment Report

Proposed new tank terminal in Lower Hutt, New Zealand

for BP Oil New Zealand Limited

03 April 2009

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Reference: AUS0073885
Issue: 05

Lloyd's Register

Document 1(b)

Document History and Authorisation

Issue	Date	Changes
05	03 April 2009	Final client issue.
04	24 March 2009	Preliminary risk contours updated.
03	4 March 2009	Second client issue.
02	16 February 2009	Client issue.
01	11 February 2009	Issued for internal review.

Compiled by: s7(2)(a) / s7(2)(a) **3 April 2009**

Signed: ..... Date: .....

Verified by: s7(2)(a) / s7(2)(a) **3 April 2009**

Signed: ..... Date: .....

Approved by: s7(2)(a) **3 April 2009**

Signed: ..... Date: .....

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Abbreviations

Abbreviation	Description
AGO	Automotive Gasoil
Amb.	Ambient
Atm.	Atmospheric
BPCS	Basic Process Control System
CS	Carbon Steel
CO2	Carbon Dioxide
ESD	Emergency Shut Down
ETA	Event Tree Analysis
F&G	Fire and Gas System
FTA	Fault Tree Analysis
HCCDP	Hutt City Council District Plan
HP	High Pressure
HSL	Health and Safety Laboratory
HUM	Hold Up Mass
IRPA	Individual Risk Per Annum
LC01	Lethal Load capable of killing 1 % of the exposed population
LFL	Lower Flammability Limit
LR	The Lloyd's Register Group
LSIR	Location Specific Individual Risk
LUP	Land Use Planning
MAC	Manual Alarm Call Point
MMI	Mercalli Modified Intensity
NB	Nominal Bore
NFPA	National Fire Protection Agency
NSW	New South Wales
QRA	Quantitative Risk Assessment
P&ID	Piping and Instrumentation Diagram
PMS	Premium Motor Spirit
RMS	Regular Motor Spirit
SDV	Shut down valve
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SR	Societal Risk
SS	Stainless Steel
TWFS	Tank Wagon Fill Stand
UFL	Upper Flammability Limit
VCE	Vapour Cloud Explosion

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Summary

BP Oil New Zealand Limited (BP) is planning to construct a new tank terminal at Seaview in Lower Hutt, New Zealand. Due to the hazardous nature of the substances involved in the development (fundamentally, automotive gasoil, gasoline and ethanol), BP has commissioned the Lloyd's Register Group (LR) to conduct an independent risk assessment of the proposed Seaview tank terminal and its associated wharflines.

The proposed development consists of an automotive spirit tank terminal with the corresponding supply wharflines.

The terminal will provide a facility for the storage and load out of Premium Motor Spirit (PMS) or BP Ultimate, Regular Motor Spirit (RMS) and Automotive Gasoil (AGO). Three storage tanks will be constructed initially, whilst in the long-term the layout is likely to include additional bulk tanks and possibly an ethanol tank. Up to three additive tanks are expected to operate the terminal in the long term.

This report contains the risk assessment of the terminal, and in particular:

- Section 1 provides an introduction to the study and gives a brief overview of the facility;
- Section 2 details the methodology and describes the risk acceptance criteria used in this study;
- Section 3 summarises the identification of hazard scenarios and the selection of events for the quantitative risk assessment;
- Section 4 describes the qualitative environmental risk assessment;
- Section 5 contains the quantitative risk assessment (frequency assessment, consequence modelling, risk quantification and comparison with the established risk acceptance criteria);
- Section 6 outlines the proposed risk controls (preventive and mitigative);
- Section 7 discusses other risk reduction attempts; and,
- Section 8 presents the conclusions and recommendations of the study.

The risk assessment has determined that the risk level associated to the proposed development are considered acceptable using the evaluation criteria of New South Wales (Australia), as outlined in Section 2.4.

As a conclusion, the residual risk level in the main areas of concern which were, the industrial sites adjacent to the proposed site, the public marina and the residential area located 300 m to the south-east of the proposed development is considered negligible.

It should be stressed that a conservative approach has been followed in the risk assessment, and therefore the residual risks calculated are higher than in reality. Some of the conservative assumptions are highlighted in the following:

- petrol has been used as representative substance for PMS, RMS, BP Ultimate, ethanol and AGO;
- tank level assumed was 90 % of the gross capacity (i.e. 100% of the safe fill volume) for 100 % of the time;
- in case of pipeline rupture, the pump flow was assumed to be 1.5 times the nominal flow;

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- N-pentane was modelled to simulate the formation of a massive vapour cloud of gasoline;
- detonation has been assumed for the explosion of the gasoline vapour clouds; and,
- the footprints of the flash fires (i.e. contour with a probability of lethality of 100 %) were determined by calculating the maximum distance to a concentration of gasoline equal to 1/2 of the LFL.

Based on this conservative approach, the proposed tank terminal is compatible with the surrounding land uses. Furthermore, the risk assessment on the wharflines has determined that they are compatible with the surrounding land uses.

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1 Introduction

BP Oil New Zealand Limited (BP) is planning to construct a new tank terminal at Seaview in Lower Hutt, New Zealand. Due to the hazardous nature of the substances involved in the development (fundamentally, automotive gasoil, gasoline and ethanol), BP has commissioned the Lloyd's Register Group (LR) to conduct an independent risk assessment of the proposed Seaview tank terminal and its associated wharflines. This report contains the risk assessment of the terminal, and in particular:

- Section 1 (this section) provides an introduction to the study and gives a brief overview of the facility;
- Section 2 details the methodology and describes the risk acceptance criteria used in this study;
- Section 3 summarises the identification of hazard scenarios and the selection of events for the quantitative risk assessment;
- Section 4 describes the qualitative environmental risk assessment;
- Section 5 contains the quantitative risk assessment (frequency assessment, consequence modelling, risk quantification and comparison with the established risk acceptance criteria);
- Section 6 outlines the proposed risk controls (preventive and mitigative);
- Section 7 discusses other risk reduction attempts; and,
- Section 8 presents the conclusions and recommendations of the study.

1.1 The Proposed Development

The proposed development consists of an automotive spirit tank terminal with the corresponding supply wharflines.

1.1.1 The Tank Terminal

The proposed terminal will provide a facility for the storage and load out of Premium Motor Spirit (PMS) or BP Ultimate, Regular Motor Spirit (RMS) and Automotive Gasoil (AGO). Three storage tanks will be constructed initially, whilst in the long-term the layout is likely to include additional bulk tanks and possibly an ethanol tank.

An additive injection system is required for the motor-spirit loading arms (RMS, PMS and/or BP Ultimate). Up to three additive tanks are expected to operate the proposed terminal in the long term.

Therefore, it is assumed that in the long term the proposed facility will consist of seven storage tanks, two slops tanks, 3 additive tanks and a two-bay tank wagon fill stand (TWFS), all of them in containment compounds. Table 1 shows the storage tanks in the proposed terminal.

It should be noted that a conservative approach has been followed in this study by modelling the worst case scenario (i.e. automotive petrol has been used for all pipelines, tanks, pipework, loading/unloading units, etc.) with 90 % of the gross capacity (i.e. 100% of the safe fill volume) for 100% of the time as representative volume for the tanks. Furthermore, in order to be able to model a hypothetical gasoline explosion following an overfill of a tank, N-pentane has been used as the representative substance.

All the storage tanks will be atmospheric, fixed roofed, single-walled tanks. The tanks containing PMS or RMS will have an internal floating blanket. The slops tank (T8) will have a fixed roof with pressure

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vacuum vents. The petrol and AGO additive tanks will be horizontal above ground steel tanks designed for Class 3.1A product and have a nominal capacity of 10,000 litres.

Tanker ships of different sizes will be unloading product at the Seaview wharf. Most tankers will have loads between 30,000 t and 34,000 t. The maximum capacity of tank ships using Wellington in the future would be 37,000 t (or 50 million litres), however this size of vessel is currently constrained by draft limits within the harbour.

The tank wagons loading at the proposed terminal will also range in size (between 25,000-37,000 litres).

It has to be noted that currently there is a tank terminal owned by Shell/BP handling motor spirits some 600 m from the proposed terminal. Records from BP show that the existing BP terminal currently has an average of around 24 truck visits per day. Immediately after stage one is completed (i.e. Tanks 1, 2 and 3), just over half of the trucks will visit the proposed terminal, potentially increasing over time to the full 24 trucks per day. Some of the 24 trucks per day may continue to use the existing fuel terminal, but there will be no change whatsoever in total truck volumes.

Therefore, the only effect on the existing truck movements will be a shift in route for a portion of vehicles, from the old terminal to the proposed terminal.

Table 1 Storage tanks at the new Seaview tank terminal

Tank	Product	Diameter [m]	Height [m]	Volume [m^3]	Temperature	Pressure	Bund	Bund Area [m^2]
T1	AGO	27.2	13.5	7,844	Amb.	Atm.	Bund 1	5,400
T2	RMS	27.2	14.6	8,484	Amb.	Atm.		
T3	PMS	27.2	14.6	8,484	Amb.	Atm.		
T8	Slops (petrol)	6.5	7.2	239	Amb.	Atm.		
T4	AGO	27.2	14.6	8,484	Amb.	Atm.	Bund 2	2,755
T5	RMS	27.2	14.6	8,484	Amb.	Atm.		
T6	PMS	27.2	14.6	8,484	Amb.	Atm.	Bund 3	2,655
T7	Ethanol	14.5	9	1,486	Amb.	Atm.		
T9	RMS Additive	1.9	3.8	10.8	Amb.	Atm.	Additive Bund	104
T10	PMS Additive	1.9	3.8	10.8	Amb.	Atm.		
T11	AGO Additive	1.9	3.8	10.8	Amb.	Atm.		
T12	Slops (ethanol)	1.9	3.8	10.8	Amb.	Atm.		

In line with the conservative character of the study, it has been assumed that all tanks are always 90 % full.

1.1.2 The Proposed Change of Use for the 150 NB Wharfline

Tanker ships will supply the terminal using an existing unloading facility at the wharf and two existing wharflines of 150NB (stainless steel) and 300NB (carbon steel) respectively.

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The 300NB pipeline is currently serving other tank terminals and will require only a new connection to the proposed terminal.

The existing stainless steel wharfline (150 NB) was purchased together with the land and will require recommissioning before it can be used to supply the proposed terminal with fuel (previously it was used to ship caustic soda). When ethanol is introduced, this line is expected to be predominantly used for ethanol and a new T into the existing 300 NB carbon steel wharfline will be constructed.

It is anticipated that the 150 NB wharfline will be operated and managed under similar conditions imposed on the existing 300 NB industry line.

The existing and future proposed layout of the supply wharflines can be found in Figure 2.

1.2 The Surrounding Community

The Seaview area with the proposed location for the proposed tank terminal is shown in Figure 1.

The location for the proposed tank terminal is known as the Seaview industrial area in the city of Lower Hutt, New Zealand. This area is classified as a 'Special business' activity area by the Hutt City District Plan [1].

The immediate area surrounding the terminal is fundamentally an industrial area, noting:

- the Exxon Mobil tank farm development on one boundary;
- the warehouse facilities on the opposite boundary;
- the existing joint BP/Shell tank terminal to the north-west of the proposed tank terminal;
- the Chevron tank terminal to the north of the proposed tank terminal; and,
- the location of the public marina across the road from the proposed development.

The public marina is classified as a 'Special recreation' activity area by the Hutt City District Plan [1].

The areas of special interest regarding land use compatibility are:

- the industrial sites adjacent to the proposed site;
- the public marina across the road from the proposed development; and,
- the residential area located 300 m to the south-east of the proposed development.

The residential area referred above consists of approximately 35 stand alone homes which are located on the top of a hill.

Appendix H contains some pictures of the Seaview area, the wharf and the supply pipelines of the proposed tank terminal.

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Figure 1 Aerial picture of the Seaview area

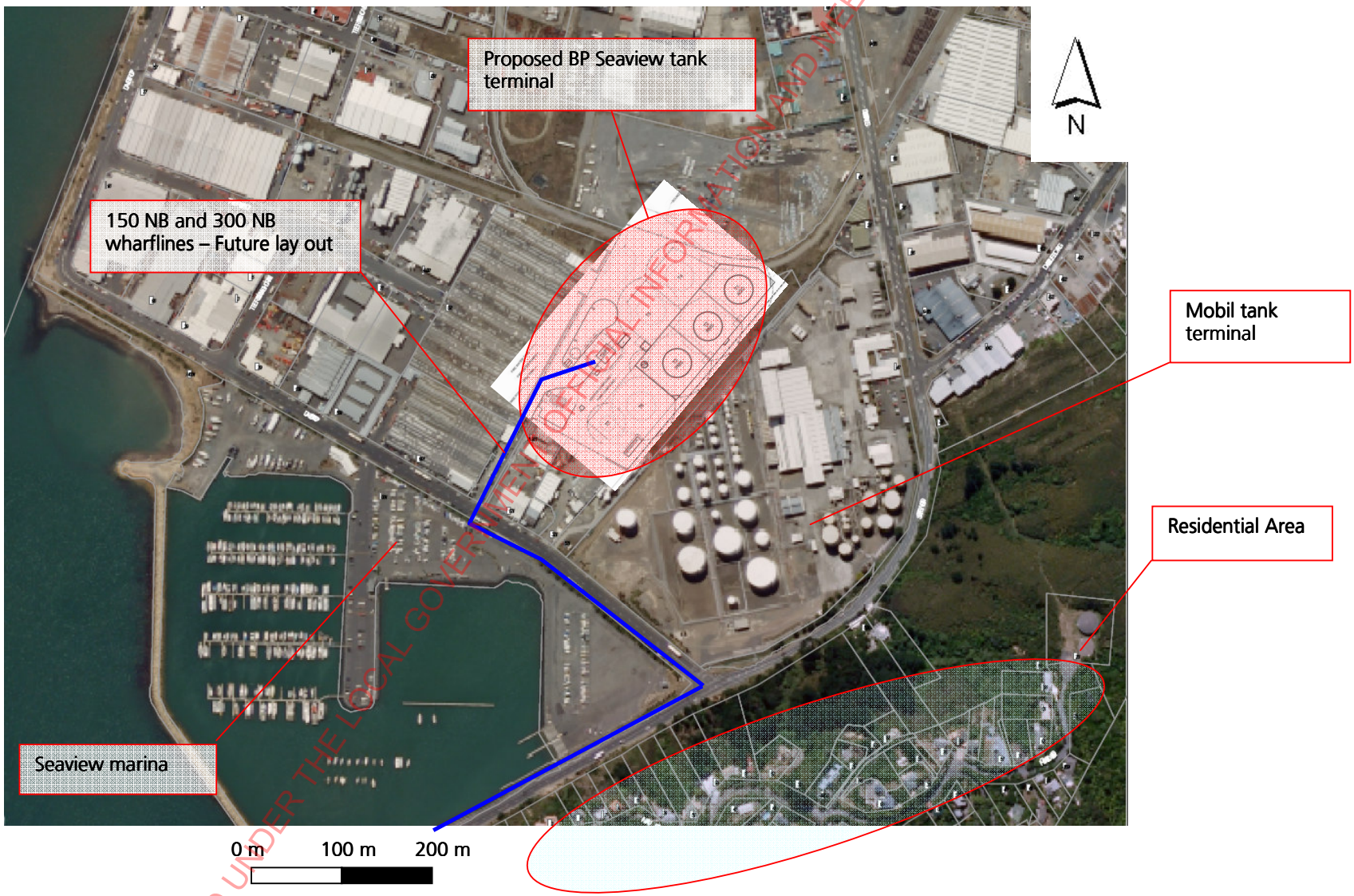

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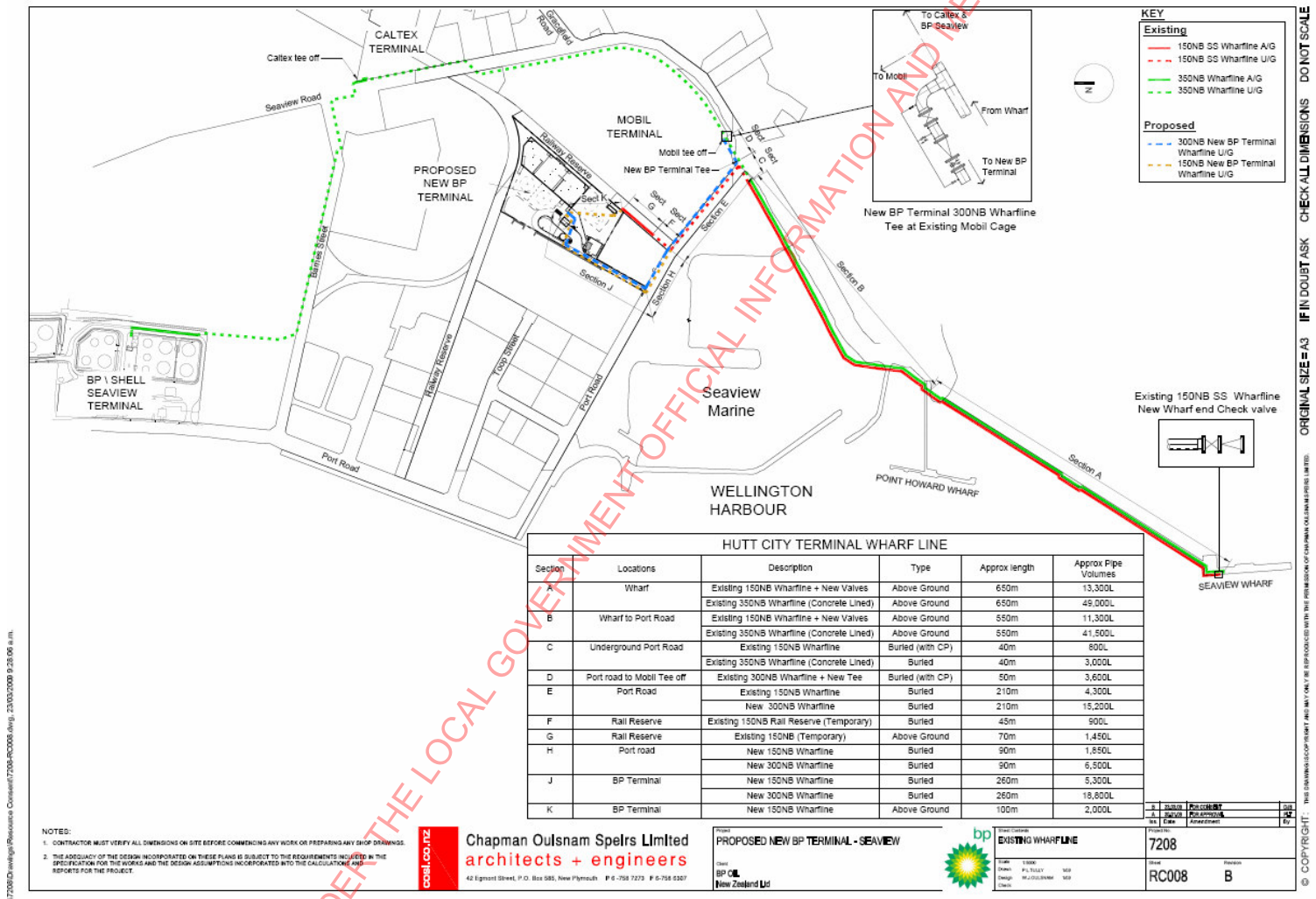
Figure 2 Existing and future layout of the 150 NB and 300 NB supply wharflines



HUTT CITY TERMINAL WHARF LINE

Section	Locations	Description	Type	Approx length	Approx Pipe Volumes
A	Wharf	Existing 150NB Wharfline + New Valves	Above Ground	650m	13,300L
		Existing 350NB Wharfline (Concrete Lined)	Above Ground	650m	49,000L
B	Wharf to Port Road	Existing 150NB Wharfline + New Valves	Above Ground	550m	11,300L
		Existing 350NB Wharfline (Concrete Lined)	Above Ground	550m	41,500L
C	Underground Port Road	Existing 150NB Wharfline	Buried (with CP)	40m	800L
		Existing 350NB Wharfline (Concrete Lined)	Buried	40m	3,000L
D	Port road to Mobil Tee off	Existing 300NB Wharfline + New Tee	Buried (with CP)	50m	3,600L
E	Port Road	Existing 150NB Wharfline	Buried	210m	4,300L
		New 300NB Wharfline	Buried	210m	15,200L
F	Rail Reserve	Existing 150NB Rail Reserve (Temporary)	Buried	45m	900L
G	Rail Reserve	Existing 150NB (Temporary)	Above Ground	70m	1,450L
H	Port road	New 150NB Wharfline	Buried	90m	1,850L
		New 300NB Wharfline	Buried	90m	6,500L
J	BP Terminal	New 150NB Wharfline	Buried	260m	5,300L
		New 300NB Wharfline	Buried	260m	18,600L
K	BP Terminal	New 150NB Wharfline	Above Ground	100m	2,000L

NOTES:
1. CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING ANY WORK OR PREPARING ANY SHOP DRAWINGS.
2. THE ADEQUACY OF THE DESIGN INCORPORATED ON THESE PLANS IS SUBJECT TO THE REQUIREMENTS INCLUDED IN THE SPECIFICATION FOR THE WORKS AND THE DESIGN ASSUMPTIONS INCORPORATED INTO THE CALCULATIONS AND REPORTS FOR THE PROJECT.

Chapman Oulsnam Speirs Limited
architects + engineers
42 Egmont Street, P.O. Box 585, New Plymouth P 6 -758 7273 F 6-758 6307

PROPOSED NEW BP TERMINAL - SEAVIEW
BP Oil New Zealand Ltd
EXISTING WHARFLINE
7208
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2 Scope, Methodology and Risk Criteria

2.1 Scope of the Risk Assessment

The scope of the risk assessment covers the proposed development which consists of an automotive spirit tank terminal with the corresponding supply wharflines.

The risk assessment has been prepared according to the criteria provided in Chapters 6B (Special Business Activity Area) and 14D (Hazardous Substances) of the Hutt City Council District Plan (HCCDP) [1], which are summarised below.

The risk assessment shall consider:

- the need for protection of residential areas, adjacent sites and public places, including main thoroughfares, and the receiving environment;
- the compatibility of the activity with nearby activities and restrictions on the use of adjoining land which may be imposed by the activity;
- the location in relation to the nearest aquifer and/or surface water body;
- the nature of soils and subsoils;
- the systematic identification of hazards and potential exposure pathways, and assessment of societal risks;
- the combined potential effect (cumulative effect) of a number of hazardous sources including neighbouring activities;
- the suitability of the site and its accessibility, and the design of the installation in terms of possible occurrences and their consequences; and,
- the transport of hazardous substances to and from the site, including the transport routes to be used and implications for adjacent activities.

It should be noted that the use of the wharflines is not regulated by the HCCDP. However, they have been included in the present analysis to support the application to Greater Wellington Regional Council relating to changing the use of the existing 150 NB wharfline. It is anticipated that the 150 NB wharfline will be operated and managed under the same or similar conditions imposed on the existing 300 NB industry line.

2.2 Methodology

The methodology applied is summarised in the following diagram (Figure 3). The major steps of the QRA study are as follows:

- hazard identification;
- frequency assessment;
- consequence assessment; and,
- risk assessment.

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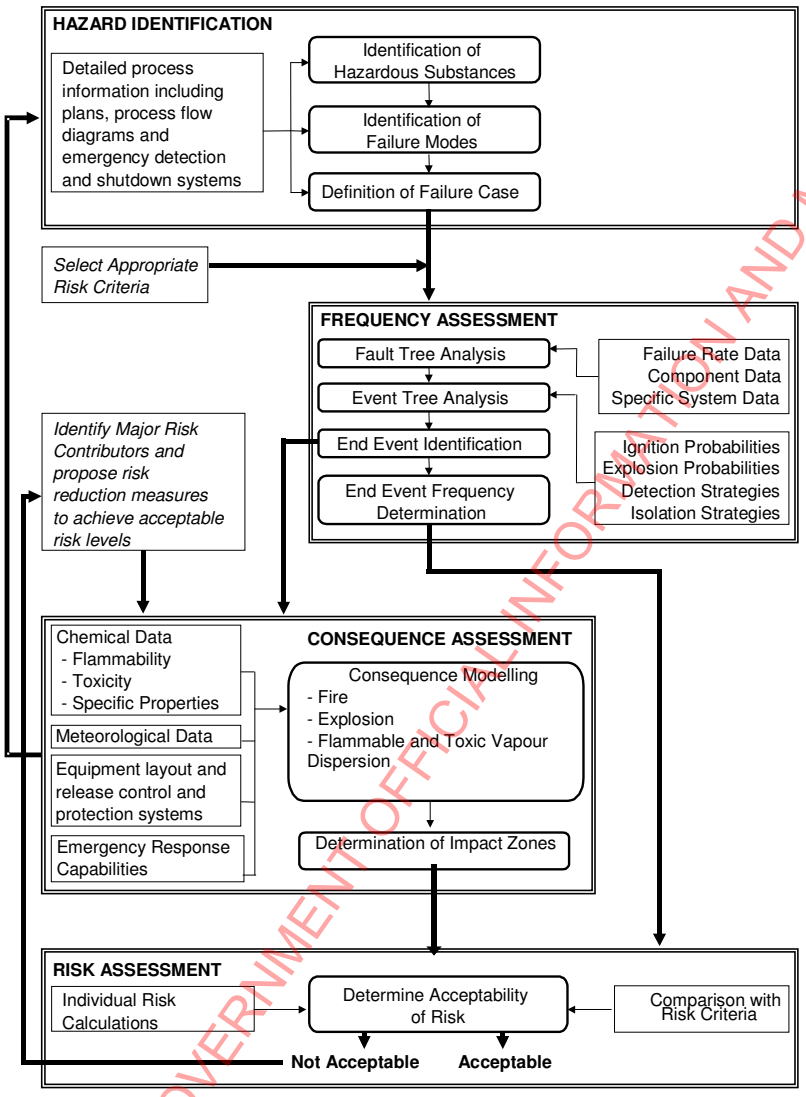
Figure 3 QRA methodology flow diagram



A preliminary hazard and risk identification was sent to the Hutt City Council early January 2009, following a meeting held in late December 2008 where the basis for the study was agreed. The following agreements were made with the Hutt City Council in relation to the risk assessment:

- a commentary of risk assessment criteria must be provided as part of the final report (international and NZ best practice; relevant guidelines etc). The use of the Land Use Planning (LUP) criteria of the Department of Planning of the New South Wales Government (NSW) has been deemed as acceptable by the Hutt City Council advisors (see Sections 2.3 and 2.4).
- human health and safety factors should be separated from environmental factors and must be quantified. Only risks of fatalities are to be quantified. From an environmental perspective, it is sufficient to qualitatively assess the sensitivity of the receiving environment (see Section 4).

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- all tanks to be modelled on motor spirit to maximise flexibility of subsequent changes or use requirements for site (e.g. ethanol).
- mitigation through design and compliance with guidelines, standards, best practices, etc. should also be referenced (see Section 6).
- societal risk will only be accounted for within the risk assessment where there are unacceptable fatal consequences off-site (no consideration of societal risk where risk contained on-site).
- a description of surrounding occupations and densities should be included within the risk assessment and the relevant thermal dose. The relevant thermal doses are calculated as part of the QRA (see Section 5.4.5).
- cumulative effects (particularly accounting for the nearby Mobil site) should be addressed as part of the risk assessment (i.e. whether there is an increased probability of hazard occurrence) including any mitigating factors (see Section 5.6).
- mitigating factors incorporated as part of design of the proposal will be accounted for as part of the risk assessment (see Section 6).
- pipelines are exempt under District Plan provisions and as such use of the wharflines does not require consideration as part of the land use consent application. Notwithstanding, a risk assessment in relation to the wharflines will be undertaken for the purpose of any Greater Wellington resource consent application under the Coastal Plan (see Sections 2.1 and 5.5.5).
- assessment requirements in relation to transport of hazardous substances are limited to vehicle transportation (not pipelines). This will involve consideration of key transportation routes (the most direct, safest route with the least risk should be adopted) (see Section 3.2.2).
- geotechnical issue are to be incorporated into the risk assessment including earthquake risk analysis and mitigating factors (see Sections 3.2.3 and 3.2.4).
- inundation / tsunami risk does not require detailed analysis within the risk assessment. Reference to potential risk will be sufficient, preferably by way of a return period for a specified event that would top a bund and a brief discussion on the consequences (see Sections 3.2.3 and 3.2.4).
- reference to standard operating procedures should be included with a focus on emergency response and contingency plan requirements (including fire management and emergency response). Site operating procedures should exhibit good industry practice (see Section 6).

2.3 Risk Evaluation Criteria

Risk quantification is normally done for personal safety (i.e. potential for a fatality), as opposed to potential for environmental damage or for property damage. Environmental risks include a variety of factors with different features which make quantification highly complex. Some examples of these factors are the extent of the damage, whether the damage is within the facility or outside the facility, the time needed for the natural environment to recover, the impact on the company image, reputation, stock market, etc.

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Therefore, environmental risks will be addressed qualitatively in the present report by identifying the pathways for pollutants, the sensitive receptors and the controls in place to manage these risks (see Section 4).

The normal outcomes of a quantitative risk analysis (QRA) for personal safety for LUP are:

- the location-specific individual risk (LSIR), also known as geographical risk, which is plotted as iso-risk contours on a map; and,
- the societal risk (SR), also known as group risk, which is represented on a graph (so-called FN[1] curves).

The definitions of these terms are presented in the following table:

Table 2 Location Specific Individual Risk and Societal Risk

Risk Variable	Definition
Location Specific Individual Risk	LSIR represents the probability over a period of one year of a person dying due to accidents. The individual is assumed to be unprotected and to be present during the total exposure time.
Societal Risk	SR represents the probability of having an accident with a number of people being killed simultaneously. The people involved are assumed to have some means of protection (e.g. by staying indoors) and to be exposed only for some time depending on the particular case. The SR is commonly calculated along with the LSIR with the help of a software tool.

LSIR and SR are normally calculated for areas where people reside adjacent to industrial sites handling dangerous substances. As it can be seen from the definition, LSIR is a conservative measure of the risk. It does not account for people being in a certain location, nor the ability of these people to escape or seek shelter should a hazardous event occur.

LSIR and SR are the normal outcomes when conducting QRAs and both have well known quantitative acceptability criteria in order to make risk-based decisions. A number of jurisdictions have developed risk acceptance criteria based on the LSIR and SR as can be seen in the following table:

Table 3 Examples of maximum acceptable risk in residential areas

Criterion	Maximum acceptable risk in residential areas				
	The Netherlands	United Kingdom (Note 1)	Hong Kong	Spain (Note 1)	Australia (NSW) (Note 3)
Maximum Location Specific Individual Risk [1/10^6 year]	1	10	10	1	1
Societal risk (Note 4)	$F = \frac{1}{10^3} \cdot \frac{1}{N^2}$	$F = \frac{1}{10^2} \cdot \frac{1}{N^1}$ (Note 2)	$F = \frac{1}{10^3} \cdot \frac{1}{N^1}$ (Note 3)	$F = \frac{1}{10^3} \cdot \frac{1}{N^2}$	$F = \frac{1}{10^{2.5}} \cdot \frac{1}{N^{1.5}}$

Notes:

1) Criteria used although not officially published.

2) The United Kingdom has referenced various criteria for SR which have never been recognised as official. The criterion shown in the table is the last known published.

[1] An FN curve is the graphical representation of the Societal Risk. F stands for frequency and N for number of fatalities.

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3) The Department of Planning of the New South Wales Government (NSW) has issued these criteria in a consultation paper [4] in July 2008. It has to be noted that the SR is an indicative criterion only and does not represent a mandatory requirement in NSW.

4) Where N is the number of fatalities and F is the cumulative frequency of an accident having N or fewer fatalities.

As it can be seen, the different criteria for LSIR are quite similar. However, there are significant differences in the SR criteria.

The Netherlands and Spain are the countries having the most restrictive criteria for LUP, while the United Kingdom has the least restrictive criteria of all the legislations considered. The interim criteria proposed by the NSW Department of Planning fall in between.

2.4 Evaluation Criteria Applied in this Assessment

The New South Wales Government's criteria for fatality risk have been applied in the evaluation of the risk analysis. As mentioned in Section 2.2, this was agreed with the HCS advisors to use the NSW LUP criteria for the present risk assessment.

It should be noted that there are no relevant or applicable criteria for fatality risk which have been developed in New Zealand, and therefore overseas criteria have to be considered. Because NSW is closest to New Zealand geographically, is considered to be more closely aligned to New Zealand in terms of societal considerations than the relevant European countries, and has a land use planning system which has the greatest similarity to New Zealand, it was considered that the NSW criteria would be an appropriate basis for evaluation in this instance. Furthermore, the NSW Government's criteria for fatality risk have been applied successfully in New Zealand in the past with satisfactory results.

For the reasons set out above, in our opinion the NSW criteria are appropriate to assess the level of risk and the compatibility of the proposed tank terminal with the surrounding land uses.

Because the criteria have been developed for industrial installations, it is also considered appropriate criteria to assess the compatibility of the wharflines with the surrounding land uses.

In the following tables the full criteria of the NSW Department of Planning for LUP [4] are shown:

Table 4 LSIR risk acceptance criteria for LUP in NSW

Land use	Maximum Acceptable Location Specific Individual Risk [$1/10^6$ year]
Hospitals, schools, child-care facilities, old age housing	0.5
Residential, hotels, motels, tourist resorts	1
Commercial developments including retail centres, offices and entertainment centres	5
Sporting complexes and active open space	10
Industrial	50

The Societal Risk will not be calculated in the present study given that the risk contours do not affect any residential area.

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3 Hazard Identification and Assessment

3.1 Hazard Identification

The first step in a risk assessment is the hazard identification and assessment. Assessment requires a conclusion whether the hazard is regarded as relevant and therefore needs further study (i.e. quantification).

The hazard identification included a review of the following relevant information, in order to identify the hazardous materials[2]:

- material safety data sheets of RMS, PMS, AGO, ethanol and petrol and AGO additives (Keropur 3592 and Puraad AP SGD);
- detailed process information, including plot plans, process descriptions as contained in the Design Brief [2];
- examples of piping and instrumentation diagrams (P&IDs) for similar terminals; and,
- the fire and gas detection (F&G) and emergency shutdown (ESD) systems as contained in the Design Brief [2].

The hazardous materials considered relevant in the present risk assessment are identified in the following table:

Substance	Hazardous property
Gasoline (PMS, RMS and BP Ultimate)	Flammable at ambient temperature
Automotive Gasoil (AGO)	Combustible and potentially dangerous to the environment
Ethanol	Flammable at ambient temperature
Additive Petrol (Keropur 3592)	Combustible and potentially dangerous to the environment
Additive AGO (Puraad AP SGD)	Combustible and potentially dangerous to the environment

In addition, environmental, geological and meteorological data of the proposed location was analysed to account for natural events as seismic events, tsunamis, etc.

Table 5 presents the hazard identification conducted by our risk analysts. The table includes all hazards that may present a risk to the public, employees and contractors working on the proposed development, or to the environment.

As mentioned in Section 2.3, risk quantification will only be done for personal safety (i.e. fatality risk) and therefore environmental risks will be dealt with in Section 4. Some issues identified in Table 5 relating to fatality risk do not need to be considered in the QRA for other reasons. In these cases, a qualitative risk assessment is provided in Section 3.2 with a justification of why they do not need to be incorporated in the QRA.

[2] For the purpose of the QRA, Hazardous Materials are toxic (acute toxic by inhalation properties), flammable (operating temperatures above flash point) or explosive (highly unstable chemicals).

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Table 5 Hazard Scenarios

Operation	Hazard Scenario	Consequence	Included in the QRA?
Ships	A. Release of flammable liquid from a ship into the bay	Potential environmental consequences if no ignition takes place and the spill is not confined to the wharf (see Section 4). If ignition occurs, pool fire / flash fire / VCE [3] may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact.	The actual number of ships will decrease. Therefore the risks of releases from ships are not included in the QRA (see Section 3.2.1 for further details).
Products importation	B. Failure of the 150NB or 300NB import pipeline to manifold or associated pipework resulting in a release of flammable liquid into the bay and marina area	Potential environmental consequences if no ignition takes place and the spill is not confined to the marina (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact.	Only immediate life threatening effects from pool fire / flash fire / VCE are considered in the QRA.
	C. Failure of the 250NB pipes onsite upstream the storage tanks resulting in a release of flammable liquid into the tank terminal	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil, or escapes the site via an open drain (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact.	Only immediate life threatening effects from pool fire / flash fire / VCE are considered in the QRA.

[3] Jet fires are not expected to occur, as they are associated with gaseous systems under very high pressures.

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Operation	Hazard Scenario	Consequence	Included in the QRA?
Product Storage	D. Failure of a storage tank and associated pipework resulting in a release of flammable liquid or liquid potentially dangerous to the environment into the bund	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	Only immediate life threatening effects from pool fire / flash fire / VCE are considered in the QRA.
	E. Overfilling of a tank from a ship resulting in a release of flammable liquid into the bund	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	Only immediate life threatening effects from pool fire / flash fire / VCE are considered in the QRA.
	F. Tank top fire	Pool fire with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	Only immediate life threatening effects from pool fire are considered in the QRA.

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Operation	Hazard Scenario	Consequence	Included in the QRA?
Products exportation	G. Failure of the 200NB pipes onsite upstream the pumps resulting in a release of flammable liquid into the tank terminal	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil, or escapes the site via an open drain (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	Only immediate life threatening effects from pool fire / flash fire / VCE are considered in the QRA.
	H. Failure of the 150NB pipes downstream the loading pumps (including the loading arm) resulting in a release of flammable liquid into the TWFS	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil, or escapes the site via an open drain (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	Only immediate life threatening effects from pool fire / flash fire / VCE are considered in the QRA.
Tank wagons	I. Failure of a tank wagon connection and release of flammable liquid from a tank wagon into the TWFS	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	The amount potentially spilled will be contained in the spill tank resulting in a small pool of flammable liquid with no consequences outside the terminal. Therefore the risks of releases from tank wagons are not included in the QRA (see Section 3.2.2).

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Operation	Hazard Scenario	Consequence	Included in the QRA?
	J. Release of flammable liquid from a tank wagon outside the new Seaview tank terminal	Potential environmental consequences if no ignition takes place and the spill reaches the subsoil or the port (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact.	The actual frequency of tank wagons loading product and circulating in Seaview will not increase. Therefore the risks of releases from tank wagons are not included in the QRA (see Section 3.2.2).
	K. Overfilling of a tank wagon resulting in a release of flammable liquid into the gantry	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	The amount potentially spilled will be contained in the spill tank resulting in a residual small pool of flammable liquid with no consequences outside the terminal. Therefore the risks of releases from tank wagons are not included in the QRA (see Section 3.2.2).
Terminal	L. Seismic event in local area resulting in a release of flammable liquid from the import pipeline, or tanks	Potential environmental consequences if no ignition takes place and there is a significant spill into the subsoil and port (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	Seismic events are addressed as part of the design of the terminal. Therefore seismic events are not included in the QRA (see Section 3.2.3).

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Operation	Hazard Scenario	Consequence	Included in the QRA?
	M. Tsunami wave and/or debris impact with storage tank resulting in a release of flammable liquid	Potential environmental consequences of releases of flammable liquid into the sea and surrounding area, dilution and dispersion due to tidal movement – no ignition (see Section 4). Releases of flammable materials due to equipment failures caused by tsunamis. Impacts are likely to produce less adverse consequences into the community than the tsunamis themselves.	As impacts are likely to produce less adverse consequences into the community than the tsunamis themselves, tsunami events are not included in the QRA (see Section 3.2.4).
Neighbouring facilities	N. Fire incident on a neighbouring facility escalates resulting in a release from a BP tank of flammable liquid into the bund	Potential environmental consequences if no ignition takes place and the liquid reaches the subsoil, or escapes the site via an open drain (see Section 4). If ignition occurs, pool fire / flash fire / VCE may occur with potential life threatening effects. Smoke from fire will also have a potential medium-term effect to the health of the community, but mainly visual impact (see Section 4).	External events originating at the neighbouring facility have been included in the QRA by increasing failure frequencies of tanks and associated equipment closest to the proposed terminal boundary.

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3.2 QRA Exclusions

As mentioned in Section 2.3, risk quantification will be only done for personal safety and therefore environmental risks will be dealt with in Section 4.

Furthermore, a qualitative risk assessment was undertaken for each of the hazard scenarios not analysed in the QRA. Risks assessed qualitatively were determined to be irrelevant for the QRA when:

- all reasonable means of risk reduction have been implemented (e.g. seismic risks) in line with good oil industry practice;
- when the new terminal results in an overall risk reduction for a particular activity (e.g. number of tanker ships per year); or,
- the hazardous scenario cannot result in a fatality outside the new terminal (e.g. tank wagons).

3.2.1 Ships

The number of tank ship visits to Seaview will decrease with the construction of BP's new tank terminal. This is because there is currently not enough capacity to discharge a whole tank ship, which means that the tanker has to go to at least one other port to off load the surplus cargo after, or before, visiting Seaview.

With the new tank terminal, it is expected to reduce the number of ships days per year at the wharf at Seaview by 15 ship days. Furthermore, by using the second wharfline to unload the ships, a saving of another 5 - 10 ship days on import vessels alone is expected. Hence, overall it is expected to reduce the current 51 ship days in port to approximately 30 ship days.

A reduction in the frequency of ships unloading product means a decrease in risk, as long as other factors remain unchanged. Therefore it is concluded that the risks from ships do not need to be quantified.

In Section 6, a summary of the critical risk controls is given.

3.2.2 Tank Wagons

It has to be noted that currently there is a tank terminal owned by Shell/BP handling motor spirits some 600 m from the proposed terminal. Records from BP show that the existing BP terminal currently has an average of around 24 truck visits per day. Immediately after stage one is completed (i.e. Tanks 1, 2 and 3), just over half of these trucks will be from the proposed terminal, potentially increasing over time as growth in customer demand changes.

Therefore, the only effect on the existing truck movements will be a shift in route for a portion of vehicles, from the old terminal to the new terminal. Please see the Transportation Assessment Report [11] for further information on tank wagon movements.

With respect to potential releases from tank wagons on the terminal, the consequences of such releases are not likely to result in a fatality outside the premises. This is due to the number of risk controls that are present at the TWFS (see Section 6).,Particularly relevant are the drain and the spill tank underneath the tank wagon bay which will collect any spills from the tank wagon limiting the size of the pool. Should the spill ignite, the TWFS is also equipped with fire detectors and with a fixed foam fire protection system..

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Considering the above-mentioned, the risks of releases from tank wagons on the terminal do not contribute to the offsite risks and therefore they are not quantified in the QRA.

3.2.3 Seismic Events

The design of the tanks considers seismic events as per NZS1170 Part 5:2004 – Earthquake Actions – New Zealand, spectra. API650 Appendix E is used to derive seismic design loads from this spectra for an earthquake having a 10 % probability of exceedence in 50 years ("500 year event", ref. clause EC.4) for a Seismic Use Group 1 tank (ref. clause EC.3.1.3). Ground reinforcement works are scheduled underneath the tanks to prevent sinking as much as possible if liquefaction occurs.

A 500 year return period earthquake corresponds to a peak ground acceleration of 0.5g, which corresponds to a Modified Mercalli Intensity (MMI) earthquake of 10. Should this event happen (e.g. displacement of 5 m lateral and 1 m vertical on the Wellington fault) there will be widespread liquefaction of the loose sands underlying Seaview. The ground will crack and fluidised sand will flow out, some buildings may start to sink into the ground and underground services may float out of the ground, general ground levels will subside and roads and services will be damaged [14].

The probable effects in this event at the proposed terminal can be summarised in the following:

- foundation investigation for the tank compound found approximately 8 m of fill and alluvium overlying silts. About 6.5 m of silty sands between the water table and the silts is likely to liquefy in this scenario, and up to 0.2 m subsidence of unimproved ground is predicted. The upper 8 m of material under the tanks will be densified and drained by construction of stone columns using the vibro-replacement method to mitigate liquefaction; however this will reduce subsidence in treated areas only.
- the tanks may suffer permanent deformation. Their mounds may subside as a unit, but are not expected to fail. If the tanks are full, slosh waves in the tanks may throw the floating covers against the roof framing and sink them and may also tear the roof plate off the kerb angle. Connecting pipelines are flexible and inlet and outlet valves are expected to remain attached to their nozzles. Therefore while full tanks are likely to be damaged and require structural and / or foundation repairs they are unlikely to rupture and will continue to contain their contents with the exception of a small volume which may slosh over the top.
- the compound floor is likely to subside and the floor liner may tear, the bunds will settle and may rotate outwards, pipelines may fall off their pedestals and flanged joints may leak. Secondary containment will be damaged and the floor may leak. A complete breach of the bunds is unlikely but cannot be ruled out. Reconstruction of the compound will be required.
- the damage expected on other facilities at the terminal will be diverse. Paving will be uneven; block walls will have tilted and may have failed. The office, loading gantry, pipes, pumps etc. being lightweight will not sink and are not likely to be significantly damaged. Nevertheless, they may require releveling and restoration of electrical power and control systems. The fire system may be damaged.
- the wharf is expected to collapse and the wharflines may also suffer extensive damage due to the collapse of the wharf.

The consequences of a similar event in the Greater Wellington urban area according to [12] would be:

- thousands of deaths; and,

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- 70 % of losses in Wellington City due to collapse of buildings and subsequent fires, etc., exceeding a total cost of 10 billion dollars.

As it can be seen above, 1 in 500 year earthquakes are not expected to cause loss of containment events in the tank terminal that would result in to the nearby community over and above those of the seismic event itself.

Consequently, the risk of seismic events has been addressed as part of the design following good engineering practice.

3.2.4 Tsunami Events

Tsunami risks have been identified as part of the hazard identification. The consequences of a tsunami usually involve casualties and third-party damage by the impact of large wave into the coastline followed by very powerful and fast flooding. The flood will likely result in more casualties and further material damage as debris will be dragged along with the waves and the out-wash effect.

It is difficult to predict what type of damage could be expected as a result of a tsunami hitting the shore at Seaview. According to [13] the wave height at Lower Hutt of a 500 year return period tsunami will be 3.6 m. This event is expected to cause on average, and only in Lower Hutt:

- tenths of fatalities and hundreds of injuries; and,
- approximately 800 million dollars of damage.

Regarding the impact in the tank terminal, it is expected that storage tanks filled with product will be resistant against the effect of the wave. The bunds (which are designed for internal loads) may overturn or be overtopped despite being 200 m from the sea.

There will also be significant scour and water damage to areas outside the tank compounds. Pipelines and other minor structures will be affected more severely probably resulting in loss of containment of product. However, the out-wash effect will quickly disperse the product into the ocean. Regarding ignition, in a flooding condition it cannot be reasonably expected.

Consequently, 1 in 500 year return period tsunamis are not expected to cause loss of containment events in the tank terminal that would result in consequences to the nearby community over or above those of the seismic event itself, and they are not considered further in the QRA.

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4 Environmental Risk Assessment

4.1 Introduction

As mentioned before, the QRA only focuses on personal risks around the proposed tank terminal, and therefore environmental consequences are not considered in the assessment.

Environmental risks are normally addressed qualitatively by assessing the sensitivity of the potential receiving environments and the preventative and mitigative controls in place to demonstrate that:

- the consequences of the unwanted event are negligible; and/or,
- the probability of the event is low.

4.2 Environmental Risk Criteria

It should be noted that there are no relevant or applicable environmental consequence criteria which have been developed in New Zealand, and therefore overseas criteria have to be considered. Because NSW is closest to New Zealand geographically, is considered to be more closely aligned to New Zealand in terms of societal considerations than the relevant European countries, and has a land use planning system which ahs the greatest similarity to New Zealand, it was considered that the NSW criteria would be an appropriate basis for evaluation in this instance.

To aid the selection of the environmental consequences, the criteria of the NSW Government [4] were followed:

Table 6 Environmental consequences (NSW Government LUP criteria [4])

Consequence type	Description
Catastrophic	Irreversible alteration to one or more eco-systems or several component levels. Effects can be transmitted, can accumulate. Loss of sustainability of most resources. Life cycle of species impaired. No recovery. Area affected 100 km^2.
Very serious	Alteration to one or more eco-systems or component levels, but not irreversible. Effects can be transmitted, can accumulate. Loss of sustainability of selected resources. Recovery in 50 years. Area affected 50 km^2.
Serious	Alteration/disturbance of a component of an ecosystem. Effects not transmitted, not accumulating or impairment. Loss of resources but sustainability unaffected. Recovery in 10 years.
Moderate	Temporary alteration or disturbance beyond natural viability. Effects confined<5,000 m^2, not accumulating or impairment. Loss of resources but sustainability unaffected. Recovery temporarily affected. Recovery < 5 years.
Not detectable	Alteration or disturbance within natural viability. Effects not transmitted, not accumulating. Resources not impaired.

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4.3 Description of the Sensitivity of the Potential Receiving Environments

The proposed tank terminal will be located in the Seaview area in Lower Hutt (see Figure 1). The 150 NB wharfline and the existing 300 NB industry line run for 600 m from the tanker berth to the shoreline in the wharf. Then, they run parallel to the shoreline along Marine Drive until Port Road, where they turn left until the entrance of the proposed terminal (see Figure 2).

The terminal and the supply pipelines will be located in a range of environments. The area around the tank terminal has relatively flat topography, being an area of reclaimed land. The area, with the exception of the marina which is a 'Special Recreation Area', is fundamentally an industrial area and has been identified as 'Special Business' activity area by the HCCDP [1].

4.3.1 Soil

The geotechnical report of the proposed land for the development [14] has determined the typical geological profile, as shown in the following table:

Table 7 Typical geological profile Seaview

Unit	Thickness [m]	Comments
Reclamation Fill	0 – 3	Gravely silt / Silty sand
Taita Alluvium	3 – 8	Silty sand with seashells
Petone Marine Beds	8 – 18	Sandy silt / silty clay
Artesian Gravels	> 18	Gravel

4.3.2 Groundwater

The Seaview area is underlain by the Hutt aquifer system. The groundwater is comprised of a surficial unconfined aquifer (the Taita Alluvium), a confining aquitard (the Petone Marine Beds) and a deep confined aquifer (the Artesian Gravels). It is this latter deep confined aquifer that is tapped for a potable municipal groundwater supply.

Groundwater occurs at Seaview at approximately 1 to 1.5 m. Based on the proximity from the sea, the groundwater in the unconfined aquifer is expected to largely be controlled by the sea level. There are no known groundwater takes for potable water in the Seaview area.

The confining silts and sands aquitard will have the effect of limiting the vertical movement of potential contaminants from the surficial unconfined aquifer to the deep confined aquifer. This movement will be further retarded by the upward hydraulic gradients that occur within the artesian confined aquifer.

4.3.3 Terrestrial Ecology

In the Seaview area the terrestrial environment is industrial and commercial in nature, with limited vegetation present.

To the east of the proposed development, the hillside is steeply sloping up to a height of between 30 and 70 m, depending on the location. In the hill there is native vegetation and exotic trees running into East Harbour Regional Park. According to Chapter 14E of the HCDP [1], the Mount Hawtrey Bush and the coastal plant *melicytus obovatus ssp.* have been identified as a significant natural resource.

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4.3.4 Marine Ecology

The Seaview marina is a reclaimed area, with the most recent reclamation in the late 1950s and early 1960s. Prior to the construction of the Seaview Marina in the early 1990s, the area was a sheltered beach of sand of about 150 m in length. As part of the Marina development plan, an ecological survey was carried out, which identified five biotic areas and 142 species including polychaetes, molluscs, crustacean and echinoderms.

Much of the marine fauna and flora around Point Howard and Seaview Marina is the result of colonisation of recent intertidal fill material, with similar organisms present on much of the local coastline. Of significance are the little blue penguins, which may use the area for breeding and roosting. They may be present all year around.

The Hutt River estuary, 600 m to the west of the proposed development, is an important feeding ground for wading birds. Mokopuna and Somes Islands have also been identified as significant natural resources.

4.4 Pollutant Pathways

According to the hazard identification described in Section 3.1, fundamentally 4 types of scenarios have been assessed, as shown in the following table:

Table 8 Environmental Scenarios

Scenarios	Comments
Discharges to air	The only volatile products capable of entering the atmosphere by evaporation after a spill occurs are the RMS, PMS, BP Ultimate and the ethanol. The expected effects will be negligible as the wind will rapidly disperse the vapours without further damage for the environment. If the vapours ignite, the risk of fire and explosion have been analysed in depth in the QRA in Section 0. Black smoke produced on fires can also be an environmental issue, mainly due to its visual impact.
Discharges to land and groundwater	As mentioned above, liquid discharges of petrol and ethanol will not have any significant environmental consequences for the soil and underground water. In addition, ethanol is highly miscible in water which will result in a rapid dilution of it. Should the primary and secondary containments fail, releases of AGO or additives into the soil will infiltrate to the unconfined aquifer. The confining silts and sands aquitard will prevent the movement of potential contaminants from the surficial unconfined aquifer to the deep confined aquifer, where the public water is being tapped from. Most likely, the pollutants will flow out to the marine waters (see below) or remain on the soil. Residual product in the soil is likely to be degraded due to the action of the bacteria, although this is not a substitute for soil remediation.

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Scenarios	Comments
Discharges to marine water	As mentioned above, liquid discharges of petrol and ethanol will not have any significant environmental consequences as they will evaporate. In addition, ethanol is highly miscible in water which will result in a rapid dilution of it without representing a hazard for the aquatic environment. Releases of AGO or additives into the marine waters will form a floating pool (typical bright stain). They may need to be confined and collected.

4.5 Environmental Risk Assessment Results

The environmental risk assessment was carried out in Wellington on the 11 March 2009 with representatives of BP from different disciplines and was facilitated by Angel Casal from the Lloyd's Register Group, using the criteria outlined in Section 4.2.

The outcomes of the risk assessment are summarised in the following table:

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Table 9 Environmental Risk Assessment

#	Process Plant Area/Equipment	Process Plant Scenario or Activity	Possible Causes	Consequences	Category	Specific Controls
A	Ships	Release of liquid from a ship into the bay	Rupture of the unloading hose due to ship movement (strong wind gust).	If AGO or additives are released, depending on the location it may be confined to the wharf (small compound area). If the spill is big or it is unconfined, there will be a spill on the water. If wind blows from South, the AGO will be pushed to the Petone shore. If wind blows from the North, the AGO pool will move down and will leave the harbour. The recovery period is estimated to be less than 5 years.	Moderate	• Ship to shore discharge procedures (adverse weather is included). • Shore officer responsible for the discharge. • Hose integrity management procedures. • Containment on the wharf. • Fire Protection. • Regional Council Emergency Spill Response Plan.
B	Products importation	Failure of the 150NB or 300NB import pipeline to manifold or associated pipework resulting in a release of flammable liquid into the bay and marina area	Rupture of the pipeline due to third-party damage.	If AGO or additives are released from the offshore sections of the pipelines, a spill on water will be formed. If wind blows from South, the diesel will be pushed by wind to the Petone shore. If wind blows from the North, the AGO pool will move down and will leave the harbour. The recovery period is estimated to be less than 5 years. If AGO or additives are released from the onshore section of the pipelines, a filtration to the subsoil will occur (unconfined shallow aquifer). The confining silts and sands aquitard will prevent the movement of potential contaminants from the surficial unconfined aquifer to the deep confined aquifer. Most likely, the pollutants will flow out to the marine waters.	Moderate	• Design codes and standards. • Pipeline integrity management. • Anti-crash barriers (along the road) • Signage (especially for the buried sections). • Extensive monitoring during ship discharges and continuous communication with the vessel. • Wellington Regional Council Spill Containment Plan.

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#	Process Plant Area/Equipment	Process Plant Scenario or Activity	Possible Causes	Consequences	Category	Specific Controls
C	Products importation	Failure of the 250NB pipes onsite upstream the storage tanks resulting in a release of flammable liquid into the tank terminal	Flange leaking due to over pressurisation or flange failure.	The manifold area is sealed. Therefore, a potential spill on the manifold area will be drained to the API separator and contained. Product is pumped from separator into slops tank. Otherwise, the spill will be contained in the bund area, and from there sent to slops.	Not detectable.	• Design codes and standards. • Pipeline integrity management • BP Quality procedures during installation • Drain system. • API separator. • No flanges outside compounded areas. • Emergency Response Plan.
D	Storage tanks	Failure of a storage tank and associated pipework resulting in a release of flammable liquid into the bund	Flange leaking due to over pressurisation or flange failure.	AGO or additive spill is contained in the compound and after inspection, spill is drained to the slops tank. Should there be a filtration to the subsoil (very unlikely), the receptor is not sensitive as there is migration of the groundwater to the sea. Note that the aquifers providing drinking water to the community are confined and located up gradient of the terminal.	Not detectable.	• Design codes and standards. • Pipeline integrity management • BP Quality procedures during installation • Extensive monitoring during ship discharges and continuous communication with the vessel • Secondary containment (bund) exceeding HSNO and BP standards (intermediate bund walls will be provided to contain small spills) • HDPE liners • Tell tale pipes under tanks to detect any leaks • Emergency Response Plan

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#	Process Plant Area/Equipment	Process Plant Scenario or Activity	Possible Causes	Consequences	Category	Specific Controls
E	Storage tanks	Overfilling of a tank from a ship resulting in a release of flammable liquid into the bund	Operator not responding to alarms or failure of the overfill system.	Spill is contained in the compound and after inspection, spill is drained to the slops tank. Should there be a filtration to the subsoil (very unlikely), the receptor is not sensitive as there is migration of the groundwater to the sea. Note that the aquifers providing drinking water to the community are confined and located up gradient of the terminal.	Not detectable.	• BPCS • Extensive monitoring during ship discharges and continuous communication with the vessel • Overfill protection • Emergency shut-down and fire alarm buttons • Secondary containment (bund) exceeding HSNO and BP standards • HDPE liners • Emergency Response Plan
F	Storage tanks	Tank top fire	Floating blanket sink (lighting).	During the first stages of the fire (before the floating blanket sinks) there will be intermittent smoke coming from the tank, which will be dispersed by the wind. The quality of the air surrounding the terminal will decrease although it is not expected that the smoke would reach toxic concentrations at ground level. The smoke may be an irritant to some neighbours. In any case, the most probable wind directions are North and South, and the residential areas identified near the terminal are on the East. Should the fixed foam system not extinguish the fire (very unlikely), the hot combustion gasses will form a vertical column of black smoke due to their buoyancy until the gasses are cool enough to undergo passive (horizontal) dispersion. This dispersion will occur however at very high levels in the atmosphere not endangering the receiving environments, including the local community, except for the visual impact.	Moderate.	• Lightning protection • Ignition prevention • Earthing and bonding • Emergency shut-down and fire alarm buttons • Secondary containment (bund) exceeding HSNO and BP standards (intermediate bund walls will be provided to contain small spills) • HDPE liner • Fixed foam system on each bulk tank • Fixed water drench rings on each bulk tank • Emergency Response Plan

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#	Process Plant Area/Equipment	Process Plant Scenario or Activity	Possible Causes	Consequences	Category	Specific Controls
G	Products exportation	Failure of the 200NB pipes onsite upstream the pumps resulting in a release of flammable liquid into the tank terminal	Flange leaking due to over pressurisation or flange failure.	The manifold area is sealed. Therefore, a potential spill on the manifold area will be drained to the API separator and contained. Product is pumped from separator into slops tank. Otherwise, the spill will be contained in the bund area, and from there sent to slops.	Not detectable.	• Design codes and standards. • Pipeline integrity management • BP Quality procedures during installation. • Drain system • API separator • Emergency Response Plan
H	Tank wagons	Failure of the 150NB pipes downstream the loading pumps (including the loading arm) resulting in a release of flammable liquid into the TWFS	Flange leaking due to over pressurisation or flange failure.	The TFWS area is sealed. Therefore, a potential spill on the manifold area will be drained to the underground spill tank (25,000 l). From there, product is pumped to the slops tank or the separator.	Not detectable.	• Design codes and standards. • Pipeline integrity management • BP Quality procedures during installation. • Continuous supervision by driver (deadman control) • Remote operated (pneumatic) shutdown valves on the outlet of the tanks • Fast shut-off valves (fire resistant and fail-safe) • Spill tank in TWFS • Emergency shut-down and fire alarm buttons Drain system • API separator • Emergency Response Plan

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#	Process Plant Area/Equipment	Process Plant Scenario or Activity	Possible Causes	Consequences	Category	Specific Controls
I	Tank wagons	Failure of a tank wagon connection and release of flammable liquid from a tank wagon into the gantry	Operator trying to load wrong amount, and overfill protection system failure.	The TFWS area is sealed. Therefore, a potential spill on the manifold area will be drained to the underground spill tank (25,000 l). From there, product is pumped to the slops tank or the separator.	Not detectable.	• Design codes and standards. • Pipeline integrity management • Scully overfill protection system • Continuous supervision by driver (deadman control) • Remote operated (pneumatic) shutdown valves on the outlet of the tanks • Fast shut-off valves (fire resistant and fail-safe) • Spill tank in TWFS • Emergency shut-down and fire alarm buttons • Drain system • API separator • Emergency Response Plan
J	Tank wagons	Release of flammable liquid from a tank wagon outside the new Seaview tank terminal [4]	Not analysed.	Not analysed.	Not analysed.	-

[4] As mentioned in Section 3.2.2, the number of trucks in the Seaview area will not increase as a result of the installation of the proposed tank terminal and therefore this scenario has not been analysed.

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#	Process Plant Area/Equipment	Process Plant Scenario or Activity	Possible Causes	Consequences	Category	Specific Controls
K	Tank wagons	Overfilling of a tank wagon resulting in a release of flammable liquid into the gantry	Operator trying to load wrong amount, and overfill protection system failure.	The TFWS area is sealed. Therefore, a potential spill on the manifold area will be drained to the underground spill tank (25,000 l). From there, product is pumped to the slops tank or the separator.	Not detectable.	• Design codes and standards. • Pipeline integrity management • Scully overfill protection system • Continuous supervision by driver (deadman control) • Remote operated (pneumatic) shutdown valves on the outlet of the tanks • Fast shut-off valves (fire resistant and fail-safe) • Spill tank in TWFS • Emergency shut-down and fire alarm buttons • Drain system • API separator • Emergency Response Plan
L	Terminal	Seismic event in local area results in a release of flammable liquid from the import pipeline, or tanks	Faults in the vicinity.	As discussed in Section 3.2.3, a credible earthquake will result in minor releases from the tank terminal, with moderate impacts on the soil, groundwater and marine waters. However, these consequences are totally acceptable when compared to the destruction that the earthquake would cause in the Wellington region.	Moderate.	• Seismic loading considered in design • Ground reinforcement works • Earthquake Warning System • Procedures for seismic event • Emergency and Community response
M	Terminal	Tsunami wave and/or debris impact with storage tank resulting in a release of flammable liquid	Local seismic events.	As discussed in Section 3.2.4, a credible tsunami will result in minor releases from the tank terminal, with moderate impacts on the soil, groundwater and marine waters. However, these consequences are totally acceptable when compared to the destruction that the earthquake would cause in the Wellington region.	Moderate.	• Seismic loading considered in design • Ground reinforcement works • Tsunami Warning System • Procedures for seismic event • Emergency and Community response

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#	Process Plant Area/Equipment	Process Plant Scenario or Activity	Possible Causes	Consequences	Category	Specific Controls
N	Neighbouring facilities	Fire incident on a neighbouring facility escalates resulting in a release from a BP tank of flammable liquid into the bund	See scenario D.	See scenario D.	See scenario D.	See scenario D.

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4.6 Conclusions

Out of the fourteen scenarios analysed, five scenarios have been considered to have 'Moderate' consequences, while the rest have been considered to have 'Non detectable' consequences.

Qualitatively speaking, the scenarios with the greater consequences are the ones associated with low probabilities such as the natural events (tsunamis, earthquakes, lightning strikes, storms) and third-party damage.

As it can be seen in Table 9, each scenario has a set of controls which make the probability of the unwanted occurrence very low, as it requires the failure or absence of the control. Most of the controls are mitigative controls already incorporated in the design by following the HSNO regulations [9] and other design standards such as AS1940 [10].

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5 Quantitative Risk Analysis

5.1 Introduction

This section presents the results of the quantitative risk analysis (QRA) for the risk to life safety for people located beyond the boundary of the proposed development. All the scenarios listed in Table 5 have been included in the QRA except loss of containment from road tankers and ships, seismic events and tsunamis, which have been considered qualitatively in Section 3.2.

In order to carry out the QRA, the software package ORCA [15] developed by the Lloyd's Register Group was used.

The results of the QRA are presented in the form of risk contours. The risk contours represent the risk of fatality to a person. The risk level reported is conservative as the analysis assumes that an individual is located permanently at the location of the iso-contour and that they do not attempt to take evasive action to limit their exposure.

5.2 Relevant Equipment and Isolable Sections

5.2.1 Relevant Equipment

The QRA has considered loss of containment scenarios (LOCs) for each piece of equipment in the terminal containing hazardous substances. Also, the utilisation of the different equipment has been considered in the QRA. For example, releases from the wharflines have been modelled for two situations: during a ship discharge and when the pipes are resting on product.

The 150 NB wharfline and the 300 NB industry line have also been included in the relevant equipment.

Some equipment containing hazardous substances was discarded from the QRA for several reasons. This is discussed in Appendix A, Assumption #2 – Excluded Items, and summarised in the following:

- The QRA covers the situation where the terminal is in operation mode. Therefore, discrete operations such as maintenance, testing, pigging, etc. have not been considered in the QRA.
- Some equipment may contain hazardous substances under special circumstances which have been excluded from the QRA. Examples are PSVs, vents, drain lines, etc.
- Toxic effects of smoke generated on fires have not been considered in the QRA.
- Releases from equipment which are not capable of causing a fatality outside the establishment have been discarded from the QRA as these events do not contribute to the aggregated offsite risk.
- Releases from equipment with a frequency of occurrence of less than 10^{-9}/year have been discarded from the QRA as the contribution of these events to the aggregated offsite risk is negligible.

Based on operating experience in tank terminals, it is advisable to consider two additional types of scenarios on top of the generic LOCs:

- Tank top fire for every bulk storage tank in the terminal.
- Overfill scenario for every bulk storage tank in the terminal.

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The maximum distance at which lethal consequences may occur (LC01) due to heat radiation from the tank top fires does not exceed the fence of the tank terminal at any height. Therefore, tank top fires have not been considered further in the QRA as they do not contribute to the aggregated offsite risk. The overfill scenarios do have potential lethal effects outside the terminal fence and therefore need to be considered in the QRA.

Last of all, scenario "N" in Table 5 is very difficult to model in the QRA as there may be several potential effects originating on the neighbouring facility that may cause a loss of containment event in the proposed Seaview terminal such as fires, explosions, missiles, etc. Therefore, a conservative approach has been taken which consists in increase the failure frequency of all the tanks on the east side of the terminal by 10 %. Only the frequencies of the tanks have been increased as they are the most likely equipment to be impacted by accidents in the neighbouring facility due to its size.

5.2.2 Isolable Sections

Following equipment selection, the next step is to define loss of containment scenarios. In general, loss of containment scenarios will be defined for every piece of equipment. Since the equipment is interconnected, it is necessary to identify the isolation points to define the isolable sections.

Some isolable sections were broken down further to focus on specific items of equipment. For example, a large isolable section with a pump is normally split into several sections. This ensures the major failure contributor, the pump, is specifically analysed and not treated as just part of a larger system. It also allows the location of the failure to be represented more precisely, and therefore increase the accuracy of the overall QRA.

A list of the isolable sections identified is presented in Appendix B in Table B 1 and Table B 2.

Every piece of equipment is recorded for every isolable section in order to account for the overall frequency of the loss of containment scenarios. This assessment is denoted as "parts count". Table B 1 and Table B 2 in Appendix B show the part count study for every isolable section.

5.3 Frequency Assessment

Every item of equipment has the potential to fail and release inventory to the environment.

The failure frequencies of most items were estimated using generic failure frequency data. This data has been obtained from publicly available failure frequency databases and can be utilised if no special stress, corrosion, vibration, fatigue or extreme environmental conditions are present. A summary set of the failure frequency values used in this study is presented in Appendix C.

It should be noted that the failure frequency of all the tanks on the east side of the terminal have been increased by 10 % to account for potential effects originating in the neighbouring terminal.

Based on the "parts count" for every isolable section, and the generic failure frequency data, the failure frequencies for the process are quantified in ORCA [15] (see Section 5.5.1) and assigned to the corresponding location on the terminal to reflect the associated risk.

5.3.1 Failure Scenarios

A range of hole sizes were analysed for each loss of containment scenario on each piece equipment. The hole sizes and failure frequencies were selected and adjusted, if necessary, to ensure the selection is the best approximation of the hole size/frequency distribution for that particular piece of equipment. Normally, the representative hole sizes for the four categories are defined as follows:

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- Small hole: approximately 5 mm
- Medium hole: approximately 25 mm
- Large hole: from medium to rupture
- Rupture: for pipelines full bore rupture, for vessels a hole of 1,000 mm diameter.

5.3.2 Tank Overfill Scenario

Fault Tree Analysis (FTA) was used to determine the frequency of the tank-overfill scenarios. The FTA for this scenario is shown in Figure C 1 in Appendix C.

5.3.3 Utilisation Factors

The utilisation of the different equipment has been considered in the QRA. The basis for calculating the utilisation factor is the fraction of time there is a ship unloading at the wharf. It has been assumed based on information supplied by BP, that 10 ships per year are expected to unload product at the proposed Seaview terminal, with an average duration of the unloading of 3 days.

Table B 1 in Appendix B contains the utilisation factors considered in the QRA.

5.3.4 Event Tree Analysis (ETA)

For each failure scenario there are a number of different possible outcomes or end events.

For example, there are a number of different end events for a flammable material depending on the available controls for detecting and isolating accidental releases and fires. Section 6 gives an overview of the critical controls available at the terminal.

Standard event trees have been used to determine the frequency of potential consequences associated with each hazardous scenario.

The event tree branches are defined by the following factors:

- The probability of detection of a release (by personnel, BPCS, F&G and ESD).
- The probability of isolation of a release (by personnel, BPCS, F&G and ESD).
- The probability of ignition – both immediate and delayed.
- The probability of an explosion.

The following figure shows an example of an event tree for a continuous liquid release, as extracted from the QRA.

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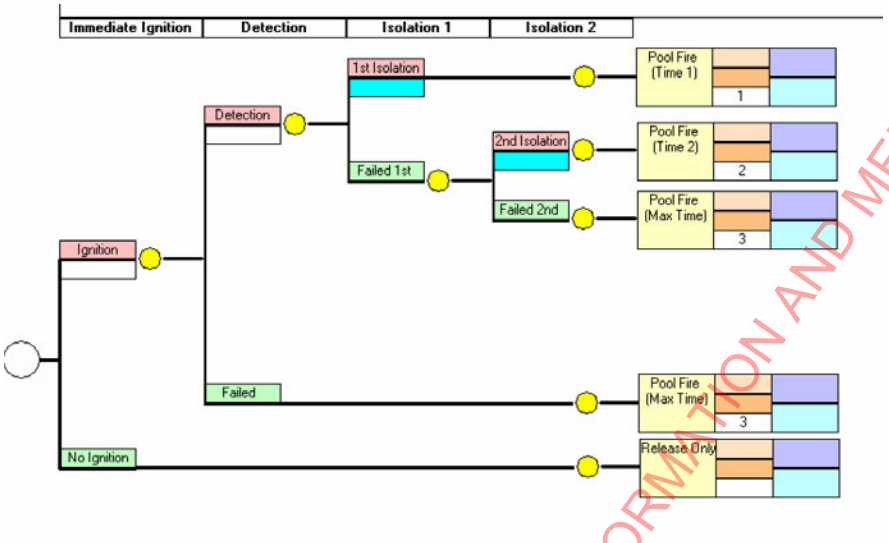
Figure 4 Example of an event tree



The values used in the event trees are listed in Table D 2 in Appendix D.

5.3.5 Frequency results

The frequencies of the final events for each isolable section are presented in Table F 1, Table F 2 and Table F 3 in Appendix F. The maximum frequencies obtained are shown in the following table.

Table 10 Maximum event frequencies

Scenario	Hole size [mm]	Impact criteria	Frequency [1/10^6 year]	Distance [m]
Leak from tanks T2 or T3	100	20 % lethality (8.7 kW/m2)	52	78
Leak from tanks T4 and T5	100	20 % lethality (8.7 kW/m2)	52	62
Leak from tank T6	100	20 % lethality (8.7 kW/m2)	52	61
Leak from lines from pump station to TWFS (pumping case)	25	20 % lethality (8.7 kW/m2)	67	64
Leak from 150mm wharf to manifold (resting on product case)	5	20 % lethality (8.7 kW/m2)	82	13
Leak from 300mm wharf to manifold (resting on product case)	5	20 % lethality (8.7 kW/m2)	84	15
Leak from lines from pump station to TWFS (pumping case)	5	20 % lethality (8.7 kW/m2)	105	63

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5.4 Consequence Assessment

The end events modelled in the QRA are:

- pool fires;
- flash Fires;
- vapour cloud explosions (VCEs); and,
- unignited releases.

The consequence modelling for each of these events is outlined in the following sections. The magnitudes of the physical effects for each of the final events (e.g. heat radiation intensity of a fire) are correlated to the probability of death by that effect by the so-called Probit equations. The time that the receptor is exposed to that effect is called 'exposure duration' and is also factored in the Probit models.

5.4.1 Representative Substances

Unleaded petrol has been used as the representative substance in all the calculations involving loss of containment events of PMS, RMS, AGO and ethanol.

From a frequency perspective, this is conservative as AGO is a combustible which needs to be heated before it can be ignited. From the consequences perspective, the assumption is conservative for ethanol as gasoline fires are more radiant than those of ethanol (i.e. gasoline has a higher heat of combustion), although not as radiant as those of AGO.

However, the assumption is still valid as AGO releases at ambient temperature are normally not considered in a QRA (e.g. combustible rather than flammable).

5.4.2 Release Rates

All release rates were calculated using Bernoulli-based models by ORCA (see Section 5.5.1). Appendix A describes some of the assumptions made to assess the release rates.

Liquid release rates were calculated for all hole sizes in each hazardous scenario using the Bernoulli equation.

5.4.3 Pool Areas

After a liquid release occurs, the liquid will spread into a pool assuming a minimum liquid layer thickness of 10 mm. If the liquid is released into a bunded area, then the bund area is the maximum pool area.

In case no bund is present, the maximum assumed pool area for releases on land is 1,500 m^2. This assumption is made on the basis that there are many obstacles in the terminal such as walkways, roads, drains, buildings, etc. that will limit the spread of the pool. On the sea, the maximum pool area has been assumed to be 10,000 m^2.

5.4.4 Pool Evaporation

The software PHAST Professional [8] was used to assess the evaporation rates for gasoline from all the pools considered. The results of simulations show that not enough flammable vapours were generated from the pools to create a flammable vapour cloud outside the pool area. Consequently, based on simulations alone, flash fires and vapour cloud explosions are not obtained for gasoline evaporating from liquid pools as the vapour pressure of gasoline at ambient temperature is very low.

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Nevertheless, the investigation report of the Buncefield accident involving a large spill of gasoline [6] states that:

"The main explosion at Buncefield was unusual because it generated much higher overpressures than would usually have been expected from a vapour cloud explosion. The mechanism of the violent explosion is not fully understood and we have commissioned further scientific investigation to explain what occurs in large flammable vapour clouds.

…

The rate of evaporation (i.e. the rate of formation of vapour) will depend on a number of factors, including the temperature of the petrol, but the free surface area of the liquid pool will be a major – indeed a limiting – factor. It was tacitly considered that the rate of evaporation of petrol which was leaking or spilling from a tank into a bund would ultimately be controlled by the free surface area of the pool of liquid petrol contained within the bund. At Buncefield, it seems likely that much higher rates of evaporation were achieved as a result of the manner in which the liquid was discharged from the tank."

The manner referred to above is the free flow of gasoline out of a vent located on top of the tank into the bund.

To be able to model this behaviour in the risk assessment of the proposed terminal, the evaporating pool of liquid spilt in the overfill scenario has been modelled using N-pentane which is more volatile than gasoline. The results show that using N-pentane, the pools generate enough flammable vapours that result in flammable clouds outside the pool footprints, and potential vapour cloud explosions.

5.4.5 Pool Fires

A pool fire event occurs when a flammable liquid spill is ignited. The heat radiation from a pool fire was modelled using the smoky hydrocarbon fire model of Mudan and Croce [5].

The probability of fatality from a pool fire was determined using a Probit equation. The heat radiation levels modelled and the resulting fatality probabilities, along with a detailed description of the criteria, are presented in Appendix E.

5.4.6 Flash Fires

It has to be noted that flash fires and vapour cloud explosions have been modelled only for the overfill scenarios and using N-pentane as the representative chemical (see Section 5.4.4).

In a flash fire scenario, the flame front moves through the cloud consuming the proportion of the cloud within the flammability limits. The extent of the flammable cloud was determined by modelling the release conditions using commercially available gas dispersion software. The gas dispersion software used in this study for flash fire modelling was PHAST Professional [8].

The vulnerability criteria for flash fires are presented in Appendix E.

5.4.7 Vapour Cloud Explosions

A vapour cloud of flammable material being dispersed by the wind can result in a vapour cloud explosion (VCE) if the cloud is (partially) confined, or if congestion is high and an ignition source is present.

The main effect of an explosion is a shock or blast wave. This generates overpressure that may cause injuries, fatalities and damage to equipment. Explosion consequences have been calculated using the

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TNO Multinenergy model [16] in PHAST. The Purple Book [7] guidelines have been used which recommend to use the maximum explosion strength (curve 10, detonation) for an explosive mass equal to 8 % of the total mass between LFL and UFL (confined mass). The explosion overpressure criteria are presented in Appendix E.

Please note that to be able to model this behaviour in the risk assessment of the proposed terminal, the evaporating pool of liquid spilt in the overfill scenario has been modelled using N-pentane which is more volatile than gasoline. The results show that using N-pentane, the pools generate enough flammable vapours that result in flammable clouds outside the pool footprints, and potential vapour cloud explosions. This is a very conservative approach.

5.4.8 Consequence Results

A series of tables presenting the results of the consequence modelling (i.e. consequence distances) for each hazardous scenario are presented in Appendix F.

The maximum consequence results are shown in the following table.

Table 11 Maximum consequence distances

Scenario	Comments	Impact criteria	Frequency [1/10^6 year]	Distance [m]
Rupture of tank T6, release of gasoline and pool fire	Bund 3 will initially be filled and then spill will overflow to bund 1. Wind speed is 6 m/s.	20 % lethality (8.7 kW/m2)	9.6	116
Overfill of tank T1, T2 or T3, release of gasoline and flash fires	This scenario assumes that large amounts of gasoline vapours are formed due to the way the discharge occurs from the top of the tank. A vapour cloud is formed and then dragged by the wind into a confined area. Detonation occurs. Meteorological conditions are stability class F and 3 m/s.	100 % lethality (direct flame contact, 50 % LFL)	1	106 x 292(1)
Overfill of tank T1, T2 or T3, release of gasoline and vapour cloud explosion	This scenario assumes that large amounts of gasoline vapours are formed due to the way the discharge occurs from the top of the tank. A vapour cloud is formed and then dragged by the wind into a confined area. Detonation occurs. Meteorological conditions are stability class F and 3 m/s.	20 % lethality (7 kPa)	0.65	163

Note:

1) Cloud length x width.

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5.5 Risk Results

5.5.1 Location Specific Individual Risk (LSIR)

The Location Specific Individual Risk (LSIR) of a given location by a given scenario is calculated by multiplying the frequency of the scenario by the consequences of the scenario expressed as the probability of death in that location. The aggregated LSIR is calculated by adding all the IR by all the scenarios at that location.

The LSIR contours are generated simply by drawing a contour on the locations with the same level of LSIR. The LSIR calculation and the generation of the contours is normally done with the aid of a software tool. IN this case, we have used ORCA [15].

5.5.2 The Software Tool: ORCA

The LSIR has been calculated using the ORCA software [15]. ORCA is a software program that provides a quick and effective method of analysing risk utilising Quantitative Risk Assessment (QRA) techniques. The software was originally developed by ModuSpec, although since the acquisition of ModuSpec by the Lloyd's Register Group in 2008, our risk analysts use ORCA in our QRAs.

A comparison by Health and Safety Laboratories (HSL), UK (Health and Safety Executive) of ORCA against their own tool, Riskat was done in September 2008. The scope of the comparison was individual risk and societal risk calculations. The preliminary results of the tests submitted were very favourable. Reports of testing results are currently being prepared by LR and HSL.

5.5.3 Maximum Acceptable LSIR Levels

The maximum acceptable LSIR levels are presented in the following table for comparison (extracted from Section 2.4).

Table 12 Maximum acceptable LSIR Levels

Land use	Maximum Acceptable Location Specific Individual Risk [$1/10^6$ year]
Hospitals, schools, child-care facilities, old age housing	0.5
Residential, hotels, motels, tourist resorts	1
Commercial developments including retail centres, offices and entertainment centres	5
Sporting complexes and active open space	10
Industrial	50

5.5.4 The Tank Terminal

The results of the risk analysis are presented in Figure G 1 in Appendix G.

- As it can be seen, the LSIR of $0.5 \cdot 10^{-6}$/year and $1 \cdot 10^{-6}$/year exceed the proposed tank terminal by approximately 70 m on the east side of the terminal and 60 m on the north-west of the terminal. Within these distances from the terminal, only industrial land uses are found. This is acceptable according with the proposed criteria outlined in Table 12.

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- As it can be seen, the LSIR of $5 \cdot 10^{-6}$/year exceeds the proposed tank terminal by approximately 70 m on the east side of the terminal and 60 m on the north-west of the terminal. Within these distances from the terminal, only industrial land uses are found. This is acceptable according with the proposed criteria outlined in Table 12.
- As it can be seen, the LSIR of $10 \cdot 10^{-6}$/year exceeds the proposed tank terminal by approximately 65 m on the east side of the terminal and 45 m on the north-west of the terminal. Within these distances from the terminal, only industrial land uses are found. This is acceptable according with the proposed criteria outlined in Table 12.
- As it can be seen, the LSIR of $50 \cdot 10^{-6}$/year is almost confined to the proposed tank terminal. It exceeds 15 m the terminal on the east side although it does not reach the Mobil site. It has to be noted that there is a buffer zone of approximately 20 m between the Mobil site and the proposed tank terminal. This is acceptable according with the proposed criteria outlined in Table 12.

As a conclusion, the residual risk level in the main areas of concern which were the industrial sites adjacent to the proposed site, the public marina and the residential area located 300 m to the south-east of the proposed development, is considered negligible.

It should be stressed that a conservative approach has been followed in the risk assessment, and therefore the residual risks calculated are higher than in reality. Some of the conservative assumptions are highlighted in the following:

- Petrol has been used as representative substance for PMS, RMS, BP Ultimate, ethanol and AGO.
- Tank level assumed was 90 % of the gross capacity (i.e. 100% of the safe fill volume) for 100 % of the time.
- In case of pipeline rupture, the pump flow was assumed to be 1.5 times the nominal flow.
- Pentane was modelled to simulate the formation of a massive vapour cloud of gasoline.
- Detonation has been assumed for the explosion of the gasoline vapour clouds.
- The footprints of the flash fires (i.e. contour with a probability of lethality of 100 %) were determined by calculating the maximum distance to a concentration of gasoline equal to 1/2 of the LFL.

Consequently, the proposed tank terminal is considered compatible with the surrounding land uses.

5.5.5 The Supply Wharflines

With respect to the LSIR contours around the wharflines in Figure G 1 in Appendix G:

- the $0.5 \cdot 10^{-6}$/year contour is placed at 40 m maximum on either side of the lines (this contour does not affect very vulnerable elements).
- the $1 \cdot 10^{-6}$/year contour is placed at 35 m maximum on either side of the lines thus not affecting any vulnerable elements.
- the $5 \cdot 10^{-6}$/year contour almost follows the route of the wharflines, hence not affecting commercial areas.
- There is no $10 \cdot 10^{-6}$/year LSIR iso-contour around the wharflines.

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- there is no $50 \cdot 10^{-6}$/year LSIR iso-contour around the wharflines.

Consequently, the wharflines are compatible with the surrounding land uses.

5.6 Cumulative Effects

Escalation effects from scenarios at adjacent sites, especially from Mobil, have been considered in the QRA of the proposed BP tank terminal by increasing the failure frequencies (see Section 5.3).

Escalation effects of the proposed BP tank terminal into the Mobil site (property damage risks) are not expected due to the existing controls. These risks are addressed by compliance with codes, standards and best industry practices that prescribe minimum separation distances. The proposed development has been designed to comply with HSNO [9] and exceeds these requirements in relation to fire protection, compounding, tank separation distances and cascade distance, where it complies with AS1940 [10].

Consequently, cumulative effects have not been investigated in detail because sufficient isolation distances exist by way of good design, which by far exceeds the requirements of the HSNO regulations, meaning that in the event of a fire for example, the likelihood of escalation to the adjacent Mobil site is extremely low.

The risk levels discussed in this report are those strictly associated with the operation of the proposed development. There may be a cumulative effect of the risk levels in the surrounding areas due to the contribution of other establishments handling dangerous materials.

The risk levels associated with other activities are unknown and therefore the overall risk levels cannot be fully determined. However, the risk level at the marina is smaller than $0.5 \cdot 10^{-6}$/year, which means that there would need to be at least 10 tank terminals like the proposed Seaview terminal in order to result in an overall LSIR greater than $5 \cdot 10^{-6}$/year, which is the maximum acceptable risk for commercial areas (see Table 4).

The residential area south to the proposed terminal falls outside the maximum effect distances (see Table 11) and therefore it can be stated that the risk levels in the residential area are not increased due to the proposed development.

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6 Risk Management Controls

The Hazard Scenarios identified in Section 3 are recognised by BP as being associated with the operation of the proposed tank terminal. The prevention of the occurrence of each of the scenarios and the mitigation of the potential consequences is essential to the safe and clean operation of the proposed tank terminal.

Measures in place to prevent and mitigate the risk from the Hazard Scenarios are referred to as 'controls'. The management of the risk from each of the identified Hazard Scenarios is a combination of design integrity controls and operations integrity controls.

Design integrity controls are put in place during the planning and design process, and include the controls such as the physical separation of the tanks to the assets, spill containment and bunds, isolation valves and equipment specification. Operations integrity controls include procedures and standards for the maintenance and operation of the facilities, for example, pipeline inspection and testing procedures, tank inspection procedures, road tanker driver training and emergency response procedures.

Following the BP Health, Safety and Environment Management System (HSE MS) will ensure that the proposed development is constructed, installed, commissioned and operated in a safe manner.

It is not feasible at this stage to give a lot of details of some of these processes as they have not yet been planned. It is expected however that the HSE MS of BP manage risks for the employees and contractors, for the public and for the environment at all stages of the lifecycle of the proposed tank terminal. Some of the manuals or plans to be developed are:

- the Detailed Design Manual;
- the Construction Manual;
- the Commissioning and Start-Up Manual;
- the Emergency Response Plan; and,
- the Maintenance and Operations Manual.

6.1 The Tank Terminal

Table 13 highlights the critical controls in place to manage the risks at the proposed tank terminal. These controls are consistent with the requirements of HSNO [9].

6.2 The Supply Wharflines

Table 13 highlights the critical controls in place to manage the risks of the supply wharflines. It is anticipated that the 150 NB pipeline will be operated and managed under the same or similar conditions imposed on the existing 300 NB industry line.

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Table 13 Proposed critical risk management controls for the new tank terminal

Operation	Hazard Scenario	Critical risk management controls
Ships	A. Release of flammable liquid from a ship into the bay	Prevention ▪ Ship integrity management ▪ Adverse weather procedures ▪ Written operational procedures (mooring, connecting hoses, start-pump, etc.) ▪ Ignition prevention Mitigation ▪ Spill containment barriers (water booms) ▪ Emergency Response Plan (in communication with tank terminal) ▪ Wellington Regional Spill Response Plan ▪ Community response

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Operation	Hazard Scenario	Critical risk management controls
Products importation	B. Failure of the 150NB or 300NB import pipeline to manifold or associated pipework resulting in a release of flammable liquid into the bay and marina	Prevention ▪ Design codes and standards ▪ Pipeline integrity management (including periodic testing) ▪ Signage (especially for the buried sections) ▪ Anti-crash barriers ▪ Extensive monitoring during ship discharges and continuous communication with the vessel Mitigation ▪ Emergency Response Plan ▪ Wellington Regional Spill Response Plan ▪ Community response

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Operation	Hazard Scenario	Critical risk management controls
	C. Failure of the 250NB pipes from the manifolds to the storage tanks resulting in a release of flammable liquid into the tank terminal	Prevention ▪ Design codes and standards ▪ Asset integrity management ▪ Written operational procedures ▪ Extensive monitoring during ship discharges and continuous communication with the vessel ▪ Ignition prevention Mitigation ▪ Secondary containment (90 % of the pipelines run in bunded areas) ▪ Operator rounds ▪ Emergency shut-down and fire alarm buttons ▪ Emergency Response Plan
Product Storage	D. Failure of a storage tank and associated pipework resulting in a release of flammable liquid into the bund	Prevention ▪ Design codes and standards (including HSNO and BP) ▪ Asset integrity management ▪ BPCS ▪ Extensive monitoring during ship discharges and continuous communication with the vessel
	E. Overfilling of a tank from a ship resulting in a release of flammable liquid into the bund	

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Operation	Hazard Scenario	Critical risk management controls
	F. Tank top fire	▪ Overfill protection ▪ Lightning protection ▪ Ignition prevention ▪ Earthing and bonding <u>Mitigation</u> ▪ Internal floating blanket (in motor spirits service only) ▪ Emergency shut-down and fire alarm buttons ▪ Remote operated (pneumatic) shutdown valves on the outlet of the tanks ▪ Secondary containment (bund) exceeding HSNO and BP standards (intermediate bund walls will be provided to contain small spills) ▪ HDPE liner ▪ Tell tale pipes under tanks to detect any leaks ▪ Fixed foam system on each bulk tank ▪ Fixed water drench rings on each bulk tank ▪ Emergency Response Plan

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Operation	Hazard Scenario	Critical risk management controls
Products export	G. Failure of the 200NB pipes from the storage tanks to the pumps resulting in a release of flammable liquid into the tank terminal	Prevention ▪ Design codes and standards ▪ Asset integrity management ▪ BPCS ▪ Ignition prevention Mitigation ▪ Secondary containment (90 % of the pipelines run in bunded areas) ▪ Remote operated (pneumatic) shutdown valves on the outlet of the tanks ▪ Portable fire extinguishers and hose reels ▪ Emergency Response Plan

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Operation	Hazard Scenario	Critical risk management controls
	H. Failure of the 150NB pipes from the loading pumps to the tank wagons (including the loading arm) resulting in a release of flammable liquid into the TWFS	Prevention ▪ Design codes and standards ▪ Asset integrity management ▪ BPCS ▪ Ignition prevention ▪ Earthing and bonding Mitigation ▪ 2 infrared flame detectors on each bay of the TWFS ▪ Remote operated (pneumatic) shutdown valves on the outlet of the tanks ▪ Fast shut-off valves (fire resistant and fail-safe) ▪ Emergency shut-down and fire alarm buttons ▪ Fixed foam fire protection system ▪ Portable fire extinguishers and hose reels ▪ Spill tank in TWFS ▪ Emergency Response Plan

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Operation	Hazard Scenario	Critical risk management controls
Tank wagons	I. Failure of a tank wagon connection and release of flammable liquid from a tank wagon into the gantry	Prevention ▪ Design codes and standards ▪ Tank wagon integrity management ▪ Ignition prevention ▪ Earthing and bonding ▪ Continuous supervision by driver (deadman control) ▪ Sculley overfill Protection System ▪ Speed limits Mitigation ▪ 2 infrared flame detectors on each bay of the TWFS ▪ Remote operated (pneumatic) shutdown valves on the outlet of the tanks ▪ Fast shut-off valves (fire resistant and fail-safe) ▪ Emergency shut-down and fire alarm buttons ▪ Fixed foam fire protection system ▪ Portable fire extinguishers and hose reels ▪ Spill tank in TWFS ▪ Emergency Response Plan

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Operation	Hazard Scenario	Critical risk management controls
	J. Release of flammable liquid from a tank wagon outside the proposed Seaview tank terminal	Prevention ▪ Design codes and standards ▪ Vehicle integrity management ▪ Placarding and labelling ▪ Prescribed routes and speed limits Mitigation ▪ Emergency Response Plan (community response)

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Operation	Hazard Scenario	Critical risk management controls
	K. Overfilling of a tank wagon resulting in a release of flammable liquid into the gantry	Prevention ▪ Design codes and standards ▪ Tank wagon integrity management ▪ Ignition prevention ▪ Earthing and bonding ▪ Interlocks ▪ Scully tank wagon overfill protection systems ▪ Continuous supervision by driver (deadman control) Mitigation ▪ 2 infrared flame detectors on each bay of the TWFS ▪ Remote operated (pneumatic) shutdown valves on the outlet of the tanks ▪ Fast shut-off valves ▪ Emergency shut-down and fire alarm buttons ▪ Fixed foam fire protection system ▪ Portable fire extinguishers and hose reels ▪ Emergency Response Plan

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Operation	Hazard Scenario	Critical risk management controls
Terminal	L. Seismic event in local area results in a release of flammable liquid from the import pipeline, or tanks	Prevention ▪ Seismic loading considered in design ▪ Earthquake Warning System ▪ Procedures for seismic event Mitigation ▪ Emergency and Community response
	M. Tsunami wave and/or debris impact with storage tank resulting in a release of flammable liquid	Prevention ▪ Tsunami Warning System ▪ Procedures for tsunamis Mitigation ▪ Emergency and Community response

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Operation	Hazard Scenario	Critical risk management controls
Neighbouring facilities	N. Fire incident on a neighbouring facility escalates resulting in a release from a BP tank of flammable liquid into the bund	Prevention ▪ Hazard Assessment (requires communication with neighbouring facility) ▪ Design codes and standards ▪ Asset integrity management ▪ Ignition prevention Mitigation ▪ Emergency shut-down and fire alarm buttons ▪ Remote operated (pneumatic) shutdown valves on the outlet of the tanks ▪ Secondary containment (bund) ▪ Fixed water drench rings on each bulk tank ▪ Emergency Response Plan (communication and sharing resources with neighbour)

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7 Further Risk Reduction

As mentioned in Section 5.5, the calculated risk levels in the immediate neighbouring facilities of the proposed tank terminal are acceptable according to the risk criteria used in the present study (see Section 2.4).

Regardless of this, LR has discussed with BP further risk reduction opportunities to ensure that the risks are as low as reasonably practicable. The risk reduction opportunities topics were discussed and the outcome is shown in the following table.

When the potential risk reduction measure seemed reasonable and cost-effective, it has been included as a recommendation.

Table 14 Outcomes of the Discussions on Further Risk Reduction Opportunities

Topic	Outcome
Ensuring validity of the risk levels calculated in this report	Recommendation # 1 BP should ensure that the controls highlighted in Section 6 are effectively designed, constructed, installed, commissioned and operated so that the risks levels associated to the proposed development are being managed, and that they do not increase to unacceptable levels.
BP should assess whether the high-high level independent alarm could be upgraded into a safety instrumented system that stops the transfer of products from the ship into the tanks.	BP has assessed the feasibility of this recommendation and the result is that it is not feasible. The installation of the so-called Remotely Actuated Shut-Off Valves (ROSOVs) in wharflines is an avoided practice as a spurious trip of the ROSOV can potentially cause extensive damage to the line, the hose or the ship pump.
Gas detectors in the bunded areas	Recommendation # 2 BP should consider installing gas detectors in the compound areas.
Fire monitors	BP considers fire monitors to be redundant as fixed fire water drench rings and foam systems on each bulk tank will be provided.
Minimise plant confinement as much as possible	Recommendation # 3 BP should consider minimizing plant confinement as much as possible in the detailed designed.
Office building safety glass	Recommendation # 4 BP should ensure that the windows in the office building facing the compound areas have a safety glass.

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8 Conclusions and Recommendations

BP is planning to construct a new tank terminal at Seaview in Lower Hutt, New Zealand. Due to the hazardous nature of the substances involved in the development, BP has commissioned the Lloyd's Register Group to conduct an independent risk assessment of the proposed Seaview tank terminal and the associated wharflines.

The risk assessment has met the requirements of the Hutt City Council District Plan, and we have determined that the risk level associated with the proposed development is considered acceptable. The Societal Risk has not been calculated in the present study given that the risk contours do not affect any residential area.

Therefore, based on the results of the risk assessment and using a conservative approach, it can be concluded that the projected development is compatible with the surrounding land uses.

Regardless of this, LR would like to make the following recommendations:

1. BP should ensure that the controls highlighted in Section 6 are effectively designed, constructed, installed, commissioned and operated so that the risks levels associated to the proposed development are being managed, and that they do not increase to unacceptable levels.
2. BP should consider installing gas detectors in the compound areas.
3. BP should consider minimizing plant confinement as much as possible in the detailed designed.
4. BP should ensure that the windows in the office building facing the compound areas have a safety glass.
5. Should the proposed Seaview tank terminal and supply wharflines obtain approval from the regulatory authorities, we recommend the Hutt City Council to observe the risk acceptance criteria as presented in this report when assessing further urban or industrial developments in the area, in order to ensure that the risk levels of the residents are acceptable.
6. Should the Greater Wellington Regional Council approve the 150 NB wharfline, the Council should ensure that, as a minimum, the same general procedures and conditions as apply to the existing 300 NB industry wharfline are applied to the 150 NB wharfline.

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9 References

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[3] HSE UK, http://www.hse.gov.uk/comah/circular/perm09.htm.

[4] Risk Criteria for Land Use Planning, Hazardous Industry Planning Advisory Paper No 4, Department of Planning, NSW Government, Consultation draft July 2008.

[5] Mudan, K. S. & Croce, P. A., "Fire Hazard Calculations for Large Open Hydrocarbon Fires", The SFPE Handbook of Fire Protection Engineering, 1st Edition, 1988.

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[9] HSNO - Hazardous Substances and New Organisms Act 1996.

[10] AS1940 – 2004 - The storage and handling of flammable and combustible liquids.

[11] BP Fuel Seaview, Transportation Assessment Report, Traffic Design Group, March 2009.

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[15] ORCA version 1.08, The Lloyd's Register Group, 2009

[16] TNO, Yellow Book CPR 14E, Methods for the calculation of physical effects, Committee for the Prevention of Disasters, CPR 14E, Third Edition, The Hague 1997

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Appendices

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Appendix A Assumption register

A.1 Introduction

This appendix documents the assumptions that have been made during the analysis. Justifications for the assumptions have been included where applicable.

Some assumptions associated with the scope (boundaries) of the modelling are presented in the main report while assumptions associated with event tree data are presented in Appendix D.

A.2 Assumptions

Assumption No. 1 - General	
Assumption	
○ The QRA covers the situation where the terminal is in operation mode. Therefore, discrete operations such as maintenance, testing, pigging, etc. have not been considered. ○ Releases have been modelled at a constant release rate. Maximum flow values have been considered in the calculation of release rates. ○ Process conditions were based on information provided by BP. ○ Process equipment and failure items have been based on P&IDs from similar installations provided by BP. ○ In process units, only main pipe work has been included (i.e. drain piping, instrument piping, by-passes, etc. have been discarded.). ○ All liquid releases have been modelled as gasoline. N-pentane has been used to model the formation of a flammable vapour cloud to account for flash fire and explosion effects.	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

Assumption No. 2 – General – Excluded Items	
Assumption	
○ Any vessels, pipes or equipment not containing hazardous substances. For the purpose of the QRA, Hazardous Materials are toxic (acute toxic by inhalation properties), flammable (operating temperatures above flash point) or explosive (highly unstable chemicals). ○ Some equipment may contain hazardous substances under special circumstances which have been excluded from the QRA. Examples are PSVs, vents, drain lines, etc.). ○ The toxic effect from fires has not been modelled in the present QRA as they are not expected to contribute to the offs-site risks. Open-air fires will normally result in hot combustion gases quickly dispersing vertically until they cool down enough so that passive dispersion (downwind) can occur. This will normally occur at some height, without impacting at ground level.	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

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Assumption No. 3 – General – Pipelines	
Assumption	
o Most pipe lengths were determined by estimating the pipe path and calculating the pipe length using a scaled plot plan. A factor of 20% was applied to the pipe lengths to account for the vertical sections. o Pipes are assumed to be resting on gasoline whenever no loading/unloading operations are underway o Loss of containment events have been considered both for the situation of a ship unloading (pipeline pressurised) and the pipe resting on product. o Tanker ships will use the 150 mm and the 300 mm wharflines simultaneously to discharge to the terminal. o For ruptures in lines downstream a centrifugal pump, the release rate considered is 1.5 times the nominal pump flow to account for the pressure loss on the discharge line. o All pipework was assumed to run via the main unit pipe rack or inter-unit pipe racks unless items were located close together, in which case, pipework was assumed to run directly between the items.	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

Assumption No. 4 – Vessel Volumes	
Assumption	
o Internal fittings and packing in vessels have not been considered to account for the internal volume. o The filling degree of the tanks has been assumed conservatively as 90 %.	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

Assumption No. 5 – Frequency Assessment	
Assumption	
<u>Underground Pipelines</u> The failure frequency for normal steel pipes was used for underground pipelines. <u>Low Frequency Cut Off</u> Release frequencies have been based on operation for 365 days per year. Shutdown periods have not been considered. Events with frequencies of less than 1.0×10^{-9} per year have been excluded. These events will not make a significant contribution to the risk profile.	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

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Assumption No. 6 - Meteorological Data	
Assumption	

The meteorological conditions were taken from various sources [1], [2] and [3]. The average temperature is 13.7°C, average wind speed 5 m/s and the average humidity is 73%.

A total of 16 wind directions were used in the analysis, as listed below. Based on this, the stability class of F (3 m/s) and D (6 m/s) were used as representative conditions for the consequence modelling. The probability distribution of these weather classes is as follows:

- Pasquill Stability Class D and wind speed of 6m/s: 80 % of the time
- Pasquill Stability Class F and wind speed of 3 m/s: 20 % of the time

		Wind speed		
		F - 3 m/s	D - 6 m/s	Total
Wind direction	NNE	2.93	11.56	14.48
	NE	2.65	2.82	5.47
	ENE	1.54	1.53	3.07
	E	0.43	0.23	0.66
	ESE	0.55	0.86	1.41
	SE	0.67	1.49	2.16
	SSE	1.15	6.73	7.88
	S	1.64	11.96	13.60
	SSW	1.21	6.83	8.04
	SW	0.78	1.71	2.49
	WSW	0.52	0.93	1.45
	W	0.25	0.16	0.41
	WNW	0.29	1.03	1.31
	NW	0.32	1.89	2.21
	NNW	1.76	11.09	12.85
	N	3.20	20.29	23.49
	Calm	0.00	0.00	0.00
	Total	**19.87**	**81.09**	**100.96**

LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

Assumption No. 7 – Pool evaporation
Assumption

- The type of soil for pool evaporation on land has been assumed to be concrete.
- For spills in bunds, the bund area is the maximum pool area.
- For spills on land outside bunded areas, a maximum pool area of 1,500 m^2 has been assumed. On the sea, a maximum pool area of 10,000 m^2 has been assumed.

LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

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Assumption No. 8 – Flammable Gas Dispersion Modelling	
Assumption	
The following parameters were used in the gas dispersion modelling conducted in PHAST: Surface roughness = 1 m Release height = 0 m (for evaporating pools) Concentration averaging time = 18.5 s Maximum dispersion duration = 1 hour o Height for concentration output = 1 m o Flash fires that do not extend beyond the pool area have been excluded.	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

Assumption No. 9 - Explosion Modelling	
Assumption	
o Flammable masses were derived from flash fire modelling by considering the mass between LFL and UFL. o It has been assumed that 8% the entire calculated flammable mass (see above) is confined [5] due to the entrance of the cloud in a congested area. o Explosions were modelled using curve number 10 (detonation) of the TNO Multienergy model [5]. o The centre of the explosion has been assumed to be the centre of the bund. o Only overpressure effects have been considered. Projectiles and whole body displacement have not been considered.	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

Assumption No. 10 – Pool Fire Modelling	
Assumption	
o Pool fires have been modelled using the Mudan & Croce model [3].	
LR Analysts: s7(2)(a) & s7(2)(a)	Date: 20/01/2009

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A.3 References

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Appendix B Isolable sections

B.1 Introduction

This appendix contains a listing of the isolable sections identified and the process conditions relating to them. The following list provides a definition for each of the headings used in this appendix.

Scenario Name	The name of the isolable section or specific equipment considered as the scenario
Product	The product representing the material in the scenario
Mode	The pipe is either resting on product or operating
Diameter (m)	Diameter of vessel
Diameter (mm)	Diameter of pipeline
Length (m)	Approximate length of pipeline
Height (m)	Height/length of the vessel
Total HUM (kg/tonnes)	The hold up mass for the isolable section (pipelines in kg, vessels in tonnes)
Utilisation (%)	The percentage of time the equipment/section is in use
Temperature (°C)	Temperature in the process
Pressure (kPa (g))	Gauge pressure in the process
Liquid Level (%)	Liquid level in vessel

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B.2 Isolable sections

Table B 1 - List of isolable sections involving pipelines

Item description	Product	Pipe diameter (mm)	Length (m)	Mode (see notes)	Hold up mass (kg)	Max Release (kg)	Flanges	Valves	Other	Temperature (°C)	Pressure kPa(g)	Pump flow kg/s	Utilisation factor (%)
150mm pipe from wharf to manifold	Gasoline (unleaded)	150	1714	O	22,717	88,342	16	4	2 sight glasses	13.7	700	73	8.20%
				R	22,717	22,717					1.125	0	91.80%
300mm pipe from wharf to manifold	Gasoline (unleaded)	300	1714	O	90,867	315,867	16	4	2 sight glasses	13.7	700	250	8.20%
				R	90,867	90,867					2.25	0	91.80%
Manifold to T1	Gasoline (unleaded)	250	181	O	6,664	231,664	9	3	3 small bore fittings	13.7	700	250	2.30%
				R		6,664					1.875	0	97.70%
Manifold to T2	Gasoline (unleaded)	250	123	O	4,528	229,528	9	3	3 small bore fittings	13.7	700	250	2.30%
				R		4,528					1.875	0	97.70%
Manifold to T3	Gasoline (unleaded)	250	114	O	4197	229,197	9	3	3 small bore fittings	13.7	700	250	2.30%
				R		4,197					1.875	0	97.70%
Manifold to T4	Gasoline (unleaded)	250	134	O	4933	229,933	9	3	3 small bore fittings	13.7	700	250	2.30%
				R		4,933					1.875	0	97.70%

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Item description	Product	Pipe diameter (mm)	Length (m)	Mode (see notes)	Hold up mass (kg)	Max Release (kg)	Flanges	Valves	Other	Temperature (°C)	Pressure kPa(g)	Pump flow kg/s	Utilisation factor (%)
Manifold to T5	Gasoline (unleaded)	250	82	O	3019	228,019	9	3	3 small bore fittings	13.7	700	250	2.30%
				R		3,019					1.875	0	97.70%
Manifold to T6	Gasoline (unleaded)	250	117	O	4307	229,307	9	3	3 small bore fittings	13.7	700	250	2.30%
				R		4,307					1.875	0	97.70%
Manifold to T7	Gasoline (unleaded)	250	149	O	5486	230,486	9	3	3 small bore fittings	13.7	700	250	2.30%
				R		5,486					1.875	0	97.70%
T1 to pump station	Gasoline (unleaded)	200	146	O	3440	5,298,431	10	4	1 Strainer, 3 small bore fittings	13.7	200	28	9%
				R		3,440					1.5	0	91%
T2 to pump station	Gasoline (unleaded)	200	88	O	2073	5,728,508	10	4	1 Strainer, 3 small bore fittings	13.7	200	28	9%
				R		2,073					1.5	0	91%
T3 to pump station	Gasoline (unleaded)	200	80	O	1885	5,728,320	10	4	1 Strainer, 3 small bore fittings	13.7	200	28	9%
				R		1885					1.5	0	91%

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Item description	Product	Pipe diameter (mm)	Length (m)	Mode (see notes)	Hold up mass (kg)	Max Release (kg)	Flanges	Valves	Other	Temperature (°C)	Pressure kPa(g)	Pump flow kg/s	Utilisation factor (%)
T4 to pump station	Gasoline (unleaded)	200	100	O	2356	5,728,791	10	4	1 Strainer, 3 small bore fittings	13.7	200	28	9%
				R		2,356					1.5	0	91%
T5 to pump station	Gasoline (unleaded)	200	47	O	1107	5,727,542	10	4	1 Strainer, 3 small bore fittings	13.7	200	28	9%
				R		1,107					1.5	0	91%
T6 to pump station	Gasoline (unleaded)	200	86	O	2026	5,728,461	10	4	1 Strainer, 3 small bore fittings	13.7	200	28	9%
				R		2,026					1.5	0	91%
T7 to pump station	Gasoline (unleaded)	200	117	O	2757	1,005,922	10	4	1 Strainer, 3 small bore fittings	13.7	200	28	9%
				R		2,757					1.5	0	91%
AGO line from pump station to No.1 TWFS	Diesel	150	71	O	418	25,168	18	4	1 strainer, 1 PT, pump	13.7	10000	27.5	9%
RMS line from pump station to No.1 TWFS	Gasoline (unleaded)	150	71	O	418	25,168	18	4	1 strainer, 1 PT, pump	13.7	10000	27.5	9%

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Item description	Product	Pipe diameter (mm)	Length (m)	Mode (see notes)	Hold up mass (kg)	Max Release (kg)	Flanges	Valves	Other	Temperature (°C)	Pressure kPa(g)	Pump flow kg/s	Utilisation factor (%)
BP Ultimate line from pump station to No.1 TWFS	Gasoline (unleaded)	150	71	O	418	25,168	18	4	1 strainer, 1 PT, pump	13.7	10000	27.5	9%
AGO line from pump station to No.2 TWFS	Diesel	150	71	O	418	25,168	18	4	1 strainer, 1 PT, pump	13.7	10000	27.5	9%
RMS line from pump station to No.2 TWFS	Gasoline (unleaded)	150	71	O	418	25,168	18	4	1 strainer, 1 PT, pump	13.7	10000	27.5	9%
BP Ultimate line from pump station to No.2 TWFS	Gasoline (unleaded)	150	71	O	418	25,168	18	4	1 strainer, 1 PT, pump	13.7	10000	27.5	9%

Notes: O (Operating)

R (Resting on product)

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Table B 2 - List of Tanks

Description	Product	Tank Diameter (m)	Height (m)	Level (%)	HUM (t)	Flanges	Valves	Roof type	Temperature	Pressure
T1	Gasoline (unleaded)	27.2	13.5	90	5,295	18	6	Floating	13.7	Atmospheric
T2	Gasoline (unleaded)	27.2	14.6	90	5,726	18	6	Floating	13.7	Atmospheric
T3	Gasoline (unleaded)	27.2	14.6	90	5,726	18	6	Floating	13.7	Atmospheric
T4	Gasoline (unleaded)	27.2	14.6	90	5,726	18	6	Floating	13.7	Atmospheric
T5	Gasoline (unleaded)	27.2	14.6	90	5,726	18	6	Floating	13.7	Atmospheric
T6	Gasoline (unleaded)	27.2	14.6	90	5,726	18	6	Floating	13.7	Atmospheric
T7	Gasoline (unleaded)	14.5	9	90	1,003	18	6	Floating	13.7	Atmospheric
T8	Gasoline (unleaded)	6.5	7.2	20	36	18	6	Cone Roof	13.7	Atmospheric

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Appendix C Failure frequency data

C.1 Introduction

This appendix presents the failure frequency data used in the QRA. The failure frequencies of pipes, valves, flanges, vessels, pumps, loading arms, flexible hoses, small bore fittings etc. were derived from references such as E&P Forum [1], IChemE [2] and Lees [3].

C.2 Failure Frequency Data

The following tables present the failure frequencies used in the risk assessment.

Table C 1 - Failure Frequencies Applied to Pipework

Pipe Size (mm)	Hole Size (mm)	Failure Frequency (x 10^{-6}/year per 10m length)
25	5	317.26
25	25	58.74
40	5	178.88
40	25	50.81
40	40	5.31
50	5	135.40
50	25	45.39
50	50	7.21
60	5	107.58
60	25	40.44
60	60	8.65
75	5	80.98
75	25	34.23
75	50	7.74
75	75	2.39
80	5	74.56
80	25	32.48
80	50	7.81
80	80	2.66

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Pipe Size (mm)	Hole Size (mm)	Failure Frequency (x 10^{-6}/year per 10m length)
100	5	55.95
100	25	26.70
100	50	7.75
100	100	3.60
125	5	41.91
125	25	21.54
125	50	7.27
125	125	4.47
150	5	33.06
150	25	17.87
150	50	6.68
150	150	5.06
200	5	22.70
200	25	13.07
200	100	9.42
200	200	1.80
250	5	16.94
250	25	10.14
250	75	6.96
250	250	3.56
300	5	13.33
300	25	8.19
300	100	7.29
300	300	2.53

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Table C 2 - Failure Frequencies Applied to Valves

Valve Size (mm)	Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
25	5	108.16
25	25	2.84
40	5	102.70
40	25	8.29
40	40	0.01
50	5	98.88
50	25	12.06
50	50	0.05
60	5	95.26
60	25	15.58
60	60	0.16
75	5	90.33
75	25	20.20
75	50	0.46
75	75	0.01
80	5	88.83
80	25	21.55
80	50	0.61
80	80	0.01
100	5	83.43
100	25	26.14
100	50	1.38
100	100	0.05
125	5	77.87
125	25	30.29

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Valve Size (mm)	Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
125	50	2.64
125	125	0.20
150	5	73.30
150	25	33.17
150	50	4.06
150	150	0.47
200	5	66.20
200	25	36.50
200	50	6.87
200	200	1.43
250	5	60.90
250	25	37.99
250	75	11.38
250	250	0.73
300	5	28.37
300	25	19.26
300	100	7.63
300	300	0.24

Table C 3 - Failure Frequencies Applied to Flanges

Flange Size (mm)	Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
25	5	108.38
25	12	2.61
40	5	106.70
40	12	4.26
50	5	110.06

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Flange Size (mm)	Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
50	12	0.94
60	5	109.65
60	12	1.35
75	5	109.03
75	12	1.97
100	5	107.84
100	12	3.14
125	5	108.99
125	12	2.01
150	5	108.61
150	12	2.38
200	5	107.37
200	12	3.60
250	5	108.70
250	12	2.29
300	5	53.91
300	12	1.58

Table C 4- Failure Frequencies Applied to Pumps

Type of Pump	No. of Seals	Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
Centrifugal	Single	5	65,584.52
Centrifugal	Single	25	16185.96
Centrifugal	Single	50	4,646.39
Centrifugal	Single	Rupture	2,583.13

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Table C 5- Failure Frequencies Applied to Loading Arms

Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
5	26,280
200	262.8

Table C 6- Failure Frequencies Applied to Flexible Hoses

Specification	Failure Frequency (x 10^{-6} /year)
High pressure	350,400
Low pressure	35,040

Table C 7- Failure Frequencies Applied to Floating Roof Tanks

Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
10	1,543.75
75	617.5
100	302.75
1,000	6

Table C 8- Failure Frequencies Applied to Cone Roof Tanks

Hole Size (mm)	Failure Frequency (x 10^{-6} /year)
10	1,543.75
75	617.5
100	302.75
1,000	6

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Table C 9- Failure Frequencies Applied to Small Bore Fittings

Hole Size (mm)	Failure Frequency (x 10-6 /year)
5	144
25	575

C.3 Fault tree analysis

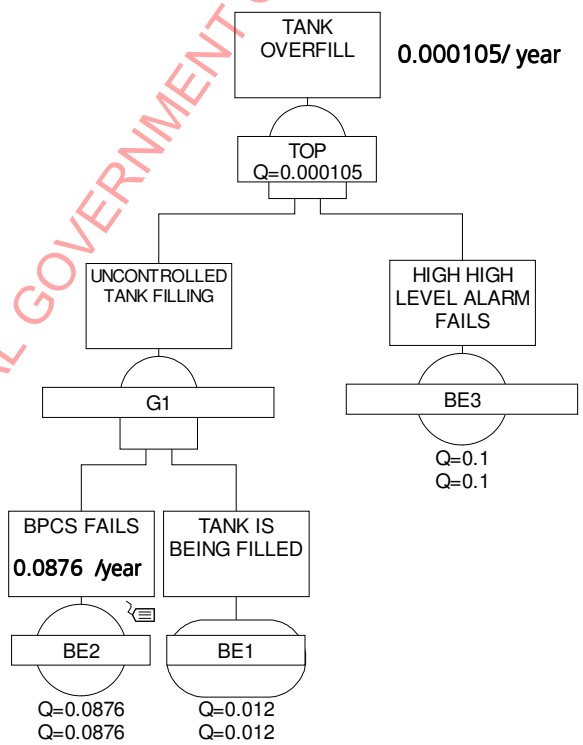
The following fault tree was developed to determine the frequency for the tank overfill scenario. The initiating event is failure of the Basic Process Control System (BPCS). IEC 61511 [4] limits the minimum failure rate assigned to the BPCS to 10-5 failures per hour (0.0876 failures/year).

The percentage of time a tank is being filled has been derived from data supplied by BP. Discharges from ships are assumed to occur 30 days per year. Assuming that all 7 tanks will be filled in every time a ship is discharging, the probability of a tank being filled is 0.012.

Assuming that a failure of the BPCS during a tank fill will lead to a potential overfill, the only independent layer is a high high-level alarm which will alert the control room to communicate the ship the shutdown of the transfer pumps. As an operator is required to respond to the alarm, conservatively it was estimated a probability of failure on demand (PFD) of this control equal to 0.1.

Hence, the frequency of a tank overfill is $1.05 \cdot 10^{-4}$/year per tank (see Figure C 1).

Figure C 1 Fault tree assessment for a tank overfill



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C.4 References

[1] E&P Forum, "Hydrocarbon Leak and Ignition Data Base", Report No. 11.4/180, May 1992.

[2] Cox, A.W., Lees, F.P. and Ang, M.L., "Classification of Hazardous Locations", The Institution of Chemical Engineers (IChemE), 1993.

[3] Lees, F.P., "Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control", Butterworth-Heinemann, Second Edition, 1996.

[4] IEC 61511 Functional Safety of electrical / electronic / programmable electronic safety-related systems Functional safety for the Process industry, International Electrotechnical Commission, 2003.

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Appendix D Event tree data

D.1 Introduction

This appendix presents the data that has been used in the development of the event trees.

D.2 Detection and isolation

General event tree data and general assumptions made for these event trees are presented in Table D 1.

Table D 1 - General Event Tree Data

Description	Probability
Probability that an operator is present at or near the tank farm. For the wharflines during ship unloading, 80% has been used.	3 %
Probability that the process will detect a small release. For the wharflines during ship unloading, 20% has been used. For the wharflines between ship unloading, 1% has been used.	10 %
Probability that the process will detect a medium release. For the tanks, 20% has been used. For the wharflines during ship unloading, 50% has been used.	60 %
Probability that the process will detect a large release (rupture). For the wharflines between ship unloading, 0% has been used.	100%
Probability that a person will detect a small release resulting in a fire. For the wharflines between ship unloading, 1% has been used.	80%
Probability that a person will detect a medium release resulting in a fire. For the wharflines between ship unloading, 10% has been used.	90%
Probability that a person will detect a large release (rupture) resulting in a fire. For the wharflines between ship unloading, 50% has been used.	100%
Probability of successful isolation in the event of a release by a shutdown valve (SDV)	90%

The specific data considered for the event trees with respect to detection and isolation capabilities is presented in Table D 2. These figures have been derived from our own experience based on the actual information provided regarding operational philosophy, risk reducing controls and technology.

Brief definitions for the headings used in the event tree tables are presented below.

- % chance of detecting - This is related to detecting the release or fire. There are three options for detecting a release or fire. The first is "Detect" which is the chance that a gas or heat detector will detect a release or fire. The second is "Process" which is the chance that the process equipment, e.g. an alarm, will detect an anomaly. The third is "Person" which is the chance that a person will detect the release or fire if they are in or near the unit.
- % chance of achieving isolation/time taken (mins) - This is the probability of achieving isolation and the time taken. This occurs only once the release or fire has been detected. There are two chances for isolation (*1st isol* and *2nd isol*) and each has an associated time.

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- Worst case time to detect (mins) - This is the longest time that the leak could go for before action is taken. Generally this is for a release in the middle of the night when personnel are unlikely to be present near the unit.

D.3 Probability of ignition

Overall Probability of Ignition

The probabilities of ignition have been derived from the original values suggested by Kletz D.5, and are calculated using the following equations:

Equation D 1

Probability of ignition (gas) = $(Q/656)^{0.6403}$

Equation D 2

Probability of ignition (liquid) = $(Q/111517)^{0.3925}$

where:

Q = release rate (kg/s).

The probabilities calculated from the above equations are that of the overall probability that once released the product will ignite. The probability does not account for the time frame of ignition. The overall probability of ignition equations represent that of a typical hydrocarbon processing plant, taking into account typical ignition sources such as hot surfaces, flares etc.

Probability of Immediate and Delayed Ignition

Based on the above, the following distribution has been applied for the probabilities of immediate and delayed ignition:

Equation D 3

Probability of immediate ignition = 0.1 x Probability of Ignition

Equation D 4

Probability of delayed ignition = 0.9 x Probability of Ignition

D.4 Probability of vapour cloud explosions

Probability of Flash Fire and Vapour Cloud Explosion

Based on the Purple Book [2] guidelines, in case delayed ignition occurred, the probability of a flash fire without overpressure effects is 0.6 and the probability of a VCE without flash fire effects is 0.4.

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Table D 2 – Event Tree Data

Isolable Section		Pipework - Static			Pipework - pumping			From pump station to TWFS (includes loading arms)			Tanks			Wharflines - static			Wharflines - pumping		
Hole Size		s	m	r	s	m	r	s	m	r	s	m	r	s	m	r	s	m	r
Operator on/near unit (%)	% time	3	3	10	40	40	40	40	40	40	3	3	10	1	1	1	80	80	80
Release	Detector	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Process	0	0	0	10	60	100	10	60	100	0	20	100	0	0	0	10	50	100
	Person	0	50	100	10	50	100	10	50	100	10	50	100	1	10	50	20	80	100
Fire	Detector	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Process	0	30	90	10	60	100	10	60	100	0	30	90	0	0	0	10	50	100
	Person	70	90	100	80	90	100	80	90	100	70	90	100	1	10	50	20	80	100
Detection	Time min	60	20	10	30	10	5	30	10	5	60	20	5	1440	60	30	30	15	5
Release	1st isol.	0	0	0	90	90	90	90	90	90	0	0	0	0	0	0	90	90	90
	Time min	0	0	0	10	5	2	10	5	2	0	0	0	0	0	0	2	2	2
	2nd isol.	0	0	0	100	100	100	100	100	100	0	0	0	0	0	0	100	100	100
	Time min	0	0	0	15	10	5	15	10	5	0	0	0	0	0	0	5	5	5
Fire	1st isol.	0	0	0	90	90	90	90	90	90	0	0	0	0	0	0	90	90	90
	Time min	0	0	0	10	5	2	10	5	2	0	0	0	0	0	0	2	2	2
	2nd isol.	0	0	0	100	100	100	100	100	100	0	0	0	0	0	0	100	100	100
	Time min	0	0	0	15	10	5	15	10	5	0	0	0	0	0	0	5	5	5
Worst case detection	Time min	720	60	20	60	20	10	60	20	10	720	60	20	576	120	60	60	30	10

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D.5 References

[1] Kletz, T.A., "Unconfined Vapour Cloud Explosions", Loss Prevention, American Institute of Chemical Engineers, Vol 11, p. 50 in Classification of Hazardous Locations, A.W. Cox, F.P. Lees and M.L. Ang, IChemE, 1993.

[2] Purple Book, Committee for the Prevention of Disasters, CPR 18E, First Edition, 1999.

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Appendix E Vulnerability criteria

E.1 Introduction

This appendix presents the general effects of thermal radiation from fires and overpressure from explosions. Information on doses for toxic releases is also provided. From this and other information, the criteria used to evaluate risk of fatality associated with each consequence such as fire, explosion and toxic releases is evaluated.

E.2 Heat Flux Criteria

The general effects of thermal radiation from fires are summarised in [1].

Table E 1 - Thermal Radiation Effects

Heat Flux (kW/m^2)	Effects
1.2	Heat flux received from the sun at noon in summer.
2.1	Minimum heat flux required to cause pain after 1 minute.
4.7	Will cause pain in 15-20 seconds and injury after 30 seconds exposure (at least second degree burns).
12.6	Significant chance of fatality for extended exposure. High chance of injury. After extended exposure, causes the temperature of wood to rise to a point where it can be readily ignited by a naked flame. Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure.
23	Likely fatality for extended exposure and chance of fatality for instantaneous exposure. Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures which can cause failures. Pressure vessels need to be relieved or failure will occur.
35	Cellulosic material will pilot ignite within one minute's exposure. Significant chance of fatality for people exposed instantaneously.

The effect of human exposure to a fire is a function of both the intensity of heat radiation and the duration of exposure. The harmful effect can be characterised by a thermal dose that is defined by the function ($tI^{4/3}$), where I is the heat radiation intensity and t is the exposure duration.

A Probit function has been used to evaluate the percentage of fatalities for different heat flux exposures. The Probit equation utilised is the Eisenberg equation [2].

Equation E 1

$$Y = -14.9 + 2.56 \ln\left(I^{\frac{4}{3}} \cdot t\right)$$

where:

Y	=	Probit value
t	=	exposure time (s)
I	=	radiation intensity from fire (kW/m^2)

In terms of human exposure, it is generally accepted that an exposure of 12.6 kW/m^2 will result in a 50% chance of fatality. Based on the Probit, the required exposure time would be 81 seconds.

To account for all the possible means by which adverse outcomes can occur, a range of heat flux levels needs to be assessed. These values are based on the exposure time of 81 seconds and are presented in the following table.

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Table E 2 - Heat Flux Levels and Corresponding Percentage Fatalities for Fires

Heat Flux (kW/m^2)	8.7	9.7	11.7	13.6	16.1
% Fatality	10	20	40	60	80

If the heat flux received at a point is between two criteria levels, the risk at this point is treated as having the higher fatality level of the two levels. For example, all points lying between the 13.6 kW/m^2 and 16.1 kW/m^2 contours for a given scenario are treated as resulting in fatality to 80% of the exposed population.

E.3 Overpressure Criteria

There are a number of effects from explosions that can cause injury or fatality to personnel. These include blast effects (overpressure, missiles), heat radiation and whole body displacement. These effects can be categorised as direct effects or indirect effects.

Estimation of the effects of explosions on personnel is considered complex due to the interactions that occur. The direct (or primary) effect is the overpressure generated as a result of the blast. The general effects of overpressure from explosions are summarised in [3].

Table E 3 - Explosion Overpressure Effects

Explosion Overpressure (kPa)	Effects
3.5	90% glass breakage. No fatality and very low probability of injury.
7	Damage to internal partitions and joinery but can be repaired. Probability of injury is 10%, but no fatality.
14	House uninhabitable and badly cracked. People may suffer temporary hearing loss or injury from secondary blast effects such as debris. No fatalities or serious injuries from direct blast effects are expected.
21	Reinforced structures distort. Storage tanks fail. 20% chance of fatality for person in a building.
24	Injuries of a serious nature or possible death are likely from fragments, debris or other objects.
35	House uninhabitable. Plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open.
70	Threshold of lung damage. 100% chance of fatality for person in a building or in the open. Complete demolition of houses.

Based on the effects of different overpressure levels above, the criteria for determining fatality from an explosion have been chosen. These are shown in [1] and [3].

Table E 4 - Overpressure Criteria

Overpressure (kPa)	% Fatality
7	0
21	20
35	50
70	100

If the overpressure is between two criteria levels, the risk at this point is treated as having the higher fatality level of the two levels. For example, all points lying between the 7 kPa and 21 kPa criteria levels are treated as resulting in fatality to 20% of the exposed population.

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E.4 Flash fire criteria

The vulnerability criteria for flash fires are defined as 100 % lethality due to flame contact within the footprint of the flammable cloud. The flammable cloud has been defined conservatively by the maximum contour to a level of concentration equal to 50 % the LFL.

E.5 References

[1] NSW Department of Urban Affairs and Planning, "Risk Criteria for Land Use Planning", Hazardous Industry Planning Advisory Paper No. 4, Second Edition, Sydney, 1992.

[2] Lees, F. P., "Loss Prevention in the Process Industries, Hazard Identification Assessment and Control", Butterworth-Heinemann, Second Edition, 1996, Volume 1.

[3] US Department of Defence Ammunition and Explosives Safety Standards, DOD5154.45, June 1980.

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Appendix F Consequence Results

F.1 Introduction

This appendix contains the consequence results for the QRA. The results are presented in table format. The following list provides a definition for each of the headings presented.

Scenario	The name of the isolable section or specific equipment considered as the scenario.
Hole Size (mm)	The specific hole size considered for the consequence scenario.
Product	The product modelled for the consequence scenario.
State	The release state, liquid (l).
Duration (s)	The time taken for the product to be released.
Release Rate (kg/sec)	The rate at which the product is expected to be released.
Distance (m)	The maximum distance at which the consequence is experienced for the given heat flux criteria, overpressure criteria or fatality level.
Frequency ($\times 10^{-6}$ per yr)	The calculated frequency of occurrence for the consequence scenario.
Release Mass (kg)	The product mass which is expected to be released.
Maximum Distance (m) for Weather Stability Class	The maximum distance to the weather stability D(6) and F(3). Half of the lower flammable limit is used for flash fires.
Distance (m) to Heat Criteria (kW/m^2)	The distance to the heat criteria for each pool fire scenario.
Distance (m) to Overpressure Criteria (kPa)	The distance (m) to the overpressure criteria for each VCE scenario.

Frequencies shown as 0.00×10^{-6} per year are frequencies of less than 1×10^{-8} per year which were included in the modelling.

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Table F 1 – Consequence results for pool fires

Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Distance (m) to heat radiation (kW/m2) for D / 6 m/s				
					8.7	9.7	11.7	13.6	16.1
150mm wharf to manifold - pumping	5	4.1E-01	> 3,600 s	25.96	44	43	42	41	40
	25	1.0E+01	3,182	6.89	66	61	54	50	49
	50	4.1E+01	2,171	4.24	64	58	52	49	49
	150	1.1E+02	480	6.4	64	58	52	49	49
150mm wharf to manifold - static	5	2.0E-02	> 3,600 s	82.29	13	13	12	12	12
	25	4.1E-01	3,600	21.85	37	35	29	25	21
	50	1.6E+00	3,600	13.48	38	34	28	24	20
	150	1.5E+01	1,547	23.86	41	36	30	26	23
300mm wharf to manifold - pumping	5	4.1E-01	> 3,600 s	23.49	44	43	42	41	40
	25	1.0E+01	> 3,600 s	3.26	66	61	54	50	49
	150	3.7E+02	862	9.42	64	58	52	49	49
	300	3.8E+02	480	3.45	64	58	51	47	50
300mm wharf to manifold – static	5	2.0E-02	> 3,600 s	84.11	15	15	14	14	13
	25	5.8E-01	3,600	11.68	39	35	29	25	21
	150	2.1E+01	3,600	40.24	51	45	38	34	34
	300	3.8E+02	1,094	24.49	54	48	41	37	36

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Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Distance (m) to heat radiation (kW/m2) for D / 6 m/s				
					8.7	9.7	11.7	13.6	16.1
Lines from pump station to TWFS - pumping	5	1.5E+00	> 3,600 s	105.39	64	62	57	52	48
	25	3.8E+01	655	67.02	64	59	52	48	48
	75	4.1E+01	421	37.95	81	76	67	63	63
	150	4.1E+01	421	0.35	81	76	67	63	63
Manifold to Tanks - pumping	5	4.1E-01	> 3,600 s	0.32	44	43	42	41	40
	25	1.0E+01	2,734	1.21	88	81	71	66	66
	150	3.7E+02	633	0.33	106	99	88	82	82
	250	3.8E+02	426	0.14	112	104	94	91	91
Manifold to Tanks - static	5	2.0E-02	> 3,600 s	4.26	15	14	14	13	13
	25	5.3E-01	2,400	16.21	34	32	30	27	23
	150	1.9E+01	351	5.17	39	38	35	30	26
	250	5.3E+01	126	3.21	56	51	43	39	39
T1	5	1.3E-01	> 3,600 s	11.43	29	28	27	25	23
	25	3.2E+00	> 3,600 s	27.04	54	48	40	36	36
	100	5.1E+01	> 3,600 s	44.96	75	67	56	51	51
	1000	5.3E+06 (kg)	1	9.59	91	83	72	67	67

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Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Distance (m) to heat radiation (kW/m2) for D / 6 m/s				
					8.7	9.7	11.7	13.6	16.1
T1 to pump station - pumping	5	1.5E-01	> 3,600 s	1.02	29	28	27	25	23
	25	3.7E+00	3,008	3.28	53	47	39	36	36
	150	4.1E+01	2,125	1.05	78	70	59	54	54
	200	4.1E+01	434	0.24	78	70	59	54	54
T1 to pump station - static	5	2.0E-02	> 3,600 s	4.63	14	14	13	13	12
	25	4.7E-01	2,400	14.87	28	28	26	25	23
	150	1.7E+01	203	4.74	33	32	30	29	27
	200	3.0E+01	114	1.15	34	33	31	30	28
T2 and T3	5	1.8E-01	> 3,600 s	13.19	32	31	29	27	23
	25	4.6E+00	> 3,600 s	31.18	58	52	43	39	39
	100	7.4E+01	> 3,600 s	51.8	78	70	60	54	54
	1000	5.7E+06 (kg)	1	9.59	92	85	74	68	68
Tanks 2 and 3 lines to pump station – pumping	5	1.5E-01	> 3,600 s	0.98	29	28	27	25	23
	25	3.9E+00	2,622	3.23	53	47	39	36	36
	150	4.1E+01	915	0.72	78	70	59	54	54
	200	4.1E+01	728	0.18	78	70	59	54	54

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Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Distance (m) to heat radiation (kW/m2) for D / 6 m/s				
					8.7	9.7	11.7	13.6	16.1
Tanks 2 and 3 lines to pump station - static	5	2.0E-02	> 3,600 s	4.37	14	14	13	13	12
	25	4.7E-01	2,400	14.35	28	28	26	25	23
	150	1.7E+01	122	3.18	33	32	30	29	27
	200	3.0E+01	69	0.78	34	33	31	30	28
T4 and T5	5	1.8E-01	> 3,600 s	13.19	10	10	10	10	9
	25	4.6E+00	> 3,600 s	31.18	58	52	43	39	39
	100	7.4E+01	> 3,600 s	51.8	62	56	47	42	42
	1000	5.7E+06 (kg)	1	9.59	115	106	94	89	89
Tanks 4 and 5 to pump station - pumping	5	1.5E-01	> 3,600 s	0.99	29	28	27	25	23
	25	3.9E+00	2,693	3.25	53	47	39	36	36
	150	4.1E+01	916	0.79	78	70	59	54	54
	200	4.1E+01	729	0.19	78	70	59	54	54
Tanks 4 and 5 to pump station – static	5	2.0E-02	> 3,600 s	4.42	14	14	13	13	12
	25	4.7E-01	2,400	14.47	28	28	26	25	23
	150	1.7E+01	139	3.5	33	32	30	29	27
	200	3.0E+01	78	0.86	34	33	31	30	28

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Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Distance (m) to heat radiation (kW/m2) for D / 6 m/s				
					8.7	9.7	11.7	13.6	16.1
T6	5	1.8E-01	> 3,600 s	13.19	32	31	29	27	23
	25	4.6E+00	> 3,600 s	31.18	57	51	42	38	38
	100	7.4E+01	> 3,600 s	51.8	61	55	46	42	42
	1000	5.7E+06 (kg)	1	9.59	116	107	95	89	89
T6 to pump station - pumping	5	1.5E-01	> 3,600 s	0.97	29	28	27	25	23
	25	3.9E+00	2,610	3.23	53	47	39	36	36
	150	4.1E+01	2,114	0.71	78	70	59	54	54
	200	4.1E+01	728	0.18	78	70	59	54	54
T6 to pump station - static	5	2.0E-02	> 3,600 s	4.36	14	14	13	13	12
	25	4.7E-01	2,400	14.33	28	28	26	25	23
	150	1.7E+01	120	3.12	33	32	30	29	27
	200	3.0E+01	67	0.77	34	33	31	30	28
T7	5	1.5E-01	> 3,600 s	12.01	32	31	29	27	23
	25	3.6E+00	> 3,600 s	28.39	52	47	38	35	35
	100	5.8E+01	> 3,600 s	47.18	60	54	45	41	41
	1000	1.0E+06 (kg)	1	0.47	58	52	43	39	39

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Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Frequency (x10-6/year)	Distance (m) to heat radiation (kW/m2) for D / 6 m/s				
					8.7	9.7	11.7	13.6	16.1
T7 to pump station - pumping	5	1.5E-01	> 3,600 s	1.01	29	28	27	25	23
	25	3.9E+00	2,794	3.28	53	47	39	36	36
	150	4.1E+01	2,119	0.89	78	70	59	54	54
	200	4.1E+01	431	0.21	78	70	59	54	54
T7 to pump station - static	5	2.0E-02	> 3,600 s	4.5	14	14	13	13	12
	25	4.7E-01	2,400	14.63	28	28	26	25	23
	150	1.7E+01	163	3.96	33	32	30	29	27
	200	3.0E+01	91	0.97	34	33	31	30	28
T8	5	6.0E-02	> 3,600 s	8.68	29	28	26	25	23
	25	1.6E+00	> 3,600 s	20.54	40	36	29	25	24
	100	2.5E+01	1,411	34.16	74	66	56	50	50
	1000	3.6E+04 (kg)	1	0.47	67	59	49	43	43
Tanks 1,2,3 Overfill	Overfill	2.5E+02	1,200	9.12	66	59	48	43	43
Tanks 4,5,6 Overfill	Overfill	2.5E+02	1,200	9.12	50	43	35	30	30

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Table F 2 – Consequence results for flash fires

Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Stability	Frequency (x10-6/year)	Distance to ½ LFL (100 % lethality)	
						Length [m]	Width [m]
Tanks 1, 2, 3, 4, 5 or 6	Overfill	2.5E+02	1,200	D6	24	100	160
				F3	6	106	292

Table F 3 – Consequence results for vapour cloud explosions

Isolable section	Hole size (mm)	Release Rate Used (kg/s)	Duration (s)	Stability	Frequency (x10-6/year)	Distance (m) to overpressure (kPa)			
						7	21	35	70
Tanks 1, 2, 3, 4, 5 or 6	Overfill	2.5E+02	1,200	D6	16	113	63	52	44
				F3	4	163	91	71	58

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Appendix G Risk results

G.1 Introduction

This appendix contains the results of the QRA, which include the Location Specific Individual Risk (LSIR) contours. The LSIR contours shown correspond to the following risk levels:

- maximum acceptable LSIR in industrial areas (50 x 10-6/year);
- maximum acceptable LSIR in sporting complexes and active open spaces (10 x 10-6/year);
- maximum acceptable LSIR in commercial developments including retail centres, offices and entertainment centres (1 x 10-6/year);
- maximum acceptable LSIR in residential, hotels, motels, tourist resorts (0.5 x 10-6/year); and,
- maximum acceptable LSIR in Hospitals, schools, child-care facilities, old age housing (0.1 x 10-6/year).

The LSIR risk countors shall be interpreted in the following manner: the area inside a certain contour has a LSIR equal or greater than the risk level indicated in the legend of that contour.

Figure G 1 shows the LSIR contours for all the scenarios included in the QRA. Figure G 2 shows the LSIR contours for all the pool fires. Finally, Figure G 3 shows the LSIR contours for all the flash fires and vapour cloud explosions.

As it can been in Figure G 1, the residual risk level in the main areas of concern which were the industrial sites adjacent to the proposed site, the public marina and the residential area located 300 m to the south-east of the proposed development, is considered negligible.

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Figure G 1 – Location Specific Individual Risk (LSIR) contours for the proposed Seaview tank terminal and wharflines

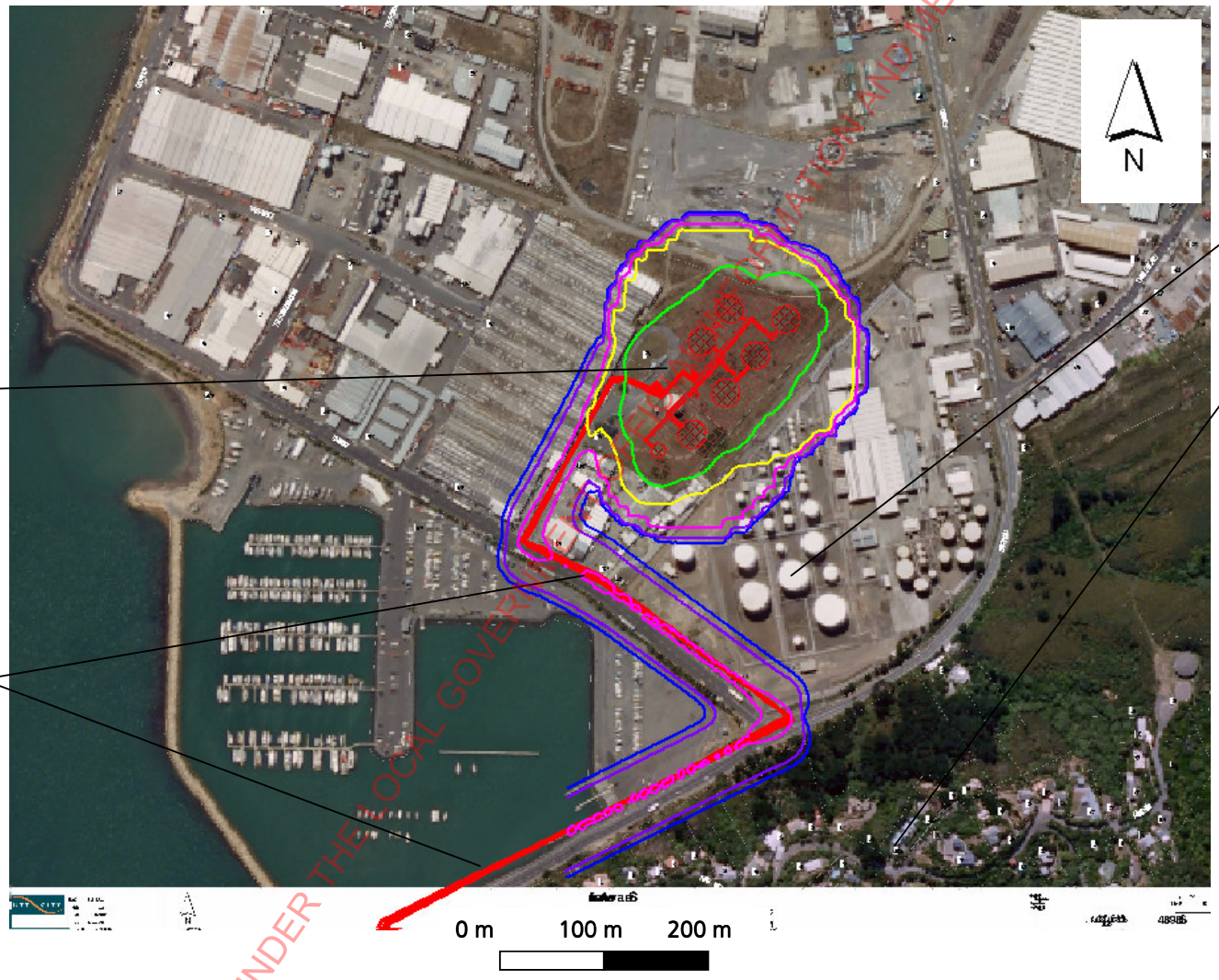

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Figure G 2 – Location Specific Individual Risk (LSIR) contours (pool fires)

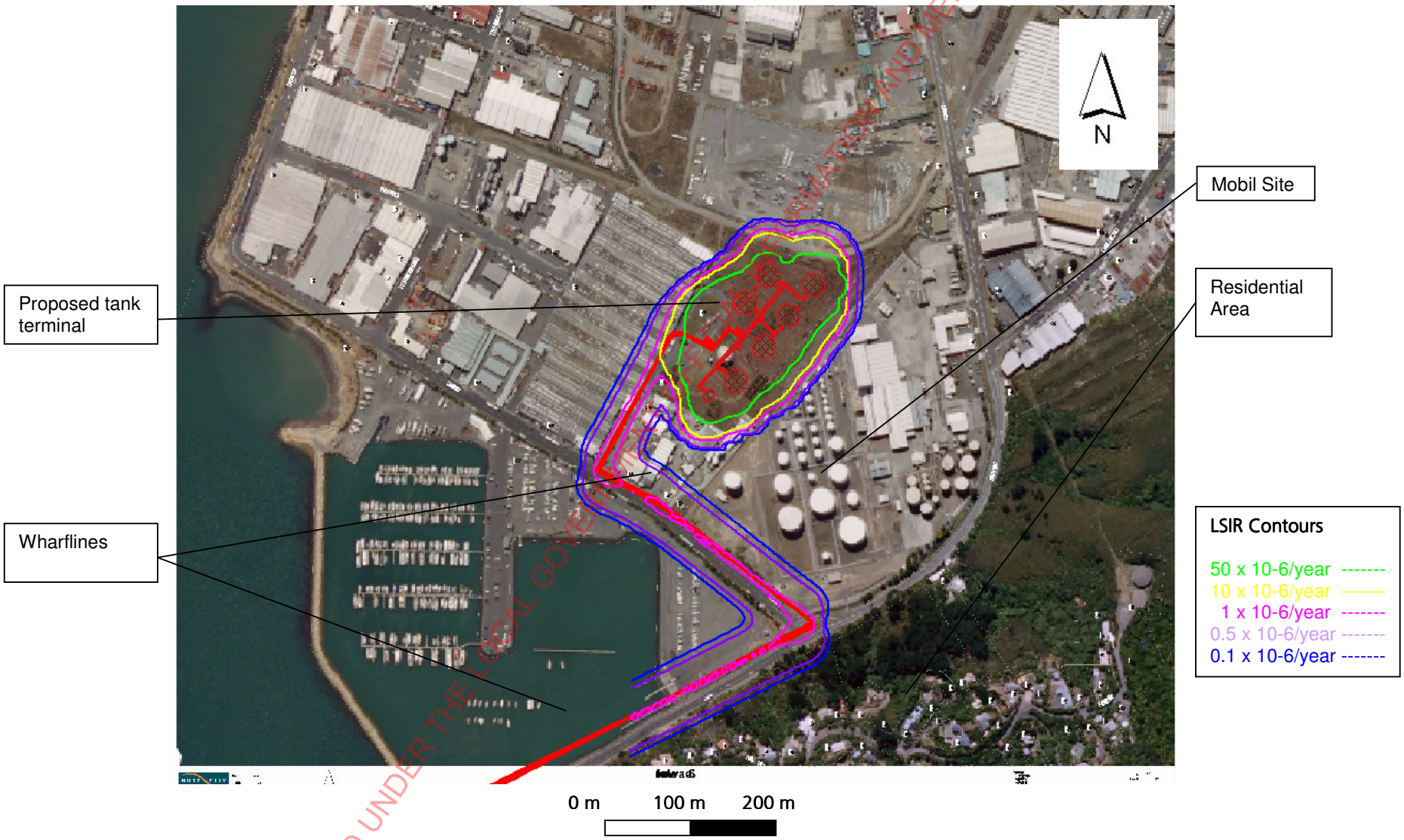

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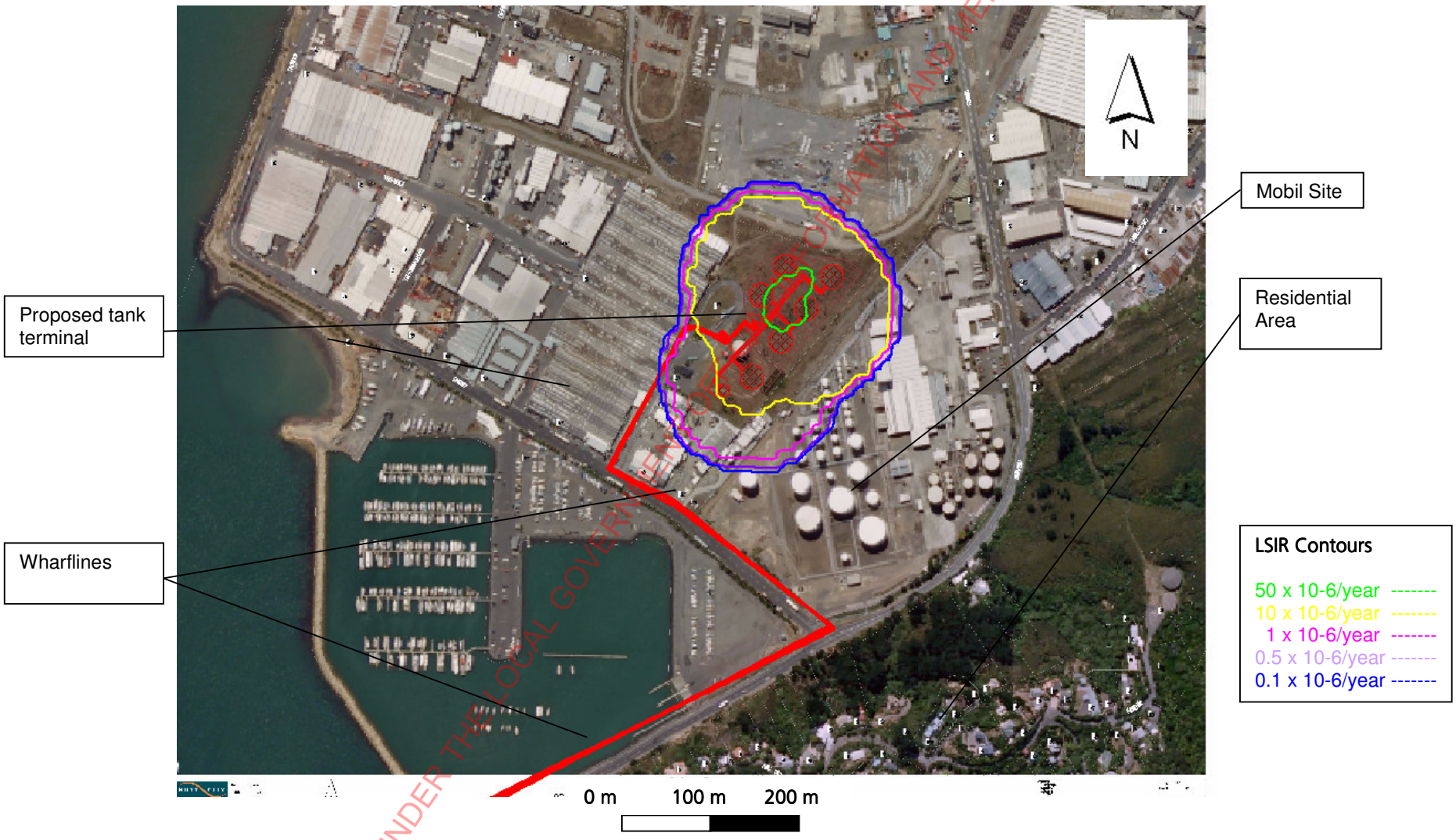
Figure G 3 – Location Specific Individual Risk (LSIR) contours (flash fires and VCEs)



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Appendix H Photographic evidence

This appendix contains some photographs taken by Lloyds Register during the site visits.

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Figure H 1 – Overview of the Seaview industrial area, Lower Hutt City

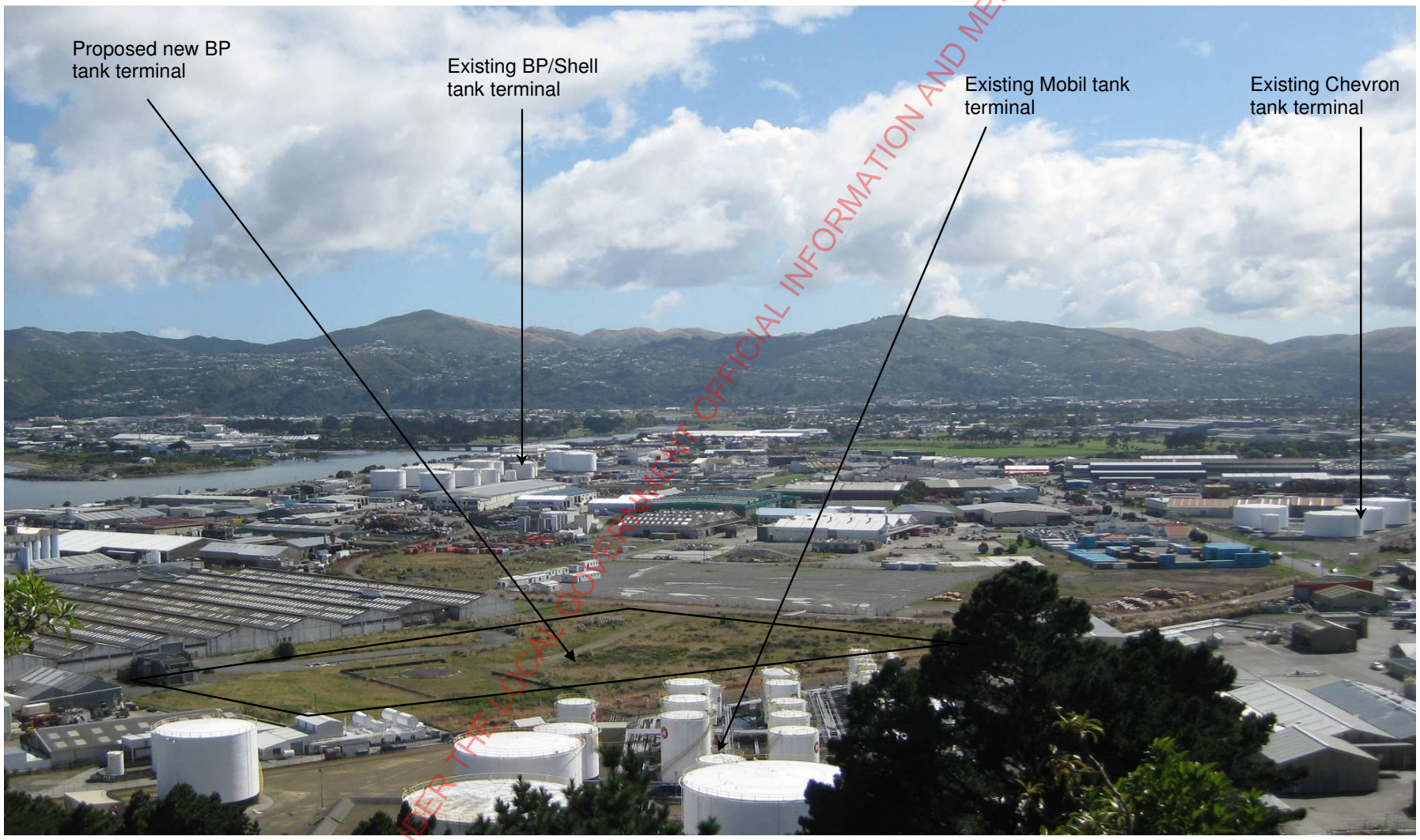

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Figure H 2 – The wharf and the wharflines

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Figure H 3 - Wharflines

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LIFE MATTERS

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CURRENT WHARFLINE ROUTE

PROPOSED WHARFLINE ROUTE

WHARFLINE 0.5x 10-6 RISK CONTOUR (40m, except where the cliff is located)

TERMINAL BOUNDARIES (parcels)

HUTT TERMINAL

SEAVIEW RD

BARNES ST

BARNES ST

PORT ROAD

Z TERMINAL

RAIL CORRIDOR

TOOP ST

BP SEAVIEW TERMINAL

GRACEFIELD RD

PORT ROAD

MOBIL TERMINAL

MARINE DR

Scale 1:5000 @ A3

0 100 200m

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SLR

810.V16188.00001 - Hutt City District Plan Review (OIEWG)

SEAVIEW WHARFLINE AND TERMINAL RISK CONTOURS

Figure prepared for HCC by SLR Consulting.

Date: 22/10/2024
Version 4.0 v1 (proposed + existing wharfline)
Drawn: s7(2)(a)
Checked: Philip Brown
Approved: Philip Brown

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Summary of feedback provided by the Fuel Companies to date in relation to the Draft Hutt City District Plan

Date: 25th October 2024

Topic / matter	Relief sought by the Fuel Companies	Reference	Response from HCC
Risk management overlay	Insertion of a risk management overlay that is consistent with the risk contour mapping for the four bulk fuel storage terminals in Seaview.	Fuel Companies' Letter dated 15 December 2023	Accepted (email from Hamish Wesney dated 9/7/24).
	Policy framework which avoids and sets a non-complying activity status for sensitive activities in the risk management overlay.	Fuel Companies' Letter dated 31 May 2024	Accepted (email from Hamish Wesney dated 9/7/24).
	Clear policy framework for risk management overlay.	Fuel Companies' Letter dated 15 December 2023 Fuel Companies' Letter dated 31 May 2024	No response/confirmation received yet.
	That the existing risk mapping around the NZOSL Terminal is retained as a 'placeholder' for the purpose of Risk Management Overlay mapping around the terminal, while the QRA is prepared.	Fuel Companies' Letter dated 9 August 2024	Accepted, provided that NZOSL Terminal QRA is provided before December 2024.
Heavy Industrial Zone	The Fuel Companies generally seek that the HIZ provisions address the following: • Objectives and policies which require that activities and built development avoids unacceptable residual risk effects and reverse sensitivity effects associated with the Hutt City fuel transmission pipeline and MHFs. • Similar restrictions to the SMP in relation to commercial activities, multi-storey buildings, sensitive (including residential) activities. • Requiring certain high-risk activities (e.g. multi-storey buildings, sensitive activities, supermarkets) to undertake a risk assessment which demonstrates that it will not change the wharfline's location classification under AS/NZS 2885.6.	Letter from 31 May 2024	No response/confirmation received yet. HCC indicated that it is not willing at this stage to support the pipeline risk classification approach.
	Objectives and Policies *HIZ-P1 Enabled activities* *Enable industrial activities and research activities, and other activities with similar effects and requirements, and provide for other supporting activities while managing them to avoid significant reverse sensitivity effects and unacceptable residual risk associated with on the industrial and research activities.* *HIZ-P2 Residential activities and sensitive activities* *Do not allow residential activity and other sensitive activities unless:* *1. They are ancillary to and critical to the functioning of an industrial activity, research activity, or emergency facility, which itself is an existing activity or has a functional or operational need to be located in the Heavy Industrial Zone, ~~and~~* *2. They are managed to avoid significant reverse sensitivity issues and unacceptable residual risk associated with ~~for~~ industry, including heavy industry, and* *HIZ-P3 Other potentially incompatible activities* *Avoid activities other than industrial activities or research activities unless they:* *…* *6. they are managed to avoid significant reverse sensitivity issues and unacceptable residual risk associated with for industry, including heavy industry.* *New Policy:* *New Policy: Managing risk in relation to the Hutt City fuel transmission pipeline* *HIZ-P13* *Avoid activities and built development within the Heavy Industrial Zone that results in a location classification change to the Hutt City fuel transmission pipeline under AS/NZS 2885.6.* Activity Standards *HIZ-R20 Activities sensitive to hazardous facilities and infrastructure ~~Sensitive activities, other than residential activity~~* *1. Activity status: Non-complying* *Where:* *a. The sensitive activity is ancillary to an industrial activity, research activity, or emergency facility* *2. Activity status: Prohibited* *a. Where compliance with HIZ-R20.1 is not achieved.* *New Standard:*	Fuel Companies' Letter dated 31 May 2024	No response/confirmation received yet. HCC indicated that it is not willing at this stage to support the pipeline risk classification approach. Note that an alternative approach (fuel transmission pipeline corridor) has been proposed by the Fuel Companies – see below.

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	HIZ-S8 Multi-storey buildings *1. Buildings within properties adjoining sections of road containing the Hutt City fuel transmission pipeline must not exceed more than one storey.* *Where Standard HIZ-S8 is not met, discretion is restricted to:* *1. Management of residual risk effects and reverse sensitivity effects associated with nearby significant hazardous facilities and the Hutt City fuel transmission pipeline* *2. Whether the activity results in a location classification change to the Hutt City fuel transmission pipeline under AS/NZS 2885.6*		
Seaview Marina Precinct	Fuel Companies seek that the Seaview Marina Precinct chapter establishes a clear policy direction, with suitable provisions, which: a) Recognises the Seaview Marina Precinct's proximity to SFHs, including associated risk considerations. b) Avoids the establishment of sensitive activities in the Seaview Marina Precinct. c) Manage activities in the Seaview Marina Precinct to ensure that they are subject to an acceptable level of risk. This includes consideration of building design, the location of activities, and site emergency management plans.	Fuel Companies' Letter dated 15 December 2023	HCC's initial response indicated that it considers the current SMP provisions to be appropriate. The Fuel Companies maintain that the draft SMP provisions are too enabling and not suitable from a risk and reverse sensitivity perspective. HCC indicated that it is not willing at this stage to support the pipeline risk classification approach. Note that an alternative approach (fuel transmission pipeline corridor) has been proposed by the Fuel Companies – see below.
	Fuel Companies generally seek that the SMP provisions address the following: • Objectives and policies which require that activities and built development avoids unacceptable residual risk effects on and reverse sensitivity effects associated with the Hutt City fuel transmission pipeline and MHFs. This includes built design and emergency management considerations. We expect that the risk management overlay (which encompasses most of the Marina) will address risk in relation to the terminals, however SMP objectives and policies are needed to address risk in relation to the HCWL included in areas not within the risk management overlay. • Setting density control of 150 people per hectare at all times in the SMP. We see this as being a particularly important matter to address, noting that this density can result in a 'high density' or 'crowd' classification which could change the location classification of the wharfline. • Requiring resource consent (at a minimum discretionary activity status) for commercial activities such as supermarkets and retail stores, noting that the cumulative addition of such activities could result in a 'town centre' which could result in a change to the HCWL location classification. • Requiring resource consent (at a minimum discretionary activity status) for multi-storey buildings. • Requiring certain high-risk activities (e.g. multi-storey buildings, sensitive activities, supermarkets) to undertake a risk assessment which demonstrates that it will not change the wharfline's location classification under AS/NZS 2885.6. • Avoiding sensitive and residential activities.	Fuel Companies' Letter dated 31 May 2024	
	Suggested changes to draft provisions: Objectives and Policies *New objective:* *GIZ-PREC1-O2 Managing residual risk and reverse sensitivity* *Activities and built development avoids unacceptable residual risk effects and reverse sensitivity effects associated with major hazardous facilities and the Hutt City fuel transmission pipeline.* *GIZ-PREC1-P1 Enabled activities* *This policy is additional within the Seaview Marina Precinct* *Enable marina activities, activities that support marina activities, and commercial activities that do not undermine the purpose, vitality, vibrancy, and co-location benefits, while managing the reverse sensitivity effects of those on existing and potential activities in the General Industrial Zone and Heavy Industrial Zone and managing residual risk effects and reserve sensitivity effects associated with major hazardous facilities and the Hutt City fuel transmission pipeline.* *GIZ-PREC1-P5 Design outcomes* *This objective replaces GIZ-P9 within the Seaview Marina Precinct* *…* *Built development is designed and managed to avoid unacceptable residual risk effects and reverse sensitivity effects associated with major hazardous facilities and the Hutt City fuel transmission pipeline.* *…* *New Policy:* *GIZ-PREC1-P6: Managing risk in relation to the Hutt City fuel transmission pipeline* *Avoid activities and built development within the Seaview Marina Precinct that results in a location classification change to the Hutt City fuel transmission pipeline under AS/NZS 2885.6.* Activity Standards *New Rule:* *GIZ-PREC1-R8 Activities sensitive to hazardous facilities and infrastructure*	Fuel Companies' Letter dated 31 May 2024	

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	Activity status: Discretionary *Where:* *a. The activity is ancillary to an industrial activity, research activity, or emergency facility* *2. Activity status: Non-complying* *Where compliance with GIZ-R20.1 is not achieved.* *Public notification is required for any application under this rule.* *IZ-PREC1-R2 Grocery stores and supermarkets* *This rule replaces GIZ-R10 within the Seaview Marina Precinct* *Activity status: ~~Permitted~~ Discretionary* *GIZ-PREC1-R3* *Food and beverage activities* *This rule replaces GIZ-R11 within the Seaview Marina Precinct* *Activity status: ~~Permitted~~ Discretionary* *GIZ-PREC1-R6 Commercial activities not otherwise provided for* *This rule replaces GIZ-R14, GIZ-R15, and GIZ-R16 within the Seaview Marina Precinct* *Activity status: Permitted* *Where:* *a. The commercial activity is ancillary to an industrial activity or research activity and no more than 20% of the gross floor area of buildings on the site are used for retailing or otherwise open to customers, or* *b. ~~The commercial activity has a gross floor area of no more than 500m2.~~* *2. Activity status: Discretionary* *Where:* *a. Compliance is not achieved with GIZ-PREC1-R6.1* *GIZ-PREC1-R7 Other activities not otherwise provided for* *This rule replaces GIZ-R17 within the Seaview Marina Precinct* *1. Activity status: Permitted* *Where:* *a. The activity is ancillary to a permitted activity, or* *b. ~~The activity has a gross floor area of no more than 500m2~~* *2. Activity status: Discretionary* *Where compliance is not achieved with GIZ-PREC1-R7.1* Development Standards *New Standards:* *GIZ-PRE1-S2 Multi-storey buildings* *1. Buildings within the Seaview Marina Precinct must not exceed more than one storey.* *Where Standard GIZ-PRE1-S2 is not met, discretion is restricted to:* *1. Management of residual risk effects and reverse sensitivity effects associated with nearby significant hazardous facilities and the Hutt City fuel transmission pipeline* *2. Whether the activity results in a location classification change to the Hutt City fuel transmission pipeline under AS/NZS 2885.6* *GIZ-PRE1-S3 Density of people* *1. The density of people within the Seaview Marina Precinct at all times must not exceed 150 people per hectare.* *Where Standard GIZ-PRE1-S3 is not met, discretion is restricted to:* *1. Management of residual risk effects and reverse sensitivity effects associated with nearby significant hazardous facilities and the Hutt City fuel transmission pipeline.*		

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	2. Whether the activity results in a location classification change to the Hutt City fuel transmission pipeline under AS/NZS 2885.6		
Fuel Transmission Pipeline Corridor (Alternative approach to pipeline risk classification method).	The Fuel Companies seek that a fuel transmission pipeline corridor is mapped into the district plan, as follows: *Fuel transmission pipeline: means any pipeline established to convey fuels.* *Fuel transmission pipeline corridor: means the area of land within 40m from the centreline of the fuel transmission pipeline.*	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
	In addition, the Fuel Companies seek that a policy and rules framework is implemented which requires the avoidance of activities sensitive to hazardous facilities and infrastructure within the fuel transmission pipeline corridor, as follows: *New objective* *Activities and built development in the fuel transmission pipeline corridor avoid unacceptable residual risk effects from, and reverse sensitivity effects on, the Hutt City fuel transmission pipeline.* *New policy* *The activity or land use in the fuel transmission pipeline corridor meets the appropriate risk acceptance criteria suitable for the land use activity and does not result in any operational constraints on pipeline use.* *New Rule: fuel transmission pipeline corridor* *Activities sensitive to hazardous facilities and infrastructure[1] in the fuel transmission corridor* *Activity status: non-complying activity*	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
Hazardous Substances Chapter	References in the Draft Plan to residual risk (in particular in Objective HS-O1, Policies HS-P1 and HS-P2) need to be amended so that they relate to *unacceptable* residual risk. The Fuel Companies also seek changes to Policy HS-P1 to recognise that the level of unacceptable residual risk is determined not only by location (i.e. proximity to SHFs), but also by management (i.e. how hazardous substances are stored / transferred / used). Fuel Companies consider changes are necessary to Objective HS-O2. The following relief is sought: *HS-O1 Protection from residual risk* *People, communities, and identified areas are protected from ~~any~~ unacceptable residual risk ~~of~~ resulting from facilities and activities involving the manufacture, use, storage, transportation or disposal of hazardous substances.* *HS-O2 Protection of existing facilities* *Sensitive activities are established in appropriate locations to ~~minimise~~ avoid reverse sensitivity effects and unacceptable residual risk from existing significant hazardous facilities.* *HS-P1 Residual risk to people and communities* *~~Avoid~~ New facilities and activities involving the manufacture, use, storage, transportation or disposal of hazardous substances, including significant hazardous facilities, are located and managed so that they do not result in unacceptable ~~from locating in areas where they may adversely affect human health unless it can be demonstrated that the~~ residual risk to human health, people and communities. ~~or these identified areas and their values will be avoided or, if avoidance is not possible, unacceptable risk is adequately mitigated.~~* *HS-P2 Location of hazardous facilities and activities* *Avoid unacceptable residual risk to people and sensitive activities from facilities and activities involving the manufacture, use, storage, transportation or disposal of hazardous substances by:* *Adequately ~~S~~separating sensitive activities from existing hazardous facilities and activities; and* *Establishing new hazardous facilities and activities in appropriate locations, separated from incompatible land uses and existing sensitive activities.*	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.

[1] A definition of Activities sensitive to hazardous facilities' was provided on page 12 of the Fuel Companies' letter to Council dated 31 May 2024.

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	HS-R2 New significant hazardous facilities *Activity status: Restricted discretionary* *Matters of discretion are restricted to:* *1. The matters in HS-P1 to HS-P3; and* *2. The probability and potential consequences of an accident leading to the release or loss of control of hazardous substances, including the design and management of the site to avoid accidents, such as spill containment measures, fire safety and fire-water management, emergency management, site drainage and off-site infrastructure (e.g. stormwater drainage system, sewer type and capacity) and the disposal of waste containing hazardous substances; and* *3. Adequate separation distances from sensitive activities, identified areas, and adjacent hazardous facilities and/or activities to ensure conflict between activities, adverse effects and reverse sensitivity effects are minimised; and* *4. The design and site layout of the activity its ability to internalise effects within the activity's site; and* *5. Whether the activity has the potential to compromise tangata whenua's relationship with their ancestral lands, water, sites, wāhi tapu, and other taonga and if so, the outcomes of any consultation with tangata whenua; and* *6. Measures to avoid or manage risks associated with natural hazards including the potential for sea level rise to impact on the operation of the activity; and* *7. The extent to which adverse effects can be avoided, or where avoidance is not possible, remedied or mitigated.* *8. Management of residual risk effects and reverse sensitivity effects associated with the Hutt City fuel transmission pipeline.*	Fuel Companies' Letter dated 31 May 2024	No response/confirmation received yet.
	Provide a permitted pathway for additions / alterations at SHFs where it does not increase risk profile, by inserting a new rule as follows: *Additions and/or alterations to existing significant hazardous facilities* *1. The activity does not change the risk profile established by QRA of the significant hazard facility, as measured from the date of notification of this Plan.* *All zones* *Activity status: Permitted* Together with an accompanying change to Rule HS-R1.	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
Three Waters Chapter	Fuel Companies seek that the Draft Plan clarifies its relationship with other legislation regarding stormwater management.	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
	References to 'development' in the Three Waters Chapter, including in the introduction section, THW-O2, THW-O3, THW-P3, THW-P4, THW-R1, THW-R2, THW-R3, THW-R5, are replaced with references to 'new or redevelopment of existing impervious areas'.	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
	The Fuel Companies consider that the rules should only be applicable where there are new or additional impervious areas proposed, or new / changes to connections to Three Water infrastructure. Amendments to Rule WH.R7 (Stormwater from new and redeveloped impervious surfaces of existing urbanised areas – controlled activity) to provide for stormwater discharges from new and redeveloped impervious surfaces at MfE guideline compliant service stations, truck stops and commercial refuelling facilities on the same basis as for other land uses. We do not expect that this amendment will be relevant to the Three Waters provisions, as these will not control the quality of discharges (being a regional authority function under s31 RMA).	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
	Amend the provisions to apply to new buildings only and increase the permitted activity standard for the provision of hydraulic neutrality and water sensitive urban design from 0m2 to 40m2, which is in accordance with the Wellington Water standards and aligns with the Greater Wellington Regional Council Plan Change 1 to the Natural Resources Plan.	Fuel Companies' Letter dated 9 August 2024	Accepted (email from Hamish Wesney dated 9/7/24).
	That if a Three Waters Chapter approach is adopted per the approach for PC1 to the NRP, the provisions do not relate to regional authority functions and the Fuel Companies' relevant submission points on PC1 to the NRP are considered by HCC.	Fuel Companies' Letter dated 9 August 2024	No response/confirmation received yet.
Contaminated Land Chapter	The following amendments to Policy CL-P1 are proposed: *CL-P1 Identification of contaminated and potentially contaminated land* *Identify contaminated land and potentially contaminated land prior to subdivision or change of use or development by:*	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.

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	1. *Working with Greater Wellington Regional Council to maintain the Selected Land Use Register; and* 2. *Requiring the investigation of contaminant risks for sites <u>where there is a potential risk to human health</u> ~~with a history of land use or activity that could have resulted in contamination of soil.~~*		
Infrastructure Chapter	The Fuel Companies seek the insertion of new provisions into the draft plan to provide a clear policy framework for regionally significant infrastructure and to ensure that it is protected from inappropriate development in close proximity. This includes the insertion of new objectives / policies that are consistent with the RPS: • Recognise the benefits of RSI (Policy 9, Policy 39), and • Enable the safe and efficient operation of RSI where it is protected from potential reverse sensitivity effects (Policy 22(m)). The Fuel Companies	Fuel Companies' Letter dated 15 December 2023 Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
	That a permissive pathway is provided for 'upgrades' to the wharfline.	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
	That the bulk and location standards are more enabling for EVCI activities, noting that EV charging infrastructure can sometimes marginally exceed 2m in height and that the zone bulk and location standards are much more enabling. For instance, INF-S8 provides for a maximum height level of 2m for electric vehicle charging infrastructure in industrial zones, while the maximum height level in the General Industrial Zone is 22m.	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
Definitions	The Fuel Companies seek that the definition of SHF is amended as follows: *Significant hazardous facilities* *Means any facility which involves one or more of the following activities:* *3. The storage/use of more than ~~100,000~~ <u>50,000</u> litres of petrol* *4. The storage/use of more than ~~50,000~~ <u>100,000</u> litres of diesel* *…..* *<u>This definition does not apply to:</u>* *<u>1. The underground storage of petrol and diesel at service stations and truck stops that is undertaken in accordance with HSNOCOP 44 Below Ground Stationary Container Systems for Petroleum – Design and Installation and HSNOCOP 45 Below Ground Stationary Containers Systems for Petroleum – Operation.</u>* *<u>2. The distribution or transmission by pipelines of petroleum products.</u>* *<u>3. Fuel installations and fuel servicing activities at airports.</u>* *<u>4. The incidental use and storage (including for disposal) of hazardous substances for emergency service activities.</u>*	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
	Amend definition of redevelopment: *For the purpose of assessment of a proposal involving the redevelopment of an existing urbanised property (i.e brownfield development, upgrades to existing roads etc.) in relation to stormwater effects, this includes the replacement, reconstruction or addition (new) of impervious surfaces. Excludes:* ▪ *minor maintenance or repairs to roads, carparking areas, driveways and paving* ▪ *installation, maintenance or repair of underground infrastructure or network utilities requiring trenching and resurfacing* ▪ *activities that only involve the re-roofing of existing buildings; <u>and</u>* ▪ *<u>resurfacing that does not involve re-direction of existing stormwater flows or drainage networks.</u>*	Fuel Companies' Letter dated 9 August 2024	No response/confirmation received yet.
	Inset a definition of regionally significant infrastructure consistent with the Wellington RPS definition.	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
	New definition: *<u>Residual risk:</u>* *<u>Means, in relation to the Hazardous Substances chapter, the level of any remaining risk of an adverse effect after other industry controls, legislation and regulations, including the Hazardous Substances and New Organisms Act 1996, the Land Transport Act 1998, the Health and Safety at Work (Hazardous Substances) Regulations 2017 and any other subordinate instruments, and regional planning instruments have been complied with.</u>*	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
	Amend the definitions of *potentially hazard sensitive activities* and *hazard sensitive activities* so that hazardous facilities and major hazard facilities are classed as *potentially hazard sensitive activities* rather than *hazard sensitive activities*.	Fuel Companies' Letter dated 2 May 2024	Accepted (email from Hamish Wesney dated 9/7/24).

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	Amend the definitions of Less Hazard Sensitive Activities, Potentially Hazard Sensitive Activities and Hazard Sensitive Activities so that they specifically refer to 'natural hazard risk', as follows: ~~*Less Hazard Sensitive Activities*~~ *Activities Less Sensitive to Natural Hazards* ~~*Potentially Hazard Sensitive Activities*~~ *Activities Potentially Sensitive to Natural Hazards* ~~*Hazard Sensitive Activities*~~ *Activities Sensitive to Natural Hazards*	Fuel Companies' Letter dated 2 May 2024	No response/confirmation received yet.
	New definition: *Activities sensitive to hazardous facilities and infrastructure:* *Activities sensitive to hazardous facilities and infrastructure are:* • *residential visitor accommodation;* • *retirement villages;* • *hospitals;* • *healthcare facilities;* • *educational facilities;* • *community facilities;* • *marae;* • *entertainment facilities;* • *residential units and minor residential units;* • *multi-unit housing.*	Fuel Companies' Letter dated 31 May 2024	No response/confirmation received yet.
	New definition: *Reverse sensitivity* *means the potential for the operation of an existing lawfully established activity to be compromised, constrained, or curtailed by the more recent establishment or alteration of another activity which may be sensitive to the actual, potential, or perceived adverse environmental effects generated by the existing activity or structure.*	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
Transport Chapter	The Fuel Companies are opposed to 'any' service station being a high trip generating activity in Table 8 and seek that the threshold is 6 fill points.	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
Service Stations and Zone Provisions	The general position of the Fuel Companies is that the zone rules should provide for existing service stations (i.e. additions or alterations) as a permitted activity where it is an industrial or commercial zones. New service stations should be permitted in zones that are appropriate for the activity, particularly the industrial zones.	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
Industrial zones	the Fuel Companies seek that the floor area limit on the rule applies only to the retail activities on the site, as follows: *Where:* *The retail activity has a gross floor area of no more than 200m²*	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.
Commercial zones	The Fuel Companies seek that the commercial zones permit the additions or alterations to existing service stations where this in in accordance with the standards for the zone. Making the following changes to the commercial zone rules: *LCZ-R17 Service stations* *1. Activity status: **Permitted*** *Where:* *a. The activity is an addition or alteration to an existing service station, and* *b. Compliance is achieved with LCZ-S1 to LCZ-S11.* *2. Activity status: **Restricted Discretionary*** *Where:* *a. Compliance is not achieved with LCZ-R17.1.* *Matters of discretion are restricted to:* *1. The matters of discretion any standard(s) not met.*	Fuel Companies' Letter dated 15 December 2023	No response/confirmation received yet.

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Natural Hazards chapter	Relief sought: Amend the Natural Hazard Chapter's hazard ranking table so that it is consistent with the definitions for High Hazard Area, Medium Hazard Area and Low Hazard Area. Amend the definitions for High Hazard Area, Medium Hazard Area, and Low Hazard Area so that they specifically refer to natural hazard risk, as follows: *High Natural Hazard Area* *Medium Natural Hazard Area* *Low Natural Hazard Area*	Fuel Companies' Letter dated 2 May 2024	No response/confirmation received yet.
	Relief sought: Amend Rules NH-R9, NH-R14, NH-R15, NH-R17 to clarify that they do not trigger consenting requirements for works involving structures which are inherently resilient to flooding and overland flowpath risks (e.g. new remote fill points, light poles, signage, rubbish storage units etc.). We note that the draft plan's definition of building, which is consistent with the National Planning Standards building definition, is supported. We have given this matter further thought and consider that the following sub-clause to rules NH-R9, NH-R14, NH-R15, NH-R17 would achieve Council's intent: *Where:* *a. The activity does not result in new or additional gross floor area unless it relates to car parking, loading docks or spaces, vehicle access aisles, manoeuvring areas / ramps, or carwashes.*	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.
	To provide a clear pathway for maintenance, upgrades, additions and repair works, amend Policy NH-P2 as follows: *Policy NH-P2: Levels of Risk* *Subdivision, use and development manages the natural hazard risk to people, buildings and infrastructure by:* *…* *Avoiding subdivision, buildings and activities in the high hazard areas of the Natural Hazard Overlays unless there is either:* *a) an operational need or functional need for the building or activity to be located in this area; or ~~and~~* *b) the building or activity mitigates the existing risk from natural hazards to people, buildings and infrastructure.* Amend any other objectives and/or policies in the Natural Hazards Chapter which require avoidance of any activity in an area sensitive to natural hazards that does not have an *operational need or functional need.*	Fuel Companies' Letter dated 2 May 2024	No response/confirmation received yet.
Zone approach to implementing a risk management framework	Risk management overlay should address only the terminals and not the wharfline, as the pipeline risk management is primarily drive by the AS/NZ 2885.6-2018 assessment framework and not the QRA framework.	Fuel Companies' Letter dated 31 May 2024	Indication from HCC is that at this stage HCC is not willing to support this approach. Note that an alternative approach (fuel transmission pipeline corridor) has been proposed by the Fuel Companies – see below.
Temporary activities	Recommend the following changes: *TEMP-R1 Temporary activities* *All zones excluding the Seaview Marina Precinct* *1. Activity status: Permitted* *……* *All zones excluding the Seaview Marina Precinct* *4. Activity status: Restricted discretionary* *….* *Seaview Marina Precinct*	Fuel Companies' Letter dated 25 October 2024	No response/confirmation received yet.

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	5. Activity status: Restricted discretionary *Matters of discretion are restricted to:* *1. Positive effects, including contribution to Lower Hutt's vibrancy, diversity, and prosperity; and* *2. The matters of discretion in any standard not met (including TEMP-S4 if it is not met).* *3. Management of residual risk effects and reverse sensitivity effects associated with nearby significant hazardous facilities and the Hutt City fuel transmission pipeline.*		

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, 22 November 2024 11:55 am
To: Stephen Davis; Hamish Wesney
Cc: David Le Marquand
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan
Attachments: 21939-RP-001-Rev0 Hutt City QRA.pdf; RE: Hutt City District Plan - NZOSL QRA and Wharfline Risk Corridor

Follow Up Flag: Follow up
Flag Status: Completed

Hi Stephen & Hamish,

As promised, please see attached the QRA for the NZOSL Hutt City Terminal. The contours we previously provided you for the Hutt City Terminal (in my recent email below dated 13 November) are consistent with the QRA findings.

The author of the QRA Report, s7(2)(a), has significant experience having been involved in preparing QRAs for the Z Seaview and Mobil Seaview terminals as well. For good measure, we asked s7(2)(a) to provide comment on our proposed approach to setting the wharfline contours (40m setback either side). s7(2)(a) confirmed that she supports this approach – I've **attached** an email from her in relation to this matter.

@Hamish Wesney – are you able to please shed light on the Risk Management Overlay extent, noting my previous emails? I thought we'd previously reached an agreement that the Risk Management Overlay mapping was to be based on the sensitive contours per the QRAs, so I'm keen to know where this is at.

Kind regards
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Wednesday, 13 November 2024 4:40 pm

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To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Perfect, thank you.

Stephen Davis
Senior Policy Planner

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Sent: Wednesday, 13 November 2024 2:40 PM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen

Please see updated link files here: GIS Shapefile V2

If there are still issues with the data let me know and we will try to assist.

Kind regards
Phil

Philip Brown
BPlan (Hons)

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Associate Consultant - Planning

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To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

I will talk to s7(2)(a) and see if we can get the appropriate file to you.

I'd be keen to hear Hamish's thoughts – as I said I thought we'd previously reached an agreement that the Risk Management Contour was to be based on the sensitive contours so I'm keen to understand why Council's position has shifted. If the underlying zone rules do not have a non-complying / avoidance approach with respect to these activities I'm not sure how this new approach is appropriate.

Another matter which we are yet to comment on: my understanding is that the Mana Whenua cultural site mapping and associated provisions are yet to be fully worked through in the draft version, but I note that the Operative district plan maps identify a Significant Cultural Resource Site (Site 19) within the NZOSL Hutt City Terminal. The site is associated with a former Pa located on a sandy spit of land at mouth of the Waiwhetu Stream. However, a Cultural Impact Report prepared by Raukura Consultants in 2018, in relation to proposed works at the Terminal at the time, concludes that site 19 is incorrectly located on the HCDP maps. This is because while a Pa was located at the mouth of the Waiwhetu Stream, the stream mouth has been altered by reclamation and the indications are that the former Pa did not extend into the reclaimed area and that the Hutt City Terminal is likely to be all on reclaimed land. This error was acknowledged by HCC at the time however no change was made to the planning maps. Will the Pa site be removed from the Hutt City Terminal in the proposed district plan? I am happy to send through additional info if that would assist.

Kind regards
Phil

Philip Brown
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Associate Consultant - Planning

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Sent: Wednesday, 13 November 2024 1:39 pm
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Philip,

Thanks for sending that through. However, the data is incomplete – there's no projection information (a .prj file). It would be ideal if you could send it in NZTM, the projection used for National Planning Standards-compliant district plan maps, but even if not we need to know what projection it's in.

I'll let Hamish comment on the choice of contours further if he wants but my understanding of the approach is that we're happy that the zone rules will do the heavy lifting in controlling activities like hospitals and childcare centres.

Kind regards,
Stephen

Stephen Davis
Senior Policy Planner

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Sent: Wednesday, 13 November 2024 10:48 AM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

Thanks for clarifying Council's proposed approach to the Risk Management Overlay provisions.

We have updated the Shapefiles, saved here GIS Shapefile (link accessible to you and Hamish). The Shapefiles now include:

- The $1.0x10^{-6}$ and the $0.5x10^{-6}$ contours for the terminals, including the NZOSL Hutt City Terminal – as the draft QRA for that terminal has just been completed. We will send you a copy of the final QRA as soon as NZOSL gives the green light to do so (should be within the next few days).
- The 35m and 40m setback for the wharfline.

I have also attached an updated PDF which shows all of the risk contours around the terminals (including the NZOSL Hutt City Terminal) and the wharfline setback contours.

However, we are quite concerned that Council's approach to mapping the Risk Management Overlay (RMO) as set out in your email below is inconsistent with the QRAs and not appropriate from a risk management perspective. Our understanding is that the RMO will include a non-complying activity status and 'avoidance' policy in relation to *activities sensitive to hazardous substance risks*. However, if the RMO is based on the residential risk contours ($1x10^{-6}$) instead of the sensitive risk contours ($0.5x10^{-6}$), then there will be a 'void' space between the two where *activities sensitive to hazardous substance risks* are not controlled and defer to the zone provisions. This anomaly creates a potential for sensitive activities such as hospitals and childcare facilities to encroach in the sensitive land use contours for the terminals. This causes a potential issue for terminal operations, noting that this falls as regionally significant infrastructure (RSI) and the RPS has very clear directives around the need to protect and enable RSI. Has Council given thought to this issue?

Kind regards
Phil

Philip Brown
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Associate Consultant - Planning

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Sent: Thursday, 31 October 2024 1:22 pm
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Philip,

Our proposed plan will have a number of different definitions of sensitive activities. The two relevant ones are:

Activity	Activities sensitive to hazardous substance risks	Activities sensitive to industry
residential activity	✓	✓*
retirement village	✓	✓
supported residential care facility	✓	✓
marae	✓	✓
hospital	✓	✓
healthcare activity	✓	✓
educational facility	✓	
community facility	✓	✓
office activity (other than ancillary)	✓	
community corrections activity	✓	
custodial corrections facility	✓	✓
visitor accommodation activity	✓	✓
place of assembly	✓	✓
* included in definition but has a separate rule as well		

(there's also activities sensitive to light, noise, privacy intrusion, and natural hazard risks).

The Hazardous Substances chapter will use a single Risk Management Overlay based on a contour of $1.0x10^{-6}$, and this will control "activities sensitive to hazardous substance risks" in relation to identified *existing* hazardous facilities. The relevant zone chapters (Heavy Industrial Zone, General Industrial Zone, Seaview Marina Zone) will have rules relating to "activities sensitive to industry" which is designed to provide protection from both existing *and potential* hazardous facilities and other industrial activities in general. Finally, in the Heavy Industrial Zone, most non-industrial activities simply default to discretionary.

We do want the $0.5x10^{-6}$ as well to provide context to the s32 report.

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Kind regards,
Stephen Davis

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Senior Policy Planner

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Sent: Thursday, 31 October 2024 10:13 AM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) [redacted] @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

We can get the contour files updated with that information. But I am first keen to understand Council's thinking with having these two contours (i.e. sensitive activity contours and also residential activity contours). In our feedback, we proposed mapping the Risk Management Overlay based on the sensitive activity contours ($0.5x10^{-6}$), with a policy direction that sought to avoid *activities sensitive to hazardous facilities and infrastructure* (definition proposed). We considered that adopting a conservative approach with respect to the risk contours is appropriate given the cumulative effects associated with all of the terminals and wharfline being in close proximity to each other. I was of the understanding that this approach with regards to the Risk Management Overlay mapping and provisions was accepted by HCC, from our previous correspondence. Is that the case or is HCC considering a slightly tweaked approach (i.e. different controls based on different contours)?

Kind regards
Phil

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Wednesday, 30 October 2024 10:23 am
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Philip,

Yes, both contours for both the wharfline and the terminals.

Cheers,
Steve

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
P: 04 570 6761 **M:** **W:** www.huttcity.govt.nz

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Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

Thanks for acknowledging receipt.

To clarify, would you like us to provide the $1x10^{-6}$ contour for the wharfline (so 35m setback either side of the pipeline), as well as the $0.5x10^{-6}$ contour (40m setback)?

Noted regarding due date of 22 November for QRA.

Kind regards
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

- PLEASE NOTE THAT FROM 29TH OCTOBER TO 15TH DECEMBER 2024 I AM WORKING REMOTELY FROM BUENOS AIRES, ARGENTINA AND MY HOURS ARE 5AM TO 11AM

O s7(2)(a)
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E philip.brown@slrconsulting.com

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Friday, 25 October 2024 11:19 am
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

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Hi Philip,

Thanks for the update. We'll have a look through and get back to you.

In the meantime:

1. Those shapefiles are an improvement on your last data and I can import them, but can you please send the $1x10^{-6}$ contour as well as the $0.5x10^{-6}$.
2. The last date we can guarantee being able to get the last QRA in the maps is if we receive it from you, with no technical issues with accessing it or the format etc, COB on Friday 22 November.

Kind regards,
Stephen Davis

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
P: 04 570 6761 **M:** **W:** www.huttcity.govt.nz

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, 25 October 2024 10:30 AM
To: Hamish Wesney <hamish.wesney@boffamiskell.co.nz>; Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) [redacted] @slrconsulting.com>
Subject: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Hamish & Stephen,

Thanks Hamish for the phone discussion a couple of weeks ago.

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As you'll recall, at the last meeting we had (23 August), there were some outstanding matters in relation to the draft district plan that we were going to look into and come back to Council on. We have now prepared a letter which addresses those outstanding matters. Apologies for the delay in getting this to you; it's been a busy past few weeks so we didn't get to this as quickly as we would have like to.

Recognising that Council is not willing at this stage to support the wharfline risk classification system / zone provisions approach at this stage, we have proposed an alternative method. This alternative method involves mapping a ' fuel transmission pipeline corridor', similar to the gas transmission pipeline corridor already in the draft plan and based on the sensitive activity risk setback (0.5×10^{-6}) for the wharfline which is identified as being 40m either side of the wharfline in the bp Risk Assessment Report. This approach, which would set up a policy framework avoiding sensitive activities in this corridor, is underpinned by risk management work undertaken and ensures that a framework is set up which reflects the clear RPS directives in relation to the need to protect / enable RSI. I am also providing Council with a drawing showing the location of this ' fuel transmission pipeline corridor', as well as the Shapefile for this.

Regarding the Hutt City Terminal QRA, we have been advised that the draft QRA is close to completion (potentially next week) so expect to be able to send this to HCC in the next few weeks, meeting the end of November deadline.

Finally, recognising that we have sent in various iterations of feedback (which I can appreciate could become hard to keep track of) I have quickly put together a word document summarising the Fuel Companies' feedback on the draft Huitt City District Plan to date. I hope that this assist Council.

Please see in this link the following FuelCo feeback - Hutt City District Plan (*I have enabled both of you access but please let me know if you can't access for some reason*):

- Letter from the Fuel Companies addressing outstanding / additional matters.
- Drawing showing the location of the ' fuel transmission pipeline corridor'.
- Bp Risk Assessment Report which speaks to the wharfline sensitive activity risk setback. I believe this was sent to Council a couple of years ago but I'm sending again in case you don't have it on file.
- Summary of FuelCo feedback to date.
- Shapefiles for the terminal risk contours and also the fuel transmission pipeline corridor. If there are still issues with importing these files to Council's GIS mapping system, it could be worth Council's GIS person making direct contact with SLR's landscape specialist s7(2)(a) (cc'd). s7(2)(a) details are as follows:

s7(2)(a)
Landscape Architect - Landscape

O s7(2)(a)
M s7(2)(a)
E s7(2)(a)@slrconsulting.com

Thanks again for these ongoing discussions and for providing the Fuel Companies with the opportunity to feedback on the plan at draft stage – we greatly appreciate it. Please don't hesitate to contact me if you have any questions or would like to discuss further.

Otherwise, I'll be in touch again soon with the QRA.

Kind regard
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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REPORT

HUTT CITY TERMINAL

QUANTITATIVE RISK ASSESSMENT

NEW ZEALAND OIL SERVICES LTD (NZOSL)

PREPARED FOR: s7(2)(a)
Risk & Compliance Manager, NZOSL

DOCUMENT NO: 21939-RP-001
REVISION: 0
DATE: 22-Nov-2024

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Title: **Report** **Hutt City Terminal** **Quantitative Risk Assessment**	**QA verified:** s7(2)(a) **Date:** □□□□ov□□□□□

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ABBREVIATIONS

□GO	□utomotive Gas Oil
□L□RP	□s Lo□ □s Reasonably Practicable
□OPS	□utomated Overfill Protection Systems
□S	□ustralian Standard
CFD	Computational Fluid Dynamics
DP□I	(NSW) Department of Planning, □ousing and Infrastructure □formerly Department of Planning and □nvironment □DP□))
□FR	□□ternal Floating Roof
□SD	□mergency S□utdo□n
F-□	Fre□uency- □umber
HAZ ID	□a□ard Identification
□IP□P	□a□ardous Industry Planning □dvisory Paper
□S□O	□a□ardous Substances and New Organisms
IFR	Internal Floating Roof
LFL	Lo□er Flammability Limit
M□PP	Ma□or □ccident Prevention Policy
M□F	Ma□or □a□ard Facility
NSW	New Sout□ □ ales
NZ	New □ealand
□□OSL	New □ealand Oil Services Limited
pa	per annum
P&ID	Piping and Instrumentation Diagram
PG□	Pea□ Ground □cceleration
PMS	Premium Motor Spirit
QRA	□uantitative Ris□ □ssessment
RMS	Regular Motor Spirit
SF□RP	So Far □s Reasonably Practicable
VC□	Vapour Cloud □□plosion

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TERMINOLOGY

Term	Definition
Combustible li□uid	□ny li□uid □ot□er t□an a flammable li□uid □t□at □as a flas□ point□ and □as a fire point t□at is less t□an its boiling point □□S □□□□–□□□□□□□GO is an e□ample of a combustible li□uid considered in t□is study□
Conse□uence	Outcome or impact of a □a□ardous incident□ including t□e potential for escalation□
Flammable li□uid	Li□uids □□□□□□ic□ give off a flammable vapour at temperatures of not more t□an □□□C □closed cup test□normally referred to as t□e flas□ point □□S □□□□□–□□□□□□□PMS and RMS are e□amples of flammable li□uids considered in t□is study□
Flas□ fire	T□e combustion of a flammable vapour and air mi□ture in □□ic□ flame passes t□roug□ t□at mi□ture at lo□ velocity□suc□ t□at negligible damaging overpressure is generated□
□eat radiation	T□e propagation of energy in t□e infra□ed region of t□e radiation electromagnetic spectrum, commonly ‘heat'.
□et□spray fire	T□e combustion of material emerging □it□ significant momentum from an orifice□
Lo□er Flammability Limit □LFL□	T□at concentration in air of a flammable material belo□ □□ic□ combustion □ill not propagate□
Offsite	□reas outside t□e bul□ storage sites boundaries□T□is includes bot□ public and private □oldings□ road□ays□ recreational facilities□
Onsite	□ it□in any bul□ storage facility site boundary□
Pool fire	T□e combustion of material evaporating from a layer of li□uid at t□e base of t□e fire□
Ris□	T□e li□eli□ood of a specified undesired event occurring □it□in a specified period or in specified circumstances□It may be eit□er a fre□uency □t□e number of specified events occurring in unit time□ or a probability □t□e probability of a specified event follo□ing a prior event□□depending on t□e circumstances□In t□is case□t□e ris□ under analysis is t□e li□eli□ood of fatality per year due to loss of containment of □a□ardous materials resulting in fire e□posure□
Vapour Cloud □□plosion □VC□□	T□e combustion of a flammable vapour and air mi□ture in an environment □□ere factors e□ist □for e□ample e□uipment causing congestion or confinement of t□e cloud□t□at result in a □ig□ flame speed□conse□uently causing damaging pressure due to t□e inertia of t□e unburnt mi□ture in front of t□e flame□

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1. SUMMARY

1.1. Background

□e□ □ealand Oil Services Limited □□□OSL□ operates a □ydrocarbon fuel storage terminal located at Lo□er □utt□□e□ □ealand□T□e □utt City Terminal □□□ic□is referred to as 'the Terminal' throughout this report) is located at □□□□□Port Road□Seavie□□Lo□er □utt□T□e Terminal is a lo□er tier Ma□or □a□ard Facility □M□F□under t□e □e□ □ealand □□□□□ealt□ and Safety at □ or□□Ma□or □a□ard Facilities□Regulations □□□□□

T□e □utt District Plan is being updated and □□OSL □is□ to provide input to t□e Council to ensure t□at t□ere is no ris□ of encroac□ment on t□e Terminal by non□industrial land uses□In ot□er Council areas in □□ fuel companies □ave prepared a □uantitative ris□ assessment □□R□□to determine a ris□ overlay area for t□is purpose□

1.2. Methodology

T□e ris□ associated □it□ □ydrocarbon loss of containment scenarios □as assessed □uantitatively□Scenarios included □ere□

- Spills into storage tan□ bunds□or piping and manifold areas resulting in pool fires or flas□ fires□
- Tan□ top fires□
- Spray fires □pumped li□uid systems only□□
- Formation of large flammable clouds and potential Vapour Cloud □□plosions □VC□□ resulting from overfills of gasoline from storage tan□s □referred to □it□in industry as t□e "the Buncefield scenario").

T□e ris□of an eart□□ua□e resulting in an elevated fre□uency and conse□uence of severe tan□ and associated bund damage □as also assessed□

Commercially available □R□ soft□are□Ge□con RIS□C□RV□S v □□□□□ □as used to generate individual ris□ contours and calculate societal ris□□

T□ere are no specific □□ ris□ criteria□□o□ever□ot□er □R□s in □□ □ave used t□e ris□ acceptability criteria publis□ed in t□e □ustralian □e□ Sout□ □ales Department of Planning□ □ousing and Infrastructure □□S□ DP□I□ □a□ardous Industry Planning □dvisory Paper □□IP□P□□o □ *Risk Criteria for Land Use Safety Planning*□□□IP□P □□ Ref □□□□□T□erefore□t□e □IP□P □ criteria □ere adopted for t□is □R□□

1.3. Results

T□e individual fatality ris□ contours for t□e Terminal are s□o□n in Figure □□□□T□e societal ris□ for t□e Terminal is presented in t□e form of an F□□ curve in Figure □□□□

T□e study s□o□ed t□at all relevant □IP□P □ ris□ criteria are met as summarised in Table □□□□

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□ sensitivity study covering t□e estimated effect of eart□□ua□es on t□e overall ris□ s□o□ed only a slig□t c□ange to t□e individual fatality ris□ results□

T□e dominant ris□ contributors outside t□e Terminal boundary □as per Table □□□□ are ma□or mec□anical failures of tan□s □it□ fre□uencies based on statistical data and mec□anical failures of tan□s due to eart□□ua□es□Ris□ contributions from operational scenarios suc□ as tan□ overfill are very lo□ as t□ese scenarios account for □ard□are control measures suc□ as t□e □utomatic Overfill Protection System □□OPS□provided for eac□ tan□□

1.4. Recommendation

T□e results suggest t□at t□e offsite ris□is already lo□ and t□at t□ere is not a strong driver for additional ris□ reduction on t□e basis of offsite ris□ levels□□o recommendation □as been made as a result of t□e study□

1.5. Conclusions

T□e □R□ s□o□s t□at□

- T□e ma□imum conse□uence is due to t□e flammable vapour cloud resulting from a gasoline tan□ overfill scenario□T□is □ust reac□es t□e Marae appro□imately □□□ m sout□ east from t□e site boundary but does not reac□ any ot□er non□industrial land uses□
- T□e □□□ □ □□⁻⁶ per year sensitive land use contour e□tends appro□imately □□ m from t□e site boundary to t□e east and □□ m to t□e sout□□T□e □ □ □□⁻⁶ per year residential land use contour e□tends appro□imately □□ m from t□e site boundary to t□e east and □□ m to t□e sout□□T□ere are currently no residential or sensitive land uses affected by t□e ris□ contours□
- The societal risk is currently in the ‘acceptable’ region.

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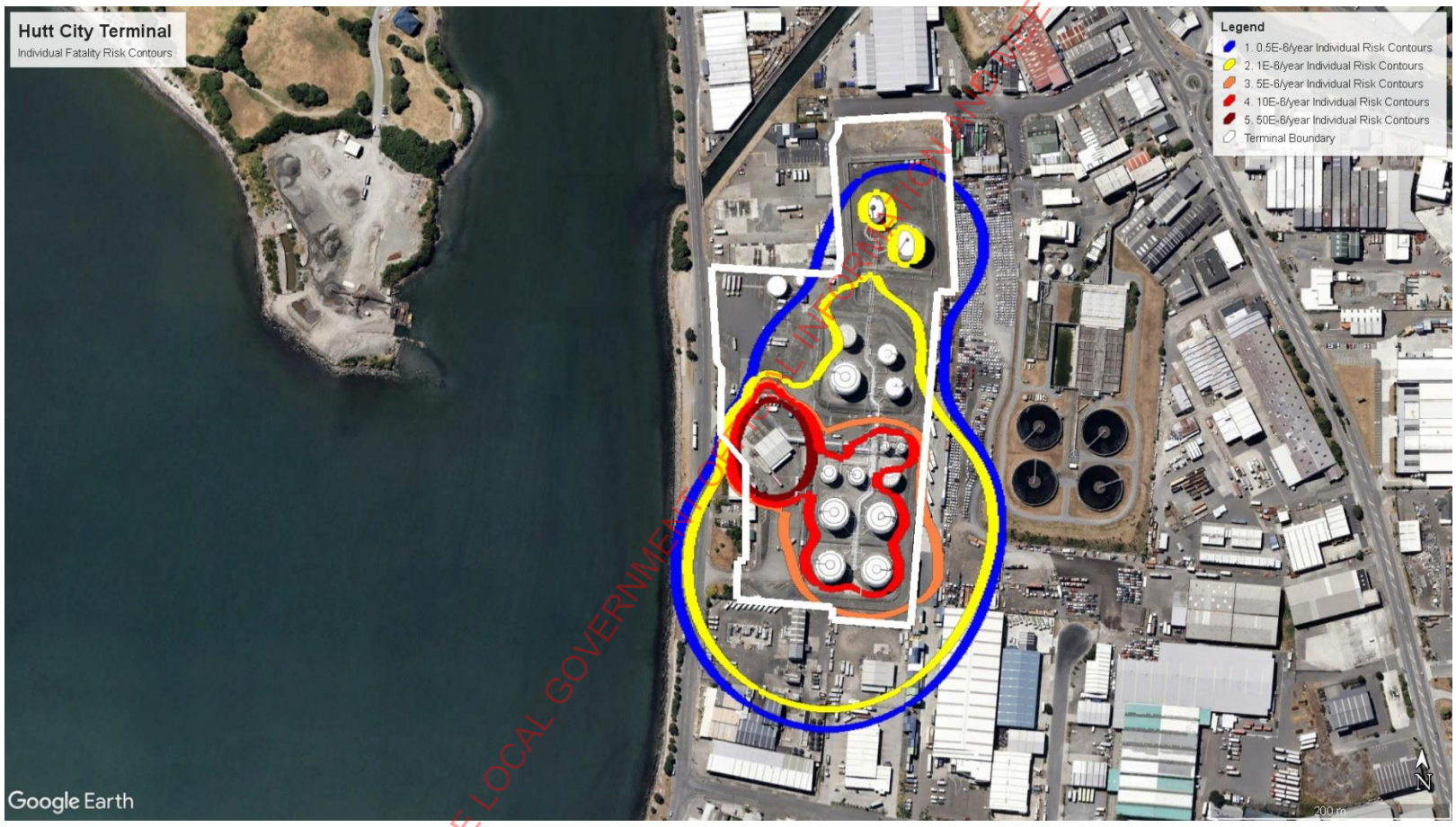
Figure 1.1: Individual fatality risk contour



□ote□T□e □□ □□□□ per year individual fatality ris□ contour □boundary limit□target for site boundary□e□tends past t□e site fence but does not e□tend outside t□e overall □□OSL site boundary of t□e Terminal□T□e ris□ contour e□tends only to t□e Office and □dmin building□□□ic□ is not an offsite land use as it is occupied by □□OSL personnel□

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Figure 1.2: Societal risk F-N curve

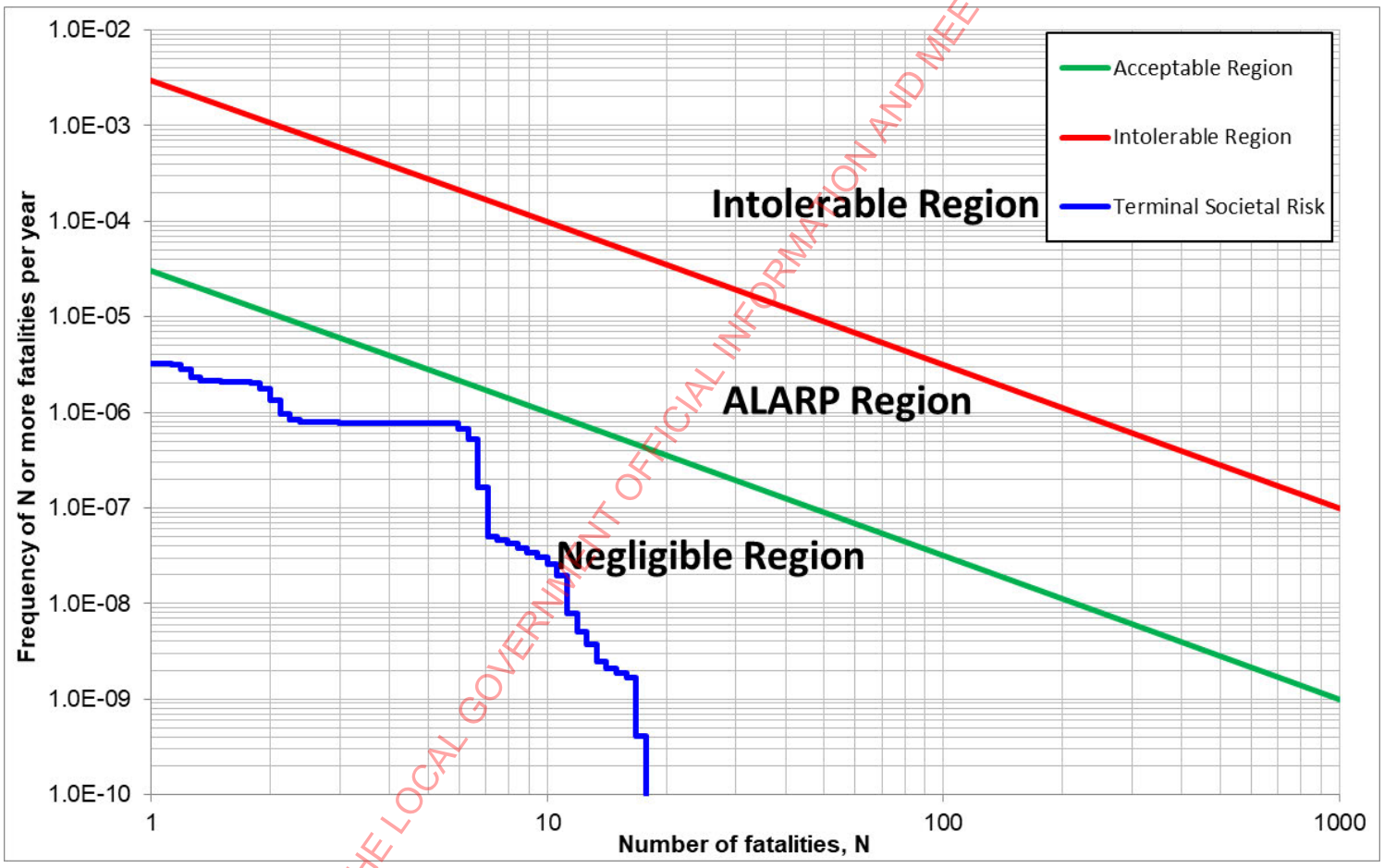

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Table 1.1: QRA results against HIPAP 4 risk criteria

Item assessed	Description and land use	Criteria (per year)	Complies with criteria?	Comments
Individual fatality ris□	□ospitals□c□ild□care facilities and old age □ousing □sensitive land uses□	□□□ □ □□⁻⁶	Yes	□□tends up to □□ m from t□e Terminal boundary but does not reac□ e□isting sensitive land uses□
	Residential developments and places of continuous occupancy suc□ as □otels and tourist resorts □residential land use□	□ □ □□⁻⁵	Yes	□□tends up to □□ m from t□e Terminal boundary but does not reac□ e□isting residential land uses□
	Commercial developments□including offices□retail centres and entertainment centres □commercial land use□	□ □ □□⁻⁵	Yes	□□tends up to □□ m from t□e Terminal boundary but does not reac□ e□isting commercial land uses□
	Sporting comple□es and active open space areas □recreational land use□	□□ □ □□⁻⁶	Yes	□□tends up to □□ m from t□e Terminal boundary but does not reac□ e□isting recreational land uses□
	Target for site boundary □boundary limit□	□□ □ □□⁻⁵	Yes	□□tends up to □□ m from t□e Terminal □estern boundary□ T□e ris□ contour e□tends only to t□e Office and □dmin building □□ic□ is outside t□e fence line but is located □it□in t□e overall □□OSL site boundary of t□e Terminal□T□e building is not an offsite land use as it is occupied by □□OSL personnel□ T□e contour does not e□tend to any ot□er properties□
Societal ris□	Ris□ belo□ t□e negligible line on t□e F□□ curve	□ot □it□in intolerable region of Figure □□□	Yes	Societal ris□ in t□is region is regarded as acceptable□

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Item assessed	Description and land use	Criteria (per year)	Complies with criteria?	Comments
In□ury ris□	□eat radiation e□ceeding □□□ □□ □m□ □residential and sensitive uses□	□□ □ □□⁻□	Yes	□□tends up to □□ m from t□e Terminal boundary but does not reac□ e□isting residential and sensitive land uses□
	□□plosion overpressures e□ceeding □□Pa □residential and sensitive uses□	□□ □ □□⁻□	Yes	T□is ris□ contour is not generated□T□e only events □it□ potential overpressures of □ □Pa e□tending a significant distance are VC□s resulting from gasoline tan□ overfills□ T□e cumulative fre□uency is □ell belo□ □□ □ □□⁻□ per year□
Ris□ of property damage and accident propagation	□eat radiation e□ceeding □□ □□ □m□ □neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□⁻□	Yes	T□e ris□ contour remains □it□in all boundaries of t□e Terminal□
	□□plosion overpressures e□ceeding □□ □Pa □neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□⁻□	Yes	T□is ris□ contour is not generated□T□e only events □it□ potential overpressures of □□ □Pa e□tending a significant distance are VC□s resulting from gasoline tan□ overfills□ T□e cumulative fre□uency is □ell belo□ □□ □ □□⁻□ per year□

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2. INTRODUCTION

2.1. Background

□□OSL operates a □ydrocarbon fuel storage terminal□□no□n as t□e □utt City Terminal (referred to as 'the Terminal' throughout this report)□located at □□□□□ Port Road□ Seavie□□Lo□er □utt□□□□T□e Terminal is a lo□er tier M□F under t□e □□ □ealt□ and Safety at □ or□ □Ma□or □a□ard Facilities□Regulations □□□□□

T□e □utt District Plan is being updated and □□OSL □is□to provide input to t□e Council to ensure t□at t□ere is no ris□ of encroac□ment on t□e Terminal by non□industrial land uses□In ot□er Council areas fuel companies □ave prepared a □R□ to determine a ris□ overlay area for t□is purpose□

□□OSL □as re□uested S□erpa to underta□e t□e □R□ for t□e Terminal□T□is document contains t□e □□□□ □R□ results for t□e Terminal□

2.2. Objectives

T□e overall ob□ective of t□e □R□ study is to dete□mine t□e offsite fatality ris□ levels and societal ris□ from t□e Terminal for t□e current operational case and assess t□e ris□ against defined criteria□

T□e □R□ results □ill be used by □□OSL and t□eir consultant planners □SLR Consulting□ to provide input to t□e □utt District Plan and consult □it□ t□e Council to develop a ris□ overlay to ensure t□at t□ere is no ris□ of encroac□ment on t□e Terminal by non□industrial land uses□

2.3. Scope

Terminal e□uipment and piping and import pipelines □it□in t□e terminal boundary are included in t□e □R□□T□e operations included in t□e □R□ are summarised in Table □□□□

Table 2.1: Terminal Operations included in QRA

Activity	Scope
Import of □ydrocarbon li□uid fuels via pipeline	Receive fuels from import pipeline□aboveground section of t□e import pipeline from t□e Terminal boundary to t□e storage tan□s
Storage of fuels	Storage of fuels in atmosp□eric storage tan□s
□□port of fuels	□□port of fuels via road tan□er gantries
Ot□er	□dditive tan□s and IBC storage

2.4. Exclusions and limitations

T□e e□clusions and limitations for t□is □R□ are described in Table □□□

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Table 2.2: QRA exclusions and limitations

No	Exclusion/ limitation	Comments
□	Future case operations	□ T□e □R□ does not account for future gro□t□ in terminal t□roug□puts□
□	Transportation ris□s	□ T□e boundary of t□e ris□assessment is t□e terminal gate□ Transport ris□on public roads is not covered□ □ For pipeline ris□s□t□e boundary of t□e ris□assessment is t□e local s□utoff valve at battery limits of t□e terminal□T□e limit of t□e □R□ is t□e Terminal boundary□and t□e part of t□e import pipeline located outside t□e Terminal is e□cluded from t□e □R□□ □ Ris□at t□e □□arf itself and pipeline bet□een t□e □□arf and t□e Terminal boundary is e□cluded□
□	Onsite□employee ris□	□ Onsite□employee ris□is not □uantified in t□e □R□□
□	□nvironmental ris□	□ □nvironmental ris□is not covered in t□e □R□□
□	□atural □a□ards ris□s – sensitivity study	□ T□e □R□ includes a sensitivity study around t□e potential effect on individual fatality ris□results of an eart□□ua□e event causing a significant loss of containment at t□e Terminal□T□is is based on e□isting li□eli□ood of eart□□ua□e information in publicly available sources for t□e site location and industry damage correlations for atmosp□eric tan□s related to pea□ground acceleration□ T□is approac□does not include assessment of li□ely eart□□ua□e intensity at t□e specific site or any detailed structural assessment of tan□response to eart□□ua□es□
□	Land uses	□ T□e □R□ □as used information supplied by □□OSL and t□e □utt City Council City district plan for determining land uses surrounding t□e Terminal□
□	Ris□reduction measures	□ Sensitivity studies around t□e effect of ris□reduction measures are not included in t□e □R□□
□	Societal ris□	□ Societal ris□calculations are included in t□e □R□ using typical population densities for t□e surrounding land uses□ Population surveys □ave not been done□
□	M□F tas□s □Safety Case□ M□PP□ demonstration of SF□RP□	□ T□e terminal is a lo□er tier Ma□or □a□ard Facility □M□F□ under t□e □□ □ealt□and Safety at □ or□□ct Ma□or □a□ards Facilities Regulations □□□□□ □ T□e □R□ does not cover update of M□F documentation or a demonstration t□at t□e controls implemented at t□e site are ade□uate□and t□e ris□ □as been reduced So Far □s Reasonably Practicable □SF□RP□□□ □OSL may use t□e □R□ as an input to t□is process□

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3. TERMINAL DESCRIPTION

3.1. Location

T□e Terminal is located at □□□□□ Port Road□Seavie□ □Lo□er □utt□□ □□□□ layout of t□e Terminal is s□o□n in Figure □□□□T□e Terminal is supplied via t□e import pipeline from t□e Seavie□ □ □arf□

3.2. Surrounding land uses

T□e land uses surrounding t□e Terminal are summarised in Table □□□□T□e Terminal is primarily surrounded by t□e industrial areas□

T□e nearest sensitive area is t□e Marae located appro□imately □□□□ m sout□□east from t□e nearest Terminal site boundary□

□ map s□o□ing t□e surrounding land uses to t□e Terminal is s□o□n in □PP□□DI□ F□

Table 3.1: Surrounding land uses of the Terminal

Direction	Surrounding land use
□ort□	Industrial sites □e□g□TR Driver Training□ O□□iti □rupa Cemetery □□□□ m from nort□□eastern boundary□
□ast	Industrial sites □e□g□Capital □uto Recyclers□□utt Valley □ aste□ater Treatment Plant□ □ □nergy Ltd Seavie□ Terminal □□□□ m from sout□□eastern boundary□ □o□iri Marae □□□□ m from sout□□eastern boundary□
Sout□	Industrial sites □e□g□□ aste Management Tec□nical Services□
□ est	□utt River

3.3. Meteorological data

For t□is study□consistent □it□ ot□er recent □R□ studies conducted for neig□bouring fuel terminals located □it□in t□e same district□□istorical meteorological □eat□er data for t□e Terminal □as obtained from t□e □e□ □ealand □ational MetService□T□e ac□uired data set □as based on readings from t□e □utomatic □ eat□er Station □□□ S□at □ ellington □irport □Station no□□□□□□ appro□imately □□ □m sout□□□est of t□e Terminal over t□e period of □anuary □□□□ – □anuary □□□□□

T□e □ind rose distribution obtained from t□e ac□uired data sets□s□o□n in □PP□□DI□ □□ □as cross□c□ec□ed against more recent meteorological data□and slig□t differences only □ere found □□ic□ are not significant in t□e conte□t of t□e □R□□

Representative □eat□er conditions □ere consolidated to input to t□e ris□ model□T□e analysis of t□e data is included in □PP□□DI□ □□

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3.4. Operations

T□e Terminal □andles bul□ □uantities of gasoline □Premium Motor Spirit □PMS□and Regular Motor Spirit □RMS□□diesel □□utomotive Gas Oil □□GO□□and □et fuel □et□□□□ only□T□ere is no et□anol stored or □andled at t□e Terminal□

T□e Terminal is manned by □□OSL staff from □ am to □ pm□Monday to Friday□as □ell as during s□ip disc□arges□□dditionally□truc□ drivers utilise t□e Terminal □□ □ours□day seven days a □ee□□

3.4.1. Product import

T□e Terminal receives bul□ li□uids only from s□ip tan□ers at t□e Seavie□ □ □arf □appro□imately □ □m sout□ from t□e Terminal□via a s□ared import pipeline□□ll s□ip import operations are overseen by a Duty S□ore Officer□□or□ing □it□ □ □arf □ttendants□ □it□ radio communications to t□e Terminal and any ot□er terminal involved in t□e disc□arge□

T□e pipeline tees off to ot□er terminals □operated by ot□er companies□along Seavie□ Road before reac□ing t□e □□OSL □utt City terminal manifold located on t□e eastern site boundary from Barnes Street□

T□e pipeline is □□□ mm in diameter□□it□ t□e import pressure restricted to □ barg□T□e pipeline is generally aboveground □it□in t□e Terminal□T□e manifold distributes t□e bul□ li□uids product to t□e bul□storage tan□s□

3.4.2. Bulk tank storage

□ summary of t□e Terminal storage tan□s and t□e materials stored is provided in Table □□□□

T□ere are □□ in service bul□ storage tan□s for Regular Motorspirit □RMS□□Premium Motorspirit □PMS□□□utomotive Gas Oil □□GO□and □et□□□ □□et□□located inside t□ree tan□s bund compounds at t□e Terminal□

- Compound □ for all Gasoline □RMS□PMS□tan□s □ P□□□ P□□□ P□□□ P□□and □et tan□s □ P□ and □ P□
- Compound □for t□ree □GO tan□s □ P□□□ P□ and □ P□□
- Compound □for t□o □GO tan□s □ P□□ and □ P□□□

□ote t□at □ P□ and □ P□□ bul□storage tan□s are out of service□

□ll t□e bul□ storage tan□s are fitted □it□ radar level gauges □□ic□ provides level measurement□independent □ig□ □ig□ level alarms and venting systems appropriate to t□e type of tan□on site□T□e □et and □GO tan□s □ave internal floating suction □to sip□on clean product from under t□e product surface□□□□ile t□e PMS and RMS tan□s □ave internal floating roof □FR□inside t□em to minimise vapours□

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□n independent □ig□ level probe □tuning for□located in a □ell□is also provided for eac□ tan□□ T□e storage tan□s are safeguarded against overfill by □utomated Overfill Protection Systems □□OPS□□□ □en t□e □i□i level is triggered by t□e tuning for□ and t□e s□utdo□n system □as not already been activated by t□e operators□t□e □OPS valve on t□e s□ared pipeline □immediately upstream of inlet manifold□□ill s□ut off t□e incoming product□T□is also raises a continuous audible and visual alarm at t□e Terminal and sends a te□t message alert bot□ t□e terminal manager and t□e assistant terminal manager□

3.4.3. Tank to tank transfers

Bul□tan□to bul□tan□transfers are not underta□en □it□in t□e terminal□

3.4.4. Additives

T□ere are four □□□□□□L fuel additive tan□s □□ P□□□□ P□□□ P□□ and □ P□□□located in a concrete bund□nort□of t□e road loading gantry used for storing motorspirit fuel additive and diesel fuel additive□

T□ese additives are stored at atmosp□eric conditions in □ori□ontal storage tan□s □it□ pressure vacuum vents in a dedicated bunded area□□dditives are supplied in drums or IBCs and transferred to storage using a diap□ragm pump□t□e transfer is fully attended by an operator□□dditives tan□s □ave level gauging but no □ig□ level alarm□

In addition□t□o □□□□□L □et additive tan□s □Tan□s T□□□□ and T□□□□located ne□t to t□e Road Tan□er Loading □RTL□gantry□are used for storing aviation fuel additive□T□e additives are pumped to t□e gantry via dedicated pumps□and in□ected into t□e re□uired product stream pipe□or□ via □ccuplus in□ectors according to t□e product and additive combination being loaded□

3.4.5. Slops

Slops from t□e left over product in t□e road tan□ers are periodically pumped from t□e road tan□er gantry to t□e Slops tan□s □ P□□ and □ P□□□T□e site also may receive slops product returns from retail petrol stations via t□e gantry□

T□e slops tan□s are located in a dedicated bunded compound ne□t to bul□storage tan□s bunded Compound □□Slops is typically blended bac□into an RMS tan□ □o□ever if t□e □uality is too poor□may be pumped out to a road tan□er for disposal offsite□

3.4.6. Product export

□ll product is e□ported from t□e Terminal via road tan□er□T□e RTL gantry comprises t□ree loading bays and e□ports all products □PMS□RMS□□et and □GO□□□mpty tan□ers are par□ed in a designated truc□par□ing area □□en not in use□□utt City Terminal □as provision for □loaded □et units to be par□ed on t□e de□gas pad and in loading bay □□

In t□e loading gantry□t□ere are □mergency S□utdo□n □□SD□buttons □□ic□ may be activated by drivers filling t□eir o□n loads□T□e RTL □SD disables po□er to t□e RTL

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stopping t□e loading pumps□ □n independent scully system is provided □□ic□ also disables po□er to t□e RTL and stops t□e product loading pumps on □ig□ tan□er compartment level or loss of eart□ing□□ lone □or□er □dead man□system is also installed □□ic□ □ill stop transfer if not activated by t□e driver at t□e re□uired fre□uency□

3.5. Fire protection

□ll bul□ storage tan□s in Compound □ and Compound □□and t□e slops tan□s at t□e Terminal are fitted □it□ fi□ed fire protections suc□ as spray cooling and foam□

□ote t□at all t□e bul□storage tan□s in Compound □are not fitted □it□fi□ed fire protection□ e□g□foam pourers and □ater cooling are not provided for combustible storage area□

T□e fire system contains□but is not limited to□fire □ater tan□s □□ P□□ and □ P□□□and fire □ater ring main□fire □ydrants□tan□ cooling rings□fire □ater pumps □t□ree off□□on□ tan□foam pourers□foam concentrate proportioners and deluge valves□

Fire □ater is supplied to t□e Terminal from fire □ater tan□s □ P□□ and □ P□□□T□e □utt City to□n main is also used to fill t□e fire □ater tan□s□□□ic□ provide appro□imately □□□□□□□□□ litres of fire □ater combined□

T□ere are t□ree fire□ater pumps for t□e site□t□o duty and one standby□eac□ rated at □□□□□□ LPM□Fire □ater pumps are used to provide fire □ater to t□e ring main for tan□ cooling □ater and for t□e foam system□T□o pumps □ill automatically start on pressing t□e fire pump start button at t□e fire response point□

T□e foam proportioner feeds t□e concentrate to t□e proportioner to give t□e correct proportion of foam concentrate to □ater□□ □ic□ is □□ foam concentrate to □□□ □ater□

T□e foam tan□ □olds enough foam concentrate for the largest ‘tank on fire’ scenario. In t□e event t□at t□e fire ta□es longer to e□tinguis□ t□an anticipated□foam can be dra□n directly to t□e foam pump from intermediate bul□containers □IBCs□□

T□ere is a brigade outlet at t□e end of t□e foam manifold at t□e fire response point□T□is outlet can be used to ta□e premi□ed foam and use it □it□ □and□eld □oses□T□is could be particularly useful to fig□t a fire in t□e tan□ truc□ loading gantry if t□e automatic system failed to e□tinguis□t□e fire□

T□ere is a t□in brigade inlet on t□e □ater main on t□e sout□ side of t□e foam pump container□T□is brigade inlet s□ould only be used if t□ere is a total failure of t□e t□ree fire □ater pumps□□ □ic□ is most unli□ely□

T□e RTL gantry is fitted □it□ a stand□alone foam deluge system□□ □ic□ is automatically activated upon detection of t□e infrared flame detectors□

F□□ □ is called automatically via t□e fire alarm panel on activation of eit□er a manual fire alarm call point□a □eat or smo□e detector □it□in t□e office building□or activation of t□e infrared flame detectors in t□e truc□ loading gantry□ T□e entry and e□it gates automatically open on fire alarm to enable F□□□ access to t□e site□

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3.6. Potential changes

□n upgrade and rerouting of t□e □□arf import pipeline is planned□□o□ever□t□is is not accounted for as t□e □R□ does not include t□e portion of t□e import line t□at is outside t□e site boundary□T□is pro□ect □ill not c□ange t□e piping □it□in t□e terminal boundary□

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Figure 3.1: Terminal overall layout

Table 3.2: Fuel storage tanks

Tank number	Typical product	Diameter (m)	Height (m)	Normal fill capacity (m³)	Max. fill rate (m³/hr)	Type	Tank overfill safeguards
□ P□	RMS	□□□□	□□□□	□□□□□	□□□□	IFR	Gauge□l□□L□ □ □OPS
□ P□	PMS	□□□□	□□□□	□□□□□	□□□□	IFR	Gauge□l□□L□ □ □OPS
□ P□	RMS	□□□□	□□□□	□□□□□	□□□□□	IFR	Gauge□l□□L□ □ □OPS
□ P□	RMS	□□□□	□□□□	□□□□□	□□□□□	IFR	Gauge□l□□L□ □ □OPS
□ P□	□et	□□□□	□□□□	□□□□□	□□□	Fi□ed roof	Gauge□l□□L□ □ □OPS
□ P□	□et	□□□□	□□□□	□□□□□	□□□	Fi□ed roof	Gauge□l□□L□ □ □OPS
□ P□	□GO	□□□□	□□□□	□□□□□	□□□	Fi□ed roof	Gauge□l□□L□ □ □OPS
□ P□	□GO	□□□□	□□□□	□□□□□	□□□	Fi□ed roof	Gauge□l□□L□ □ □OPS
□ P□□	□GO	□□□□	□□□□	□□□□□	□□□	IFR	Gauge□l□□L□ □ □OPS
□ P□□	□GO	□□□□	□□□□	□□□□□	□□□	Fi□ed roof	Gauge□l□□L□ □ □OPS
□ P□□	□GO	□□□□	□□□□	□□□□□	□□□	Fi□ed roof	Gauge□l□□L□ □ □OPS
□ P□□	Slops	□□□	□□□	□□□□	□□	Fi□ed roof	Gauge□l□□L□ □ □OPS
□ P□□	Slops	□□□	□□□	□□□□	□□	Fi□ed roof	Gauge□l□□L□ □ □OPS

□ote□□ P□ and □ P□□ □ave been decommissioned and are permanently out of service□

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4. QRA BASIS

□ number of simplifying assumptions need to be made to prepare a □R□□and t□e results are dependent on t□e assumptions made in defining t□e input scenarios□T□is is particularly true of bul□ fuel terminals due to t□e potential variety of products and t□roug□puts□ It is t□erefore important to understand any limiting assumptions in con□unction □it□t□e □R□ results□

T□e □R□ □as been prepared on t□e follo□ing basis□

- □a□ardous materials are allocated into representative fuel types □see Table □□□□□
- □□isting tan□s and infrastructure for t□e current operations are included □it□ t□e product allocation s□o□n in Table □□□□
- □o provision for potential additional tan□age or increased t□roug□puts is allo□ed for in t□e □R□□
- T□e □□□□t□roug□puts□provided in Table □□□□□ere used as input to t□is study□

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Table 4.1: Summary of QRA basis data

Parameter	The Terminal - current case	Unit	Comments
□nnual t□roug□put □m□yr□	□□□□□□	PMS	Provided by □□OSL
	□□□□□□	RMS	
	□□□□□□□	□GO	
	□□□□□□	□et	
Ship import			
□umber of s□ips per year	□□	Per year	Provided by □□OSL□most s□ips □ave gasoline and diesel compartments□only some s□ips □ave □et compartment □appro□imately □ per year□□
Ma□imum s□ip unload rate	□□□□	m□□r	Provided by □□OSL
Ma□imum pump□ine pressure	□	barg	Provided by □□OSL
Total delivery time □rs□yr□	□□	PMS	Provided by □□OSL
	□□□	RMS	
	□□□	□GO	
	□□□	□et	
Road tanker loadout			
Total number of road tan□er compartments filled	□□□□	PMS	□ll provided by □□OSL□e□cept for t□e total number of road tan□er compartments filled □it□ □et□□ □ic□ □as calculated using t□e annual t□roug□put for □et divided by an average of □□□ m□ per compartment □assumed□□
	□□□□□	RMS	
	□□□□□	□GO	
	□□□□□□	□et	
Road tan□er filling rate	□□□	m□□r	Provided by □□OSL
Ma□imum loadout pressure	□	barg	Provided by □□OSL
Total filling time □rs□yr□	□□□	PMS	Provided by □□OSL
	□□□	RMS	
	□□□□	□GO	

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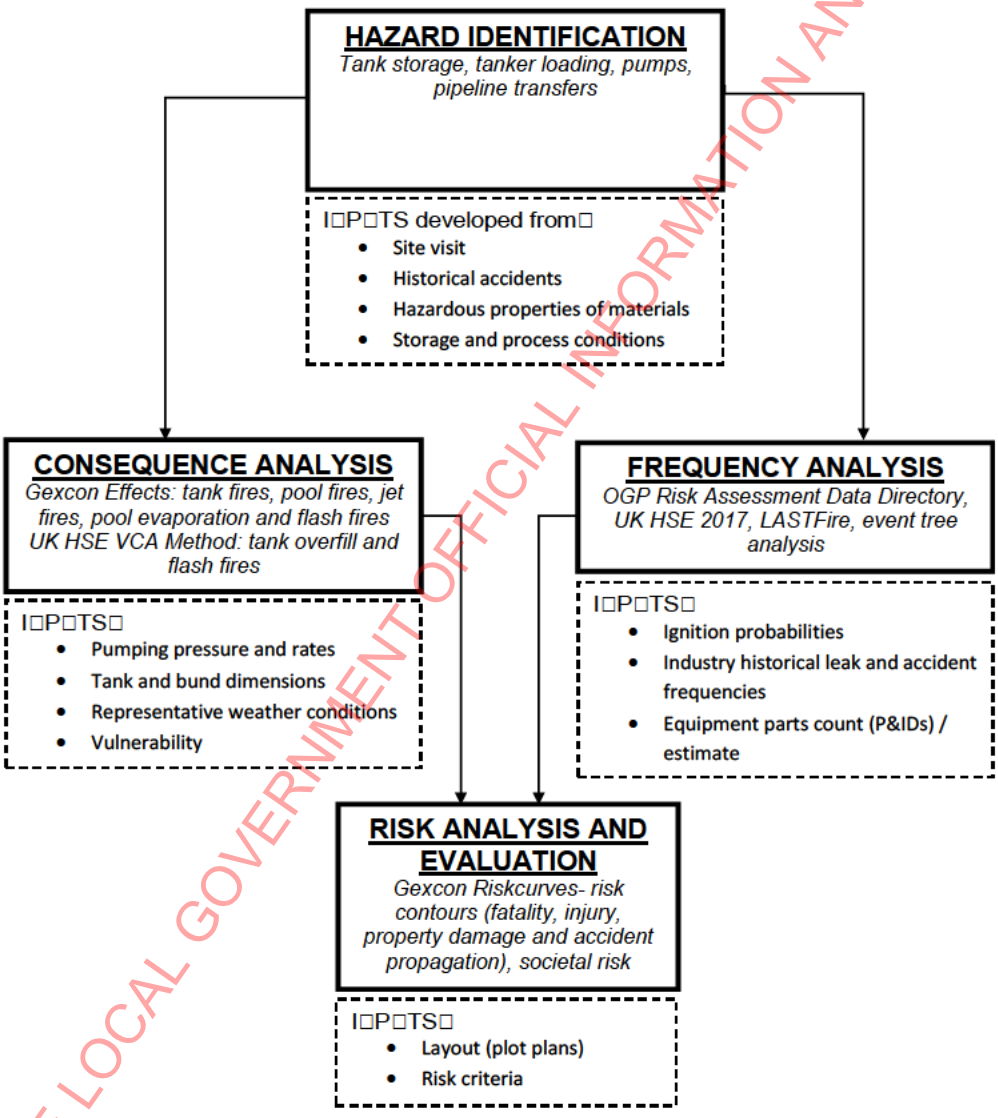
5. RISK ASSESSMENT

5.1. Overview

□n overvie□ of t□e □R□ process□including t□e steps and inputs for t□is study is s□o□n in Figure □□□□T□e subse□uent sections provide furt□er information toget□er □it□ t□e outcomes of eac□main step□

Figure 5.1: Overview of QRA process



5.2. Risk criteria

In t□e absence of □□M□F criteria□t□e □S□ DP□I □IP□P □criteria □ave been adopted□ Individual ris□criteria for fatality□in□ury and property damage are s□o□n in Table □□□□

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Societal ris□ in t□e form of an F□□ curve is considered in t□ree regions □□ic□ provide t□e ris□ criteria□

- 'Intolerable region' represented by an upper criterion line above which the activity □ould be regarded as unacceptable□
- 'Negligible region' represented by a lower criterion line below which the activity would be regarded as posing acceptable ris□ levels□
- Region in bet□een □□ere t□e ris□ may be acceptable depending on t□e benefits of t□e activity□but ris□ reduction measures s□ould be implemented to reduce t□e ris□s where practicable. This is known as the 'ALARP' or 'As Low As Reasonably Practicable' region□

T□e □IP□P □ societal ris□ criteria are s□o□n in Figure □□□□

Table 5.1: Individual risk assessment criteria (HIPAP 4, Ref [1])

Description and land use	Criteria (per year)	Assessed in study?
Individual fatality risk		
□ospitals□c□ild□care facilities and old age □ousing □sensitive land uses□	□□□ □ □□⁻□	Yes
Residential developments and places of continuous occupancy suc□ as □otels and tourist resorts □residential land use□	□ □ □□⁻□	Yes
Commercial developments□including offices□retail centres and entertainment centres □commercial land use□	□ □ □□⁻□	Yes
Sporting comple□es and active open space areas □recreational land use□	□□ □ □□⁻□	Yes
Target for site boundary □boundary limit□	□□ □ □□⁻□	Yes
Injury risk		
□eat radiation e□ceeding □□□ □□ □m⁻ □residential and sensitive uses□	□□ □ □□⁻□	Yes
□□plosion overpressure e□ceeding □ □Pa □residential and sensitive uses□	□□ □ □□⁻□	Yes
To□ic concentrations e□ceeding a level □□ic□ □ould be seriously in□urious to sensitive members of t□e community follo□ing a relatively s□ort period of e□posure □residential and sensitive uses□	□□ □ □□⁻□	□o – not applicable as fuels are not acutely to□ic
To□ic concentrations e□ceeding a level □□ic□ □ould cause irritation to eyes or t□roat or ot□er acute p□ysiological responses in sensitive members of t□e community □residential and sensitive uses□	□□ □ □□⁻□	□o– not applicable as fuels are not acutely to□ic
Risk of property damage and accident propagation		
□eat radiation e□ceeding □□ □□ □m⁻ □neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□⁻□	Yes

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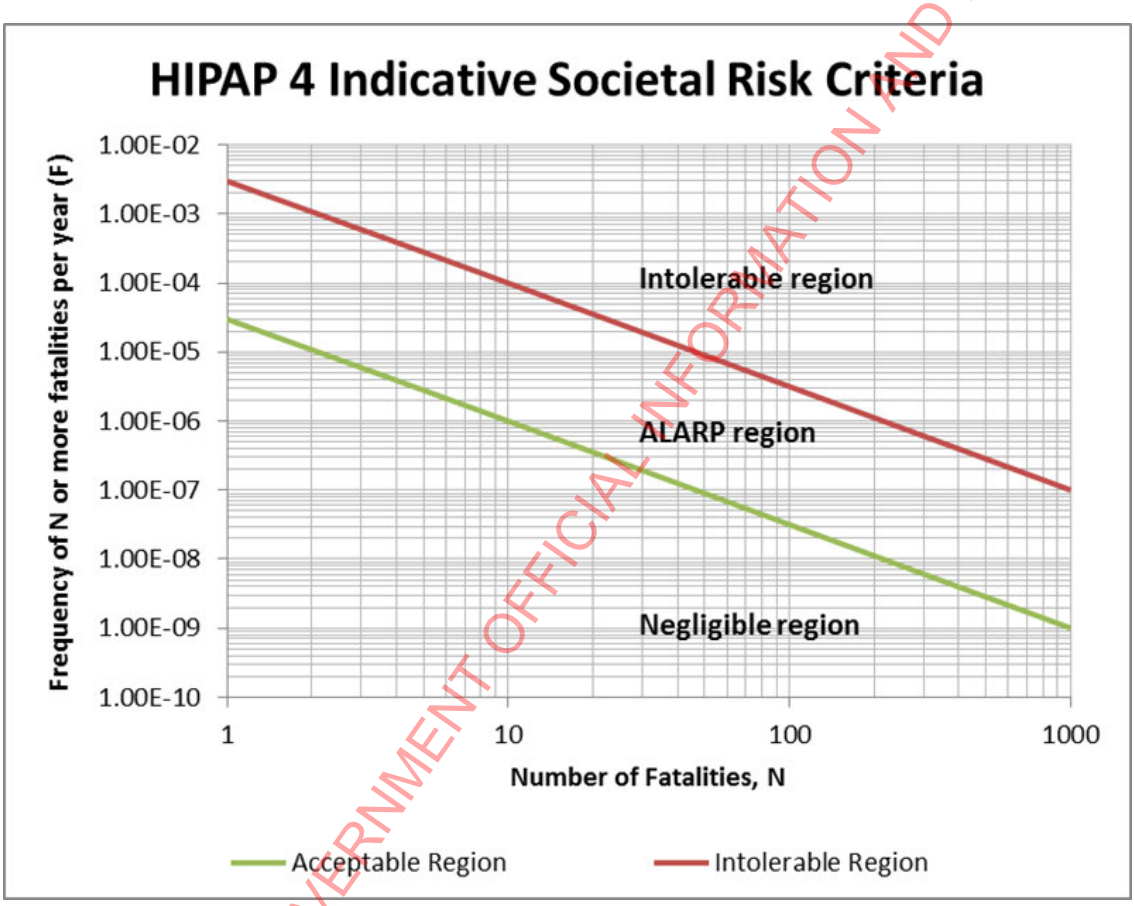
Description and land use	Criteria (per year)	Assessed in study?
□□plosion overpressure e□ceeding □□ □Pa □neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□□	Yes

Figure 5.2: Societal risk criteria (HIPAP 4, Ref [1])



5.3. Hazard identification

□a□ard identification is t□e process of identifying □a□ardous incidents t□at could result in an adverse impact□ toget□er □it□ t□eir causes□ conse□uences and e□isting safeguards□T□e main □a□ard at t□e Terminal is t□e storage and □andling of large □uantities of flammable and combustible li□uids□

5.3.1. Hazardous material properties for QRA

T□e properties of materials stored at t□e Terminal are summarised in Table □□□□

To□ic conse□uences □i□e□ dispersion of unignited □ydrocarbon vapours□ are not considered in t□e □R□ for t□e Terminal as □□ilst □aving some to□ic properties□ □ydrocarbon fuels are not acutely to□ic by in□alation and so do not □ave significant to□ic offsite effects □refer to Table □□□□□

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For t□e purposes of t□e □R□□representative materials as s□o□n in Table □□□ □ave been used in modelling□

Table 5.2: Material properties

Property	Gasoline (PMS, RMS, all grades)	Diesel (AGO)	Jet fuel
G□S Classification – Flammable Li□uid □and e□uivalent □DGC class□[a]□	G□S□Category □ □ □□□□ □ig□ly flammable li□uid and vapour □□DGC□Class □ PGII□	G□S□Category □ □ □□□□ Combustible li□uid □□DGC□C□□	G□S□Category □ □ □□□ flammable li□uid and vapor□ □□DGC□Class □ PGIII□
G□S Classification – □cute To□icity classification and □a□ard Statement [a]□	G□S□Category □ □ □□□□ □armful if in□aled	G□S□Category □ □ □□□□ □armful if in□aled	G□S□Category □ □ □□□□ □armful if in□aled
□S□O Classification □applicable in □□ only□	□□□□ □□□□□□ □□□□B□ □□□B□□□B	□□□D□□□□□□ □□□B□□□B	□□□C□□□□□ □□□□□□□ □□□B
Boiling Point □atm□□□C□	□□□□□□□	□□□□□□□	□□□□□□□
Density □□g□m□ at □□□C□	□□□□□□□	□□□□	□□□□□□□
Vapour pressure □□Pa at □□□C□	□□□□□	□□□□□	□□□□
□uto□ignition temperature □□C□	□□□□	□□□	□□□□
Flas□ Point □□C□	□□□□	□□	□□□
Lo□er Flammability Limit □LFL□□ppm□	□□□□□□□	□□□□□□□	□□□□□□□
□pper Flammability Limit □□FL□□ppm□	□□□□□□	□□□□□□□	□□□□□□□
Flammable	Yes	Combustible	Combustible
To□ic [b]□	□o	□o	□o
Material modelled	Ra□ Gasoline Sample	□□dodecane	□erosene

□otes□

□a□ □ttp□□□cis□safe□or□australia□gov□au□□a□ardousC□emical

□b□ For the purposes of QRA ‘Toxic’ means a substance that is acutely toxic by inhalation and is in a form □□ere a spill may disperse outside t□e immediate area of t□e spill in concentrations capable of causing serious in□ury or fatality□G□S □classification does not meet t□is definition i□e□□ydrocarbon fuels are not acutely to□ic by in□alation and □ence do not contribute to offsite fatality ris□ □□en unignited□Complete combustion of □ydrocarbons □ill result in combustion products of CO□ and □ater □□ic□ are not to□ic□ □o□ever□large blac□ smo□e plumes from □ydrocarbon fires can occur due to incomplete combustion□T□ere are numerous e□amples of tan□ fires occurring □including Buncefield□and publis□ed smo□e plume modelling □□ic□ demonstrate t□at □□ilst irritation may occur□one off e□posures to smo□e plumes do not pose a significant ris□ of serious in□ury or fatality□Refs □□□□□

□c□ Flammable additives are modelled as gasoline□combustible as diesel□

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5.3.2. Hazardous incident identification

□a□ard identification for t□e Terminal □as underta□en as a des□top activity based on e□perience □it□ bul□ li□uids storage and distribution terminals□revie□ of previous ris□ studies□a site visit and input from t□e site operators□

T□e □a□ardous incident identification table is provided in Table □□□□

5.3.3. External factors

If natural □a□ards □for e□ample eart□□ua□es□tsunamis□bus□fires□interact □it□ industrial facilities□large scale releases of □a□ardous material can occur t□at may be larger in scale t□an t□e e□uipment specific mec□anical failure or operational upset events typically considered in a □R□□

For a specific site□a □R□ generally includes a revie□ of e□ternal factors t□at may elevate t□e li□eli□ood or conse□uence of an incident compared to t□e statistical failure fre□uency data used in t□e modelling□

□□ternal factors □e□g□natural □a□ards□potentially relevant to t□e Lo□er □utt □□ ellington□ area and means of inclusion of effect in t□e □R□ for t□e Terminal are summarised in Table □□□□

Only t□e potential effect of eart□□ua□es on ris□ levels is □uantified for t□is site□

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Table 5.3: Hazard scenarios

Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA?
Pipe□or□	Pipe□or□ failure □□it□in t□e Terminal and up to valve cage outside site boundary□	□Corrosion □Maintenance □or□ □Pressure surge	□Ma□or spillage of flammable□combustible material□	□Regular maintenance and inspection procedures□ □T□e piping is designed to relevant codes and standards to resist t□e combined effects on internal pressure due to contents□□ind loads□ eart□□ua□e forces and □ydrostatic test loads□	Yes
Bul□tan□ storage	Tan□overfill	□□uman error □incorrect tan□ selection prior to start of fill or missed ma□imum safe fill level□	□Pool fire and potential full□surface bund fire□ □Tan□roof fire and escalation to ad□acent tan□s□ □Tan□vent fire□ □Flas□fire and vapour cloud e□plosion □gasoline all grades only□□	□CCTV at t□e tan□bund□ □Gas detection in gasoline bund and s□utdo□n □□ydrocarbon level detection in bund and s□utdo□n□ □□ig□level alarm and operator s□utdo□n□ □Independent □ig□level alarm and operator s□utdo□n also initiate □OPS valve s□utdo□n□ □Firefig□ting □□mergency Services□□	Yes □ Rim seal fires for IFR tan□s not modelled as t□e conse□uence is localised□□ scenario is included for escalation of rim seal fires to

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA?
		□Level gauge error□failure	□Pool fire and potential full□surface bund fire□ □Tan□roof fire and escalation to ad□acent tan□s□ □Tan□vent fire□ □Flas□fire and vapour cloud e□plosion □gasoline all grades only□□	□CCTV at t□e tan□bund□ □Gas detection in gasoline bund and s□utdo□n □□ydrocarbon level detection in bund and s□utdo□n□ □□ig□level alarm and operator s□utdo□n□ □Independent □ig□level alarm and operator s□utdo□n□□OPS valve s□utdo□n□ □□ourly stoc□receipt c□ec□s □it□ □□arf□ □Firefig□ting □□mergency Services□□	full surface fires□ Vent fires not modelled for any tan□s□ Flammable vapour cloud "Buncefield scenario" modelled□
	Lea□from tan□	□Tan□rupture □Fitting lea□	□Pool fire □Potential full□surface bund fire□ □Pool evaporation and flammable gas dispersion and flas□fire□	□Tan□farm operator patrols □daily□□ □□ydrocarbon level detection in bund and s□utdo□n□ □Firefig□ting □□mergency Services□□	Yes
	Lea□from tan□	De□atering stuc□open	□Pool fire	□Fully attended operation □□ydrocarbon level detection in bund and s□utdo□n□ □Dead man valve and manual isolation valve provided	□ot specifically □a cause of pool fire in bund included in statistical data□

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA?
	Tan□top full surface fire	□Lig□tning	□Tan□roof fire and escalation to ad□acent tan□s□	□Top mounted in□tan□foam pourers □remotely operable□□ □Spray cooling on sides of ad□oining tan□s□ □Firefig□ting □on site storage of fire□ater and foam□□mergency Services□□	Yes□ Rim seal fires for IFR tan□s not modelled as t□e conse□uence is localised□□ scenario is included for escalation of rim seal fires to full surface fires□

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA?
	Ma□or mec□anical failure of tan□	□Metal fatigue □Faulty fabrication □Corrosion of tan□ base□□eld □Tan□e□plosion due to lig□tning stri□e□breac□ of □a□ardous area ignition source controls □□d□acent tan□on fire □Bloc□ed vent □Fitting lea□on tan□ connection□	□Large spillage of flammable materials in bund□Fire if ignited□ □Potential full surface bund fire if rupture of tan□or connection□ □Flas□fire and vapour cloud e□plosion □gasoline all grades only□□	□Remote actuated emergency s□utdo□n valves on tan□outlet line□ □Daily operational c□ec□of t□e Terminal□ □ydrocarbon level detection in bund and s□utdo□n□ □Lea□s observed by operator during manual opening and closing of valves during tan□filling□ □□□ yearly tan□inspection and tests including □ydrostatic pressure test□ □Ignition source control onsite □tan□ bunds classified □one □ □a□ardous areas□□ □Tan□designed to relevant codes and standards□ □Regular maintenance and inspection procedures□ □Tan□and site fire protection facilities available□	Yes

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA?
	Flammable atmosp□ere in tan□ vapour space bet□een e□ternal roof and IFR	□Damage to floating roof resulting in sin□ing or partial sin□ing□ □Vents bloc□ed during filling procedure□	□Ignition by lig□tning□breac□ of □a□ardous area ignition source controls□□ot □or□on tan□□□ig□ velocity filling resulting in static during filling tan□□Results in□ □Initial e□plosion in tan□ vapour space □Rim seal fire □floating roof tan□s□ □leading to a tan□ full surface area fire□ □Potential for spill into t□e bund □it□ a bund fire□ □Boil over possible if □ater layer e□ists□ □Impact to people □adiant □eat and□or e□posure to products□□ property and t□e environment □products of combustion□□	□IFR □it□mec□anical seal minimises vapour egress□ □□□ternal roof protects IFR from rain □ater accumulation and minimises li□eli□ood of lig□tning leading to rim seal fires□ □Regular tan□ de□atering minimises □ater in tan□s□ □Permit to □or□controls□ □Regular maintenance and inspection procedures□ □Level alarms□controlled tan□filling□ □Filling rate less t□an critical velocity for static□ □Site eart□ing of e□uipment□ □□□ yearly tan□inspection and tests including roof inspection□	Yes – Internal e□plosion and rim seal fires not modelled as t□e conse□uence is localised□□ scenario is included for escalation of rim seal fires to full surface fires□
	Flammable atmosp□ere in fi□ed roof tan□ vapour space □diesel storage and slops tan□ only□	□□ir ingress to vapour space	□Internal tan□e□plosion□follo□ed by tan□ fire	□□ig□ level alarm and operator s□utdo□n□ □PV vent on interface tan□□ □Firefig□ting □□mergency Services□□ □ote□Tan□ to tan□ transfer bet□een bul□tan□s is not routinely conducted at t□e Terminal as t□ey are dedicated to particular products□	Yes □Vent fires not modelled for tan□s as t□e conse□uence is localised□□ scenario is included for escalation to full surface fires□

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA?
Product transfer pumps	Lea□ from pump during road tan□er loading	□Seal lea□ □Flange lea□ □Pump rupture	□Pool fire□ □Pool evaporation and flammable gas dispersion and flas□ fire□	□□ydrocarbon level detection□ □Tan□farm operator patrols □daily□□ □Bunding around pump compound and drainage to SP□L interceptor□ □Firefig□ting □□mergency Services□□	Yes
□dditive storage and □andling	Fire involving additive storage	□Container rupture due to □andling error during delivery to Terminal□ □Impact by road tan□er□ □Pump lea□ during blending□	□Pool fire if ignited□	□□ydrocarbon level detection in bund□ □□ll additives delivered in drums□ limiting inventory si□e□□dditives are pumped from drums to t□e additives storage tan□s□ □Lo□ pump dosing rate□ □Location in separate bund to bul□ storage tan□s and RTL gantry area□	Yes
Road tan□er loading □RTL□	Tan□er lea□ during loading	□Loading arm rupture □Loading arm□tan□er or piping fitting lea□ □Coupling error	□Pool fire □Pool evaporation and flammable gas dispersion and flas□ fire□ □Potential escalation to neig□bouring tan□er□trailer	□Operator in attendance □activates □SD button dropping po□er to RTL□□ □Lone □or□er system □Loading bay □erbing and drainage to SP□L interceptor□ □Ignition control□ □Foam deluge initiated by fire detection	Yes

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Area	Hazard scenario	Causes/threats	Consequences	Safeguards	Included in QRA?
	Tan□er overfill	□□uman error	□Pool fire □Pool evaporation and flammable gas dispersion and flas□ fire□	□Scully system □drops po□er to RTL gantry□□ Operator in attendance □activates □SD button dropping po□er to RTL□□ □Lone □or□er system□ □Loading bay □erbing and drainage to SP□L interceptor□ □Ignition control□ □Firefig□ting □currently □mergency Services□ □Foam deluge□	□ot specifically □a cause of pool fire in gantry area□
	Road tan□er drive□a□ay incident	□Failure of procedures and □ard□are interloc□s	□Lea□ of petroleum product in loading area□ □Fire if ignited □Impact to people □radiant □eat and□or e□posure to products□□ property and t□e environment □products of combustion□□ □ote□Ignition source present □road tan□er engine□□□ence fire more li□ely□	□Driver training □Driver not in cab during filling □Loading line is □RV protected □Loading arm pro□imity s□itc□es lin□ed to barriers arms and lig□ts □"Dry□brea□" □ose couplings □Loading bay □erbing and drainage to SP□L interceptor□ □Firefig□ting □currently □mergency Services□ □Foam deluge□	Yes

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Table 5.4: External factors

External factors	Damage/outcome	Comments	Inclusion in Terminal QRA
□art□□ua□e	Ground movement damaging□collapsing tan□s□loss of containment and fire	Tan□s are not mec□anically anc□ored□ □art□□ua□e sensors are provided □□ic□ s□utdo□n t□e terminal □i□e□stop RTL□if ground s□a□e detected□ Strengt□ of eart□□ua□e and t□e fre□uency□return period and probability of significant damage to tan□s assessed based on fragility curves□ Potential for multiple tan□failures simultaneously□or damage to t□e bunds as □ell as tan□s □it□ larger scale release t□at is not contained in t□e bunded areas	□dditional scenario accounting for loss of containment from tan□s and also failure of bund □see □PP□□DI□ □□□ □OT□□ □ □art□□ua□e sensors are provided at t□e Terminal t□at initiate □SD □i□e□stop all transfer and isolate po□er closing all actuated valves□if ground movement is detected□ □ Tan□s are unanc□ored
	Li□uefaction of ground damaging□collapsing tan□s□loss of containment and fire	Ris□ of fatality from li□uefaction is due to a sufficient Pea□ Ground □cceleration □PG□□ being reac□ed for t□e particular soil type t□e Terminal is located on□	□o additional ad□ustment to □R□□ □ny damage due to li□uefaction effects is assumed to be at t□e same impact scale as eart□□ua□e damage due to ground movement□s□a□ing already being accounted for□
Tsunami	Inundation and tan□ movement□damage	Ma□or damage to tan□s □as a □ig□ probability of occurring at inundation dept□s of □ m or greater □Ref □□□□□t□e ris□ of fatality from a tsunam□due directly to inundation is substantially □ig□er t□an any incremental fatality ris□ due to secondary effects from a loss of containment of □a□ardous materials and resulting fire□	□o ad□ustment to □R□□
Strong □inds	Loss of containment leading to a fire if ignited □as above□due to e□uipment damage from strong □inds	T□e tan□s are designed to relevant standards to resist t□e combined effects on internal pressure due to contents□□eig□t of platforms□ladders□live loads□□ind loads□eart□□ua□e forces and □ydrostatic test loads□ Operations stopped in adverse □eat□er conditions□	□o ad□ustment to □R□□

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External factors	Damage/outcome	Comments	Inclusion in Terminal QRA
Cyclone	□ig□ □ind speeds	□s for strong □inds□ □ ellington is not identified as a cyclone area□	□o ad□ustment to □R□□
Storm event□ flood □□ig□ rain□	Inundation due to storm surge□□ig□ rainfall resulting in flooding impacting tan□s□	Inundation due to flooding may lead to asset damage if uplifting occurs for empty tan□s□ Full tan□s unli□ely to be damaged – not a significant ris□ of loss of containment	□o ad□ustment to □R□□
Lig□tning	Ignition resulting in tan□ top full surface fire	□ ellington is not identified as a □ig□ lig□tning stri□e area□ L□STFIR□ data includes a component of tan□ top full surface fires started by lig□tning stri□es□	□o ad□ustment to □R□□
Bus□fire	□□ternal fire escalating to bul□ storage tan□s	□ot relevant – no significant surrounding vegetation	□o ad□ustment to □R□□
□ircraft cras□ due to pilot error□bad □eat□er or plane fault	Propagation to tan□□ bund fires Impact to people □radiant □eat and□or e□posure to products□□ property and t□e environment □products of combustion□	Separation distances to flig□t pat□as per aviation standards	□o ad□ustment to □R□□
Fire□e□plosion on ad□acent site	□scalation to storage tan□s	□earest ad□acent sites □it□ significant flammable material is t□e □ □nergy fuel terminal at □□□m to sout□east □i□e□no escalation ris□□ T□e separation distances to buildings on t□e neig□bouring sites is at least □□m so escalation ris□ from building fire is also lo□□ Fire protection including spray cooling on all tan□s□ □mergency Response Procedures □□RP□□	□o ad□ustment to □R□□
Breac□ of security□ sabotage	Possible release of product □it□ conse□uences as per above	Security measures include fencing□CCTV□security patrols□ operator□driver vigilance□ PLC alarms monitored and operator automatic call out□	□o ad□ustment to □R□□

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5.4. Consequence analysis

Conse□uence analysis involves □ualitative and□or □uantitative revie□ of t□e identified □a□ardous incidents to estimate t□e potential to cause in□ury or fatalities□damage to property or damage to t□e environment□

5.4.1. Scenarios

T□e materials are flammable and combustible fuels □it□ minimal acute to□icity issues□ Only ignited events □it□ t□e potential to cause in□ury □fatality are modelled□

Representative scenarios □ere developed from t□e □a□ard identification based on location and materials as follo□s□

- Pool□bund fires□Ignited vapours on t□e surface of a li□uid pool□
- Tan□top full surface fires□Ignited vapours on t□e surface of a li□uid at li□uid surface in tan□□
- □et□spray fires□T□is is an intense directional fire resulting from ignition of a vapour or t□o p□ase release □it□ significant momentum □□e□pressurised□□
- Flas□ fires□vapour cloud e□plosion□□n ignited flammable vapour cloud□Dimensions are ta□en to be t□e e□tent of t□e LFL□
- Tank overfill (‘Buncefield’ scenario) resulting in flash fire/Vapour Cloud □□plosion □VC□□

T□e model selected based on t□e material□scenario and ignition potential is s□o□n in Table □□□□

□dditional input assumptions are summarised in □PP□□DI□ B□

Table 5.5: Scenario rule set for releases

Material	Scenario	Pressure range (barg)[a]	Hole size (mm)	Ignition timing	Consequence modelled
Gasoline	Pumped li□uid □□e□s□ip import□ road tan□er e□port□	≥ □	□□□□□□[b]□	Immediate	Spray fire
				Delayed	Flas□ fire
			□□□rupture	Immediate	Pool□bund fire
				Delayed	Flas□ fire
	Storage tan□ – mec□anical failure	□tmosp□eric	Minor lea□□ ma□or lea□□ Catastrop□ic rupture	Immediate	Pool□bund fire
				Delayed	Flas□ fire
	Storage tan□ – overfill	□tmosp□eric	Ma□imum import rate	Immediate	Pool□bund fire
				Delayed	Flas□ fire □ VC□ □Buncefield scenario□

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Material	Scenario	Pressure range (barg)[a]	Hole size (mm)	Ignition timing	Consequence modelled
Diesel□ □et fuel	Pumped li□uid □i□e s□ip import□ road tan□er e□port□	□□□	□□□□□□□□□□ rupture	Immediate	Pool□bund fire
				Delayed	Pool□bund fire
	Storage tan□ – mec□anical failure	□tmosp□eric	Minor lea□□ ma□or lea□[a]□ Catastrop□ic rupture	Immediate	Pool□bund fire
				Delayed	Pool□bund fire
	Storage tan□ – overfill	□tmosp□eric	Ma□imum import rate	Immediate	Pool□bund fire
				Delayed	Pool□bund fire

□otes□

a□ Minimum pressure □barg□at □□ic□ spray fires form varies by t□e material type□ operating pressure and □ole si□e □assuming material is at ambient temperature□□ Modelling indicates t□at at above □ barg□gasoline may form sufficient droplets □spray t□at does not rain out□at □ole si□es up to and including □□ mm to result in a spray fire□For diesel□a pressure of above □□ barg is predicted to be re□uired before any significant droplet formation t□at does not rain out occurs for any of t□e □ole si□es modelled□T□erefore□pool fires only are modelled for all si□es of diesel loss of containment as t□ere are no operating pressures greater t□an □□ barg□

b□ □ □ilst □□ mm lea□si□e □et fires for gasoline are t□eoretically possible□in most cases t□ese □ill be obstructed by structures suc□ as gantry □alls bund □alls□reducing to effect area similar to a pool fire□T□is □as been accounted for in t□e modelling by using a pool fire model for □□ mm pressurised gasoline releases□

5.4.2. Software

Conse□uence modelling of identified □a□ardous events □as underta□en using Ge□con □FF□CTS v□□□□ □□FF□CTS□for all scenarios e□cept gasoline tan□ overfill□

For gasoline tan□ overfill scenarios□t□e e□tent of t□e flammable cloud envelope and associated overpressure □as modelled follo□ing t□e □ealt□ and Safety □□ecutive □□S□□ Vapour Cloud □ssessment □VC□□met□od□Ref □□□□T□e VC□ met□od is an empirical model t□at □as developed after significant researc□ as part of t□e incident investigation into t□e Buncefield incident in □□□□□□s per guidance by Fire □nd Blast Information Group □F□BIG□□Ref □□□□and t□e □□ □S□□Ref □□□□it is regarded as best practice for estimating t□e effect areas for t□is type of event □it□out underta□ing detailed site specific Computational Fluid Dynamics modelling as standard models □suc□ as D□V P□□ST and Ge□con □FF□CTS□do not predict t□e effects t□at □ere e□perienced in incidents suc□ as Buncefield□

5.4.3. Results

□ full set of conse□uence modelling results are provided in □PP□□DI□ B for all scenarios□

T□e scenario □it□ t□e largest effect area for t□e Terminal is a gasoline tan□ overfill of □ P□ or □ P□□ T□e flammable envelope e□tends up to □□□ m □assuming control measures suc□ as □ig□ level s□utdo□n □ave failed□and t□at t□e release continues for

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□□ minutes□□□ conse□uence overlay for t□is scenario s□o□ing t□e ma□imum predicted effect area is provided in □PP□□DI□ C□

5.5. Frequency analysis

□a□ardous scenarios involve loss of containment of □ydrocarbon fuels and subse□uent ignition□T□e li□eli□ood of t□ese scenarios □as estimated using □istorical data for bot□ loss of containment and for potential ignition□Loss of containment fre□uencies □ere calculated using □istorical lea□fre□uency data for eac□ e□uipment type and ad□usted for t□e number of e□uipment items and proportion of time e□uipment is in use□

T□e overall approac□ and specific fre□uencies used in t□e □R□ are given in □PP□□DI□ D and includes□

- □istorical e□uipment lea□
- an estimated count of equipment items (‘parts count’)
- online time probability
- probability of ignition
- event tree analysis
- outcome fre□uencies
- storage tan□fire fre□uencies □including tan□overfill□
- t□e effect of control measures accounted for in t□e □R□ □e□g□tan□overfill protection safeguards□operator response and isolation□□

5.6. Risk assessment

Ris□ analysis □as performed □uantitatively using Ge□con RIS□C□RV□S v□□□□ □RIS□C□RV□S□□ □□ic□ combines t□e conse□uences and fre□uencies to produce contours of e□ual ris□ values□

T□e follo□ing ris□ measures □ere assessed□

- Individual fatality ris□
- In□ury ris□
- Property damage and accident propagation ris□
- Societal ris□□

Ris□ analysis results and evaluation against criteria are presented in Section □□

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6. RISK ASSESSMENT RESULTS

6.1. Overview

This section includes all risk results. Note that the risk contours and societal risk in this section include the effect of earthquakes on risk.

6.2. Individual fatality risk

Individual fatality risk[1] represents the probability of some specified level of harm (in this case fatality) occurring to a theoretical individual located permanently at a particular location, assuming no mitigating action such as escape can be taken. Probability of presence is not accounted for. This can be regarded as risk at a location, not risk to a particular person.

The individual fatality risk contours for the Terminal are shown in Figure [illegible]. A comparison of the risk against the IP&P risk criteria is presented in Table [illegible].

All individual fatality risk criteria for offsite land uses are met.

6.3. Injury risk

Injury risk represents the probability of injury occurring to a theoretical individual located permanently at a particular location, assuming no mitigating action such as escape can be taken.

Risk contours for injury risk due to heat radiation impacts [illegible] kW/m² heat radiation level for the Terminal are presented in Figure [illegible]. Comparison of the risk against the risk criteria is presented in Table [illegible].

6.4. Property damage and accident propagation risk

Property damage and accident propagation risk represents the probability of an escalation to neighbouring equipment or property occurring assuming no mitigating action such as application of fire water or FSD is undertaken. There are several types of consequences that may result in damage or escalation but the most relevant for bulk hydrocarbon liquids storage is from heat radiation.

Escalation risk models were prepared only for the heat radiation impacts, as the cumulative frequency of events with the potential to cause explosion overpressures are less than [illegible] per year hence below the IP&P acceptability criteria.

Risk contours for property damage and accident propagation risk due to heat radiation impacts [illegible] kW/m² heat radiation level for the Terminal are presented in Figure [illegible].

Comparison of the risk against the risk criteria is presented in Table [illegible].

[1] Note: This is a different basis to the term Annual Individual Fatality Risk (AIFR) commonly used in [illegible] in natural hazards risk assessment. AIFR includes factors for probability of exposure (probability of presence). To avoid confusion with the natural hazards [illegible] the term AIFR is not used in this R[illegible]

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6.5. Sensitivity of individual fatality risk to earthquake

□ sensitivity study □as completed to determine t□e effect of including eart□□ua□e ris□ on t□e overall individual fatality ris□ contours□T□e results of t□e assessment □comparative ris□ contours □it□ and □it□out t□e eart□□ua□e ris□ scenario□ are presented in □PP□□DI□ □□

T□ese s□o□ t□at eart□□ua□e ris□ ma□es a reasonably significant contribution to t□e Terminal ris□ levels□□o□ever□t□e results of t□e assessment against t□e □IP□P □ ris□ criteria are unaffected□

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Table 6.1: Comparison with risk criteria

Description	Risk criteria (per year)	Compliance with criteria?	Comments
Individual fatality risk			
Sensitive land uses□ □ospitals□c□ild□care facilities and old age □ousing	□□□ □ □□-□	Yes	T□e ris□contour e□tends offsite□up to appro□imately □□ m from t□e Terminal boundary□ □o□ever□t□ere are no sensitive land uses in t□is area□ T□e nearest sensitive area □assumed to be t□e Marae□is located appro□imately □□□ m from t□e sout□eastern boundary of t□e Terminal□
Residential land uses□ Residential developments and places of continuous occupancy suc□ as □otels and tourist resorts	□ □ □□-□	Yes	T□e ris□contour e□tends offsite□up to appro□imately □□ m from t□e Terminal boundary□ □o□ever□t□ere are no residential land uses in t□is area□ T□e nearest residential area □Marae□is located appro□imately □□□ m from t□e sout□□ eastern boundary of t□e Terminal□
Commercial land uses□ Commercial developments□ including offices□retail centres and entertainment centres	□ □ □□-□	Yes	T□e ris□contour e□tends offsite□up to appro□imately □□ m from t□e Terminal boundary□ □o□ever□t□ere are no commercial land uses in t□is area□
Recreational land uses□ Sporting comple□es and active open space areas	□□ □ □□-□	Yes	T□e ris□contour e□tends offsite□up to appro□imately □□ m from t□e □estern boundary of t□e Terminal□ □o□ever□t□ere are no sporting comple□es and active open space areas in t□is area□ T□e nearest recreational area is located appro□imately □□□ m from t□e nort□□eastern boundary of t□e Terminal□
Boundary limit□ Target for site boundary	□□ □ □□-□	Yes	T□e ris□contour e□tends up to appro□imately □□ m from t□e □estern fence line of t□e Terminal□only to t□e Office and □dmin building □□ic□ is outside t□e fence line but is located □it□in t□e overall □□OSL site boundary of t□e Terminal□T□e building is not an offsite land use as it is occupied by □□OSL personnel□ T□e contour does not e□tend to any ot□er properties□

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Description	Risk criteria (per year)	Compliance with criteria?	Comments
Injury risk			
□eat radiation of □□□ □□ □m□ at residential or sensitive land uses□	□□ □ □□□□	Yes	T□e ris□ contour e□tends offsite□up to appro□imately □□ m from t□e □estern boundary of t□e Terminal□ □o□ever□t□ere are no sensitive or residential land uses in t□is area□ T□e nearest sensitive or residential area □Marae□is located appro□imately □□□ m from t□e sout□□eastern boundary of t□e Terminal□
Overpressure of □ □Pa at residential or sensitive land uses□	□□ □ □□□□	Yes	T□is ris□ contour is not generated□T□e only events □it□ potential overpressures of □ □Pa e□tending a significant distance are VC□s resulting from gasoline tan□ overfills□T□e cumulative fre□uency □as per □PP□□DI□ D□Section D□□□□of a delayed ignition event is □ell belo□ □□ □ □□□□ per year so a contour cannot be generated and t□is criteria is met□
Property damage and accident propagation risk			
□eat radiation of □□ □□ □m□ at neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□□□	Yes	T□e ris□ contour remains □it□in all boundaries of t□e Terminal□
Overpressure of □□ □Pa at neig□bouring potentially □a□ardous installations or at land □oned to accommodate suc□ installations□	□□ □ □□□□	Yes	T□is ris□ contour is not generated□T□e only events □it□ potential overpressures of □□ □Pa e□tending a significant distance are VC□s resulting from gasoline tan□ overfills□T□e cumulative fre□uency □as per □PP□□DI□ D□Section D□□□□of a delayed ignition event is □ell belo□ □□ □ □□□□ per year so a contour cannot be generated and t□is criteria is met□

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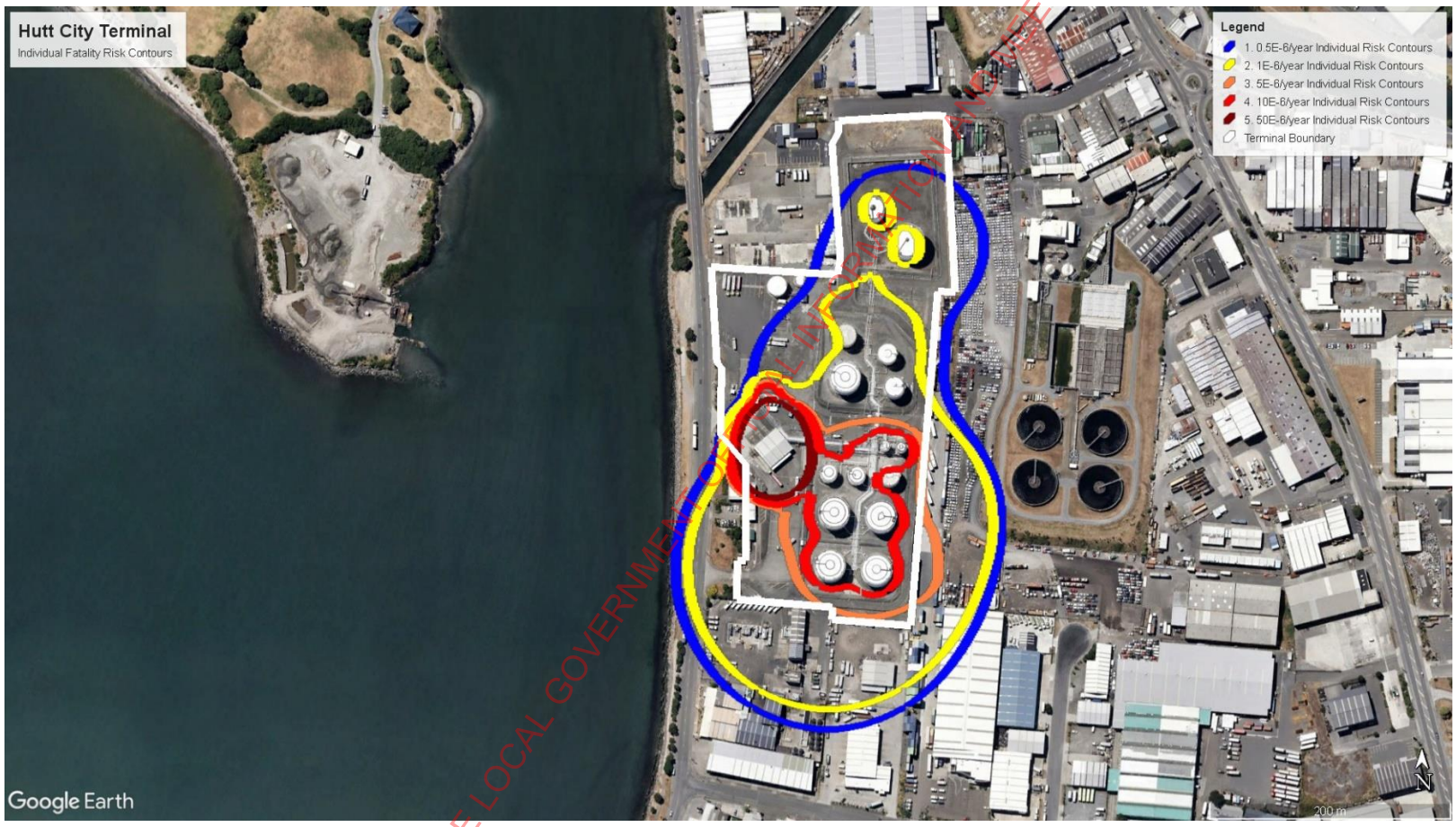
Figure 6.1: Individual fatality risk contour



□ote□T□e □□ □ □□[1] per year individual fatality ris□ contour □boundary limit□target for site boundary□e□tends past t□e site fence but does not e□tend outside t□e overall □□OSL site boundary of t□e Terminal□T□e ris□ contour e□tends only to t□e Office and □dmin building□□ □ic□ is not an offsite land use as it is occupied by □□OSL personnel□

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Figure 6.2: Injury risk contour

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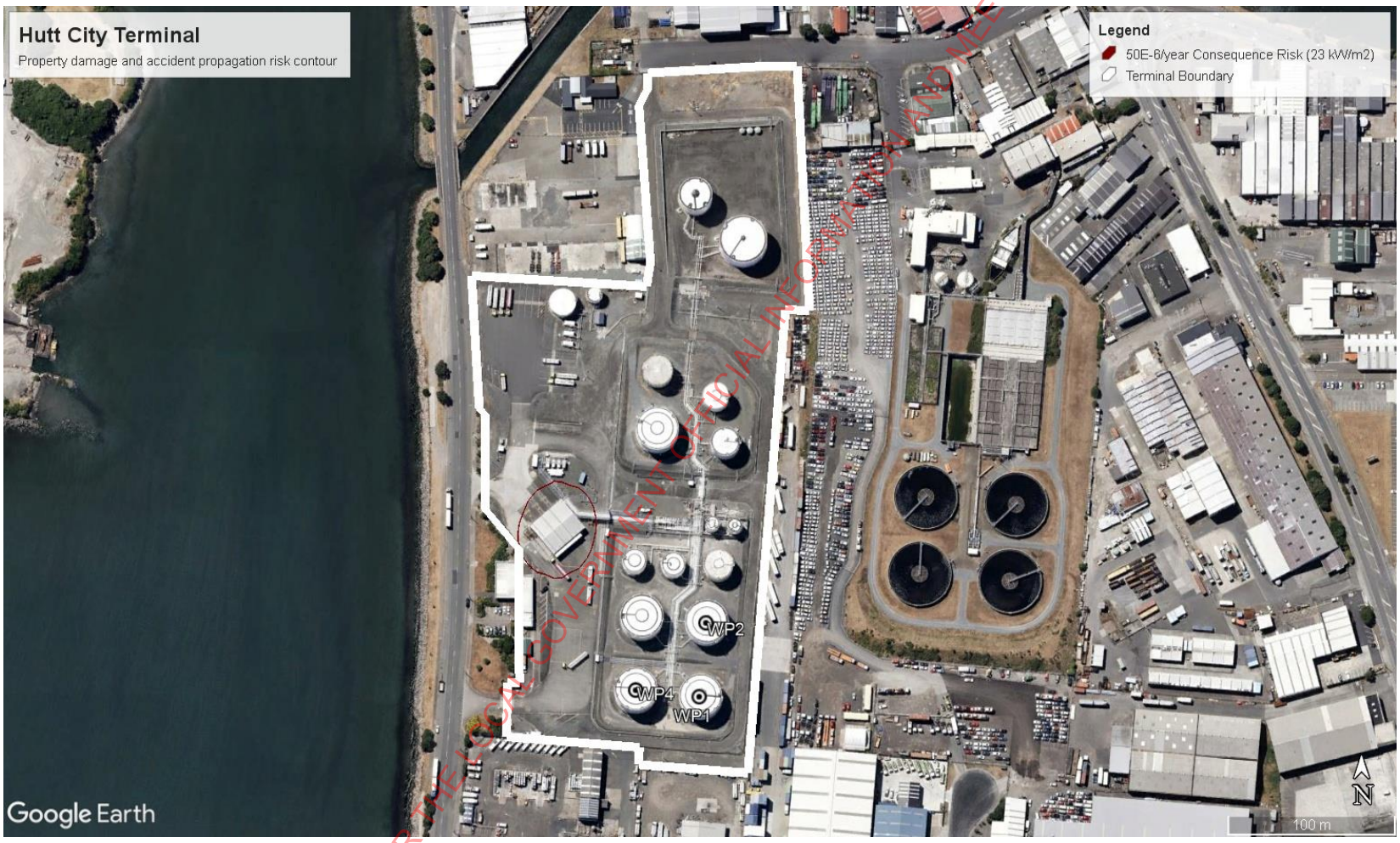
Figure 6.3: Property damage and accident propagation risk contour



6.6. Major risk contributors

T□e ma□or ris□ contributors at four points □ere e□tracted from t□e individual fatality ris□ model and summarised in Table □□□□T□e locations of t□ese analysis points are s□o□n in Figure □□□□

Ris□ analyses of ma□or ris□ contributors at t□ese selected points indicate t□at□

- □nalysis Point □□□ estern limit bet□een □□ □ □□□⁻⁶ per year and □□ □ □□□⁻⁶ per year contours

Pool fires resulting from gasoline or diesel lea□s during road tan□er filling at t□e RTL are t□e ma□or ris□ contributors to t□e offsite ris□ bet□een □□ □ □□□⁻⁶ per year and □□ □ □□□⁻⁶ per year contours to t□e □est of t□e Terminal□

- □nalysis Point □□Sout□ern limit of □ □ □□□⁻⁶ per year contour

Ma□or rupture of t□e gasoline tan□s and bund due to an eart□□ua□e□and pool fires resulting from gasoline tan□s overfill are t□e ma□or contributors to t□e offsite ris□ at t□e □ □ □□□⁻⁶ per year contour to t□e sout□ of t□e Terminal□

- □nalysis Point □□□astern limit of □ □ □□□⁻⁶ per year contour

Ma□or rupture of t□e gasoline tan□s and bund due to an eart□□ua□e□and bund fires resulting from gasoline and □et tan□s ma□or rupture are t□e ma□or contributors to t□e offsite ris□ at t□e □ □ □□□⁻⁶ per year contour to t□e east of t□e Terminal□

- □nalysis Point □□Sout□ern limit of □ □ □□□⁻⁶ per year contour

Ma□or rupture of t□e gasoline tan□s and bund due to an eart□□ua□e is t□e ma□or contributors to t□e offsite ris□ at t□e □ □ □□□⁻⁶ per year contour to t□e sout□ of t□e Terminal□

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Table 6.2: Major risk contributors at analysis points

Location	Main risk contributors	Contribution at location
□ estern limit bet□een □□ □ □□[□] per year and □□ □ □□[□] per year contours □□nalysis Point □□	Pool fire – RTL rupture □PMS□RMS□	□□□
	Pool fire – RTL rupture □□GO□	□□□
	Pool fire – □art□□ua□e tan□rupture □PMS□RMS□	□□□
	Pool fire – RTL rupture □□et□	□□
	□et fire – RTL □□ mm lea□ □PMS□RMS□	□□
Sout□ern limit of □ □ □□[□] per year contour □□nalysis Point □□	Pool fire – □art□□ua□e tan□rupture □PMS□RMS□	□□□
	Pool fire – Tan□ □ P□ □RMS□overfill	□□□
	Pool fire – Tan□ □ P□ □RMS□overfill	□□□
	Pool fire – Tan□ □ P□ □RMS□ma□or rupture	□□
	Pool fire – Tan□ □ P□ □RMS□ma□or rupture	□□
	Pool fire – Tan□ □ P□ □PMS□ma□or rupture	□□
	Pool fire – Tan□ □ P□ □RMS□ma□or rupture	□□
	Pool fire – Tan□ □ P□ □□et□ma□or rupture	□□
	Pool fire – Tan□ □ P□ □□et□ma□or rupture	□□
□astern limit of □ □ □□[□] per year contour □□nalysis Point □□	Pool fire – □art□□ua□e tan□rupture □PMS□RMS□	□□□
	Pool fire – Tan□ □ P□ □RMS□ma□or rupture	□□□
	Pool fire – Tan□ □ P□ □RMS□ma□or rupture	□□□
	Pool fire – Tan□ □ P□ □et□ma□or rupture	□□□
	Pool fire – Tan□ □ P□ □et□ma□or rupture	□□□
	Pool fire – Tan□□ P□ □RMS□ma□or rupture	□□□
	Pool fire – Tan□□ P□ □PMS□ma□or rupture	□□□
Sout□ern limit of □ □ □□[□] per year contour □□nalysis Point □□	Pool fire – □art□□ua□e tan□rupture □PMS□RMS□	□□□
	Flas□ fire – Tan□ □ P□ □RMS□overfill	□□
	Flas□ fire – Tan□ □ P□ □RMS□overfill	□□

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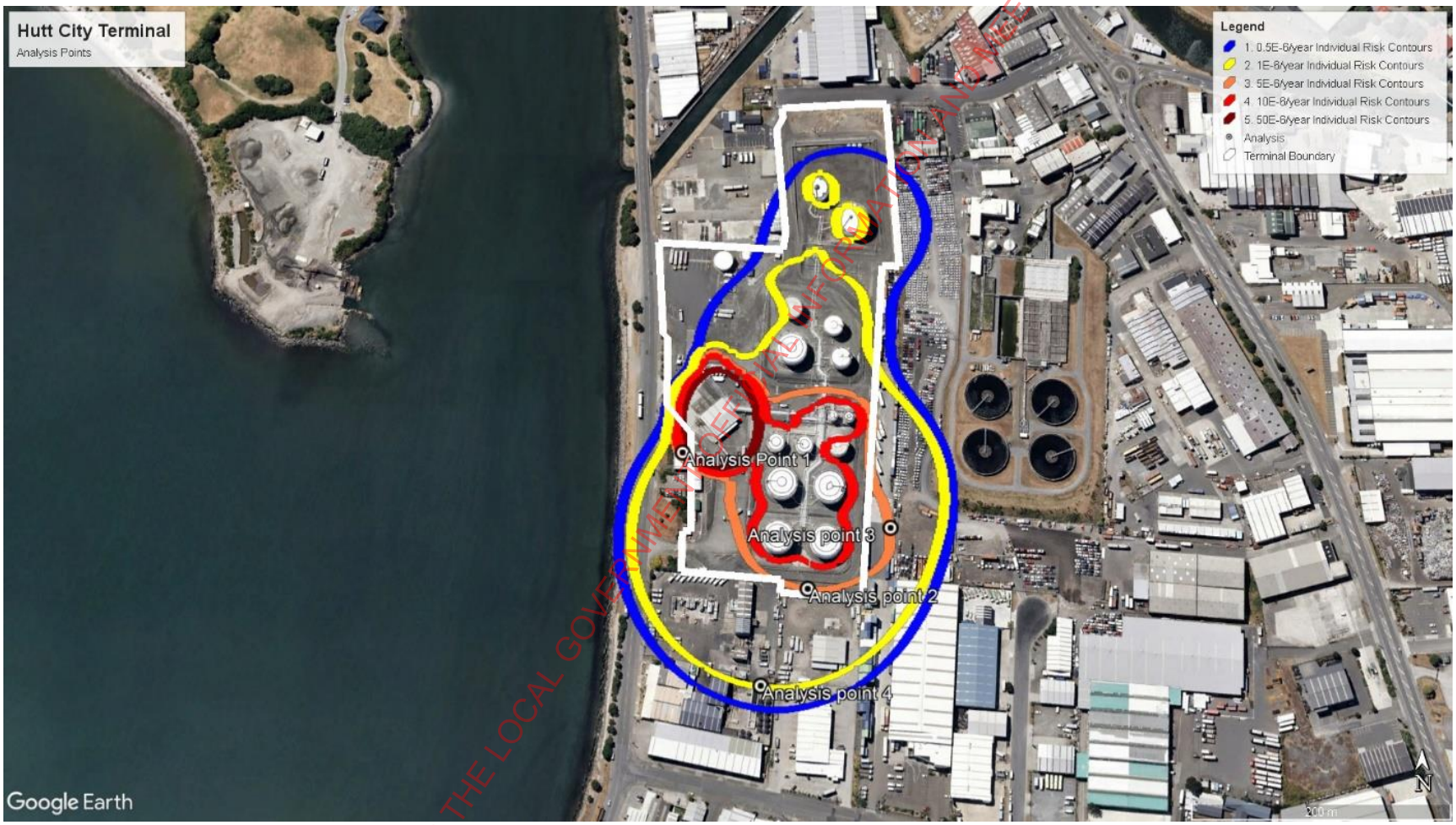
Figure 6.4: Analysis point locations



6.7. Societal risk

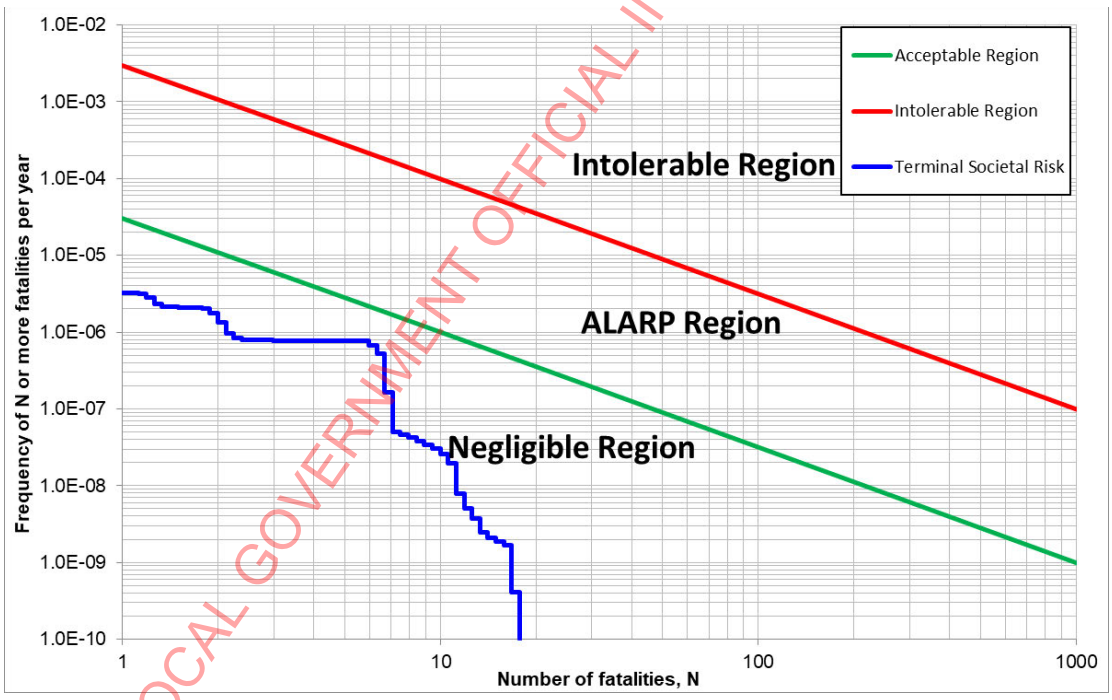
Societal ris□ is a measure of t□e probability of incidents affecting an actual population □at□er t□an a t□eoretical individual as in individual ris□□□i□e□ta□es into account t□e number of people e□posed to ris□□ Probability of presence is accounted for□ and mitigating effects suc□ as □□et□er people are located inside or outside□or emergency response occurs can also be accounted for □□ere relevant□

T□e population data set and assumptions used for t□e societal ris□ calculation are included in □PP□□DI□ F□

T□e societal ris□ for t□e Terminal is presented as a F□□ curve against t□e □IP□P □ criteria in Figure □□□□

T□e societal ris□ for t□e Terminal is in t□e negligible region of t□e F□□ curve□T□is is due to t□e limited e□tent of t□e ris□ contours and also t□e lo□ population numbers in t□e surrounding industrial areas□

Figure 6.5: Societal risk F-N curve



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7. CONCLUSIONS

The study showed that all HIPP risk criteria are met as follows:

- Individual fatality risk criteria:
  - The 50 in 1 million per year individual fatality risk contour for sensitive land uses extends up to 20 m from the Terminal boundary but does not reach existing sensitive land uses.
  - The 10 in 1 million per year individual fatality risk contour for residential land uses extends up to 20 m from the Terminal boundary but does not reach existing residential land uses.
  - The 10 in 1 million per year individual fatality risk contour for commercial land uses extends up to 20 m from the Terminal boundary but does not reach existing commercial land uses.
  - The 50 in 1 million per year individual fatality risk contour for recreational land uses extends up to 20 m from the Terminal boundary but does not reach existing recreational land uses.
  - The 50 in 1 million per year individual fatality risk contour for boundary limit target for site boundary extends past the site fence but does not extend outside the overall HSL site boundary of the Terminal.
- Injury risk criteria:
  - The 50 in 1 million per year injury risk contour for residential and sensitive land use extends up to 20 m from the Terminal boundary but does not reach existing residential and sensitive land uses.
- Property damage and accident propagation risk criteria:
  - The 50 in 1 million per year escalation risk contour for neighbouring potentially hazardous land uses remains within all boundaries of the Terminal.
- The societal risk level remains within the negligible region of the FN curve.

The results suggest that the offsite risk is already low and that there is not a strong driver for additional risk reduction on the basis of offsite risk levels.

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APPENDIX A. METEOROLOGICAL DATA

For t□is study□consistent □it□ ot□er recent □R□ studies conducted for neig□bouring fuel terminals located □it□in t□e same district□□istorical meteorological □eat□er data for t□e Terminal □as obtained from t□e □e□ □ealand MetService□T□e ac□uired data set □as based on readings from t□e □utomatic □ eat□er Station □□□ S□at □ ellington □irport □Station no□□□□□□approximately □□ □m sout□ of t□e Terminal over t□e period of □anuary □□□□ – □anuary □□□□□

□nalysis of t□e data □as performed using t□e met□odology outlined in t□e T□O Purple Boo□to obtain t□e representative □eat□er conditions □including □ind speed and stability classes□appropriate for t□e □R□□Ref □□□□

□s cloud cover data □as unavailable□ representative □eat□er conditions □ere determined based on t□e □ind speed and □□et□er occurrence □as during t□e day or at nig□t□□n overvie□ of t□e rule set used to determine t□e representative □eat□er condition using t□e Purple Boo□approac□ is s□o□n in Table □□□□

Table A.1: Rule set for representative weather conditions

Time of day	Wind speed range (m/s)	Pasquill stability class	Average wind speed (m/s)
Day	□ □	B	□□□
	□ – □	D	□□□
	□ – □	D	□□□
	□ □	D	□□□□
□ig□t	□ □□□	F	□□□
	□□□ – □	□	□□□
	□ – □	D	□□□
	□ – □	D	□□□
	□ □	D	□□□□

For t□e □R□ model□t□e data □ere consolidated into si□ different representative □eat□er conditions □□ic□ are□

- Pas□uill Stability Class□B□□ind speed □□□ m□s □B□□□□
- Pas□uill Stability Class□D□□ind speed □□□ m□s □D□□□□[1]
- Pas□uill Stability Class□D□□ind speed □□□ m□s □D□□□□
- Pas□uill Stability Class□D□□ind speed □□□□ m□s □D□□□□□
- Pas□uill Stability Class□□□□ind speed □□□ m□s □□□□□□
- Pas□uill Stability Class□F□□ind speed □□□ m□s □F□□□□□

[1] D□□□ is t□e average □ind speed from t□e day □D□□□□and nig□t □D□□□□data□as t□ese are very similar□

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□ summary of t□e meteorological data sets used for t□e □a□ard assessment are presented in Table □□**2**□T□e □ind rose is provided in Figure □□□□

T□e □ind rose distribution obtained from t□e data □as cross□c□ec□ed against t□e recent meteorological data□and slig□t difference □ere found□For t□is study□t□e previous □eat□er data set □as used as t□e c□anges are not significant in t□e conte□t of t□e □R□ inputs□

Figure A.1: Wind rose distribution

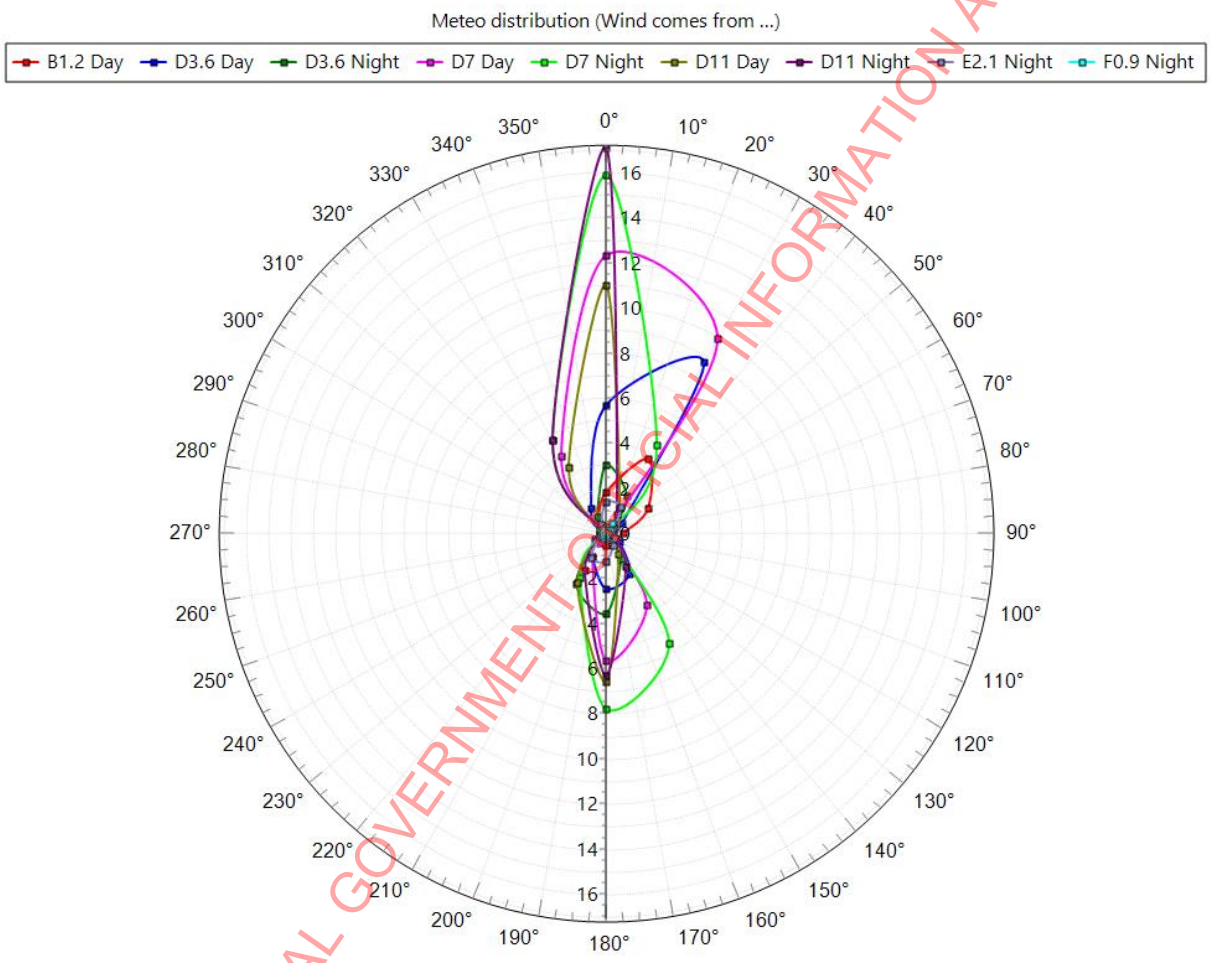

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Table A.□: Meteorological data sets used in risk model

Direction wind from (degrees true)	B1.2		D3.6		D7.0		D11.4		E2.1		F0.9		Total day	Total night
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night		
□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□	□□□□
Total	□□□□□	□□□□	□□□□□	□□□□□	□□□□□	□□□□□	□□□□□	□□□□□	□□□□	□□□□	□□□□	□□□□	□□□□□	□□□□□

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APPENDIX B. CONSEQUENCE MODELLING

B1. Overview

T□e follo□ing types of event □ere evaluated to determine t□e effects from □ydrocarbon releases at t□e Terminal□

- □et□spray fires
- Pool fires
- Flas□ fires
- Tan□top full surface fires
- Tan□bund fires
- Tank overfill flash fires (‘Buncefield’ scenario).

Conse□uence analysis □as underta□en for t□e current operations at t□e Terminal□T□e modelling approac□es □e□g□parameters and models□and results are presented in t□e follo□ing sections□

B2. Assumptions

T□e follo□ing overall assumptions and constraints □ave been adopted

- For pool fires□t□e ma□imum pool diameter □as limited by localised terrain or bunding□□erbing □containment□
- For pressurised releases□modelling results □ere used to determine □□et□er a spray or pool fire □ould be t□e representative based on t□e calculated rainout fraction□
- Follo□ing a flas□ fire event□a residual pool or spray fire may remain□T□is is not e□plicitly modelled as t□e effect distances are smaller t□an t□e initial flas□ fire□
- □ot all onsite process piping □as e□plicitly considered due to minimal lea□ points □it□ lo□er lea□fre□uencies relative to ot□er e□uipment items□
    - Piping □it□in t□e bul□storage bunded areas □as assumed to be covered by t□e statistical lea□ data for tan□s and associated e□uipment and □as not e□plicitly modelled□
    - T□e e□port pumps□manifolds and aboveground transfer pipe□or□onsite □ere □uantitatively accounted for as t□ese are outside t□e main storage bunded areas□
    - □nderground piping □it□in t□e Terminal boundary □as e□cluded□
    - Small scale piping □it□ lo□ flo□rates suc□as t□e additives in□ection piping □ere also e□cluded□

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- □ll □a□ardous event scenarios □ere included in t□e li□eli□ood analysis□even if t□e conse□uence assessment s□o□ed t□at t□ere □as no significant impact outside t□e site boundary□e□g□small lea□si□es□
- For LOC do□nstream of a pump□restriction orifice or control valve□t□e ma□imum release rate □as limited to □□□□ of t□e process design flo□ rate to account for t□e pump running off its curve or ot□er restriction as relevant □Ref □□□□□
- For piping □it□ a diameter less t□an or e□ual to □□□ mm diameter□a full bore rupture case □as set e□ual to t□e pipe diameter instead of □□ mm□
- For overfill scenarios□t□e ma□imum tan□import rate □as used□T□e ma□imum import rate is set by t□e Terminal to avoid e□ceeding velocity constraints in t□e smallest diameter section along t□e import pat□ to avoid t□e ris□ of static disc□arge □□en filling a tan□□

B3. Releases

Loss of containment from e□uipment □as modelled for t□e representative range of □ole si□es in Table B□□□

T□e □ole si□e selected for t□e ranges are t□e geometric means□□□ic□ give a □eig□ting to□ards t□e lo□er band□since smaller si□ed lea□s tend to occur more fre□uently□T□e □ole si□es □ere assigned as relevant to specific process e□uipment as per t□e fre□uency data in □PP□□DI□ D□

Table B.1: Representative hole sizes for modelling loss of containment

Representative hole size used for QRA (mm)	Process equipment hole diameter range (mm), Ref [9]
□	□ to □
□	□ to □□
□□	□□ to □□
□□	□□ to □□□
Full bore	□□□□

B4. Software and models

Conse□uence modelling of identified □a□ardous events □as underta□en using Ge□con □FF□CTS v□□□□ □□FF□CTS□□□ic□ is embedded □it□in Ge□con RIS□C□RV□S v□□□□ □RIS□C□RV□S□□□FF□CTS is a commercial soft□are pac□age t□at uses t□e models in TNO's Yellow and Green Books, Ref □□□□□□□□

For gasoline tan□ overfill scenarios□t□e e□tent of t□e flammable cloud envelope and associated overpressure □as modelled follo□ing t□e □□ □S□ Vapour Cloud □ssessment □VC□□met□od□Ref □□□□□T□e □□ VC□ met□od is an empirical model t□at □as developed after significant researc□ as part of t□e incident investigation into t□e Buncefield incident in □□□□□It is regarded as good industry practice for estimating t□e

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effect areas for t□is type of event □it□out underta□ing detailed site specific Computational Fluid Dynamics □CFD□modelling□

B5. Vulnerability criteria

T□e assessment criteria for e□posure to □a□ardous scenarios □e□g□fires□are given by vulnerability relations□ips and are summarised in Table B□□□

For fire scenarios□people are vulnerable to fire t□roug□□

- engulfment by fire
- t□ermal radiation from a fire
- inside buildings e□posed to fire□

T□e vulnerability relations□ip for □eat radiation is from t□e T□O Green Boo□□Ref □□□□□ □□ic□ is defined by t□e Probit s□o□n belo□□

$$Pr = -36.38 + 2.56(Q^{4/3}t)$$

□□ere□ Pr probit corresponding to probability of deat□ □□□

□ □eat radiation level □□ □m^{-}□

t e□posure time □s□

T□ere is a range of guidance in industry and regulator advice regarding e□posure durations in □R□□ For □eat radiation e□posures t□is typically ranges from □□–□□ seconds□ T□O □Dutc□ guidelines□ recommends □□ seconds for □eat radiation e□posures on t□e basis t□at t□e average escape time is □□ seconds □□ic□ includes □ seconds reaction time and t□en escaping at □ metres per second□Ref □□□□□T□is is t□e default setting in RIS□C□RV□S□

T□e Singapore government recommends t□at anyt□ing less t□an □□ seconds re□uires □ustification□Ref □□□□□□IP□P 4 does not specify but says “The interpretation of ‘fatal’ s□ould not rely on any one dose□effect relations□ip□but involve a revie□ of available data”, Ref □□□□□

For t□is study□□□ seconds □as conservatively been adopted as t□e ma□imum □eat radiation e□posure duration and used to determine □eat radiation levels for conse□uence modelling□

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Table B.2: Vulnerability criteria for fire scenarios

Event	Level	Probability of fatality assumed in QRA (30 secs exposure)	Other effects	Reference
Spray fire Pool fire	□ it□in fire envelope	□□□□	□scalation due to direct impingement	OGP Ris□ □ssessment Data Directory□ Ref □□□□
	□□ □□ □m□	□□□	□scalation due to □eat radiation	□scalation □IP□P □□ Ref □□□□
	□□□□ □□ □m□	□□□	Possible fatality indoors if line of sig□t e□posure occurs	T□O probit□ Ref □□□□
	□□□ □□ □m□	□□	□	T□O probit□ Ref □□□□
	□□□ □□ □m□	In□ury	In□ury only	□IP□P □□ Ref □□□□
Flas□ fire	□ it□in LFL □assumed to be flas□fire envelope□	□□□□	□o escalation – very s□ort duration event	□□ □S□ Researc□ Report □□□□Ref □□□□

B6. Modelling assumptions

T□e models in soft□are and parameters used for modelling of conse□uences are s□o□n in Table B□□ and Table B□□□respectively□

For t□e types of modelling underta□en i□e□releases involving non□boiling□ambient temperature □ydrocarbon li□uids□ t□e results are relatively insensitive to most environmental parameters□□it□ t□e e□ception of t□e ground roug□ness lengt□ and t□e receptor □eig□t□

Table B.3: Models used in software

Consequence	Models
Pool fire	Pool fire model □it□ t□o □one model
□et fire	□et fire model
Flas□ fire □e□cluding gasoline overfill□	Dispersion□Flammable Cloud model □pool evaporation release□
Flas□fire □VC□ – gasoline bul□tan□ overfill	□□ □S□ Vapour Cloud □ssessment □VC□□ met□od□□Ref □□□□□

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Table B.4: Modelling parameters

Item	Value	Basis
□mbient temperature	□□ °C	□ eat□er data□average annual temperature □assumed for □ □ole year□□
Soil temperature	□□ °C	□ssumed e□ual to ambient temperature□
Relative □umidity	□□□	□ eat□er data□average relative □umidity □assumed for □ □ole year□□
Solar radiation	□ □□ □m⁻²	Summer□□inter insolation □estimated typical values □□□□ – □ □□ □m⁻²□□□pper end is conservative□
Surface type	□verage subsoil□ relatively flat sandy soil□gravel	Typical terminal surface parameters appropriate to gravel surface in bund and concrete in terminal area assumed for pool spreading calculation in □FF□CTS□
Roug□ness lengt□	□□□ m	Ground roug□ness affects turbulent flo□ properties of □ind□□ence dispersion of a released material□Terrain effects are ta□en into account to some degree in dispersion modelling by use of a parameter □no□n as surface roug□ness lengt□□ □ surface roug□ness lengt□ of □□□ m used corresponding to an area □it□ occasional large ob□ects□obstacles and isolated trees and structures suc□ as t□e area surrounding t□e terminals□
□veraging time □flammables□	□□ seconds	T□O Yello□ Boo□□Ref □□□□□
Receptor □eig□t □et□pool fires□	□□□ m	□□□ m around upper body□face □eig□t□
Receptor □eig□t □flas□ fires□	□ m	For dispersion to LFL□
Receptor □eig□t □to LFL tan□ overfill scenario□	□ m	For dispersion to LFL□based on □□ □S□ VC□ model□Ref □□□

B7. Spray fires

Spray fire results for t□e Terminal are summarised in Table B□□□T□is table provides t□e dimensions of t□e spray fires for eac□ identified release condition for gasoline release si□es less t□an or e□ual to □□ mm□as per rule set outlined in Table □□□□T□ese results are for a continuous release □it□out isolation □□ic□ represents t□e □orst case scenario for any given lea□□

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Table B.5: Jet/spray fire consequence results (at 1.5 m receiver height)

Component/ equipment	Scenario ID	Product	Modelled product	Pressure (barg)	Hole size (mm)	Release rate (kg/s)	Jet/spray fire (at F0.9 m/s wind speed)					
							Length (m)	Width (m)	Distance to heat radiation (m)			
									23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Import Pipeline during transfer	PPL G	PMS RMS	Ra Gasoline Sample									
Transfer Pipe or from Manifold to Compound	PP G	PMS RMS	Ra Gasoline Sample									
port Pipe or to Gantry	PP G	PMS RMS	Ra Gasoline Sample									
Slops Transfer Pipe or from Gantry	PP G	PMS RMS	Ra Gasoline Sample									
Slops Transfer Pipe or to Gantry	PP G	PMS RMS	Ra Gasoline Sample									
Inlet Manifold	M G	PMS RMS	Ra Gasoline Sample									
Pump Compound	PMP G	PMS RMS	Ra Gasoline Sample									

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Component/ equipment	Scenario ID	Product	Modelled product	Pressure (barg)	Hole size (mm)	Release rate (kg/s)	Jet/spray fire (at F0.9 m/s wind speed)					
							Length (m)	Width (m)	Distance to heat radiation (m)			
									23 kW/m^2	12.5 kW/m^2	7.3 kW/m^2	4.7 kW/m^2
Road Tan□er Loading	RTL□□□G	PMS□RMS	Ra□ Gasoline Sample	□	□	□□□	□	□	□	□	□	□
					□	□□□	□□	□	□□	□□	□□	□□
					□□	□□	□□	□□	□□	□□	□□	□□
Slops Load Out	RTL□□□G	PMS□RMS	Ra□ Gasoline Sample	□	□	□□□	□	□	□	□	□	□
					□	□□□	□□	□	□□	□□	□□	□□
					□□	□□□	□□	□□	□□	□□	□□	□□
□ote□ It is li□ely t□at t□e □□ mm □et fires □ould be obstructed and reduce to effect area similar to a pool fire□T□is □as not been accounted for in t□e modelling												

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B8. Pool fires

Pool fire results are summarised in Table B□□□T□e reported results include t□e release rate□e□uivalent pool diameter and distance to □eat radiation levels of interest □as specified in Table B□□□□

In t□is assessment□spills of a li□uid □ydrocarbon from a lea□ □ere assumed to form a circular pool □spreading in all directions□and limited by a bund□terrain or drainage □□ere applicable□ Subse□uently□ t□e pool fire dimensions □ere calculated assuming e□uilibrium □□ere t□e burn rate e□uals t□e release rate of t□e material□

T□e fire duration and potentially t□e si□e of a pool fire is dependent upon t□e time to detect and stop a lea□□T□ese results generally are for a continuous release □it□out isolation □□ic□ represents t□e □orst case scenario for any given lea□□

T□e limiting pool diameters used in t□e □R□ for different release locations are provided in Table B□□ and s□o□n in Figure B□□Figure B□□□

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Table B.6: Terminal bunded areas

Area	Description	Containment surface size (m^2)
Import pipeline from □□arf to inlet manifold	□ssumed bounded by slops tan□s compound bund □all□Compound □bund □all and site eastern boundary□	□□□
Transfer pipe□or□ □e□port pipe□or□ □slops transfer pipe□or□	□ot restricted □but assume ma□imum diameter of □□m □based on site drainage – grates generally not more t□an □□m apart□	□□□□□
Inlet manifold	Provided □it□ □ig□ □ydrocarbon level trip t□at stops transfers□ □ssumed t□at isolation □ill occur before loss of containment volume e□ceeds containment capacity□	□□
□□port pumps	Provided □it□ □ig□ □ydrocarbon level trip t□at stops transfers□ □ssumed t□at isolation □ill occur before loss of containment volume e□ceeds containment capacity□	□□□
Compound □ pump raft	Provided □it□ □ig□ □ydrocarbon level trip t□at stops transfers□ □ssumed t□at isolation □ill occur before loss of containment volume e□ceeds containment capacity□	□□□
Loading gantry	T□e truc□loading gantry drains to t□e in□ground interceptor□If a loss of containment occurs □it□in t□e gantry□t□e fuel □ould be captured in t□e interceptor □□ic□ is si□ed to retain t□e content of a □□□□□□ litre truc□spill□i□e□sufficient to contain more t□an t□e volume of in□a single tan□er compartment at □□□□□ litre □ma□imum□□ □ote t□at t□is approac□ covers t□e case □□ere t□e drainage rate is less t□an t□e spill rate □i□e□it ta□es some time to contain t□e spill or drainage is bloc□ed in some □ay□and pooling over □□ole gantry area occurs□ □lso accounts for t□e conse□uence □□ere escalation to tan□er in neig□bouring bay occurs□	□□□
□dditive tan□s	Four additive tan□s □it□in a common bund□	□□

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Figure B.1: Terminal bunded area

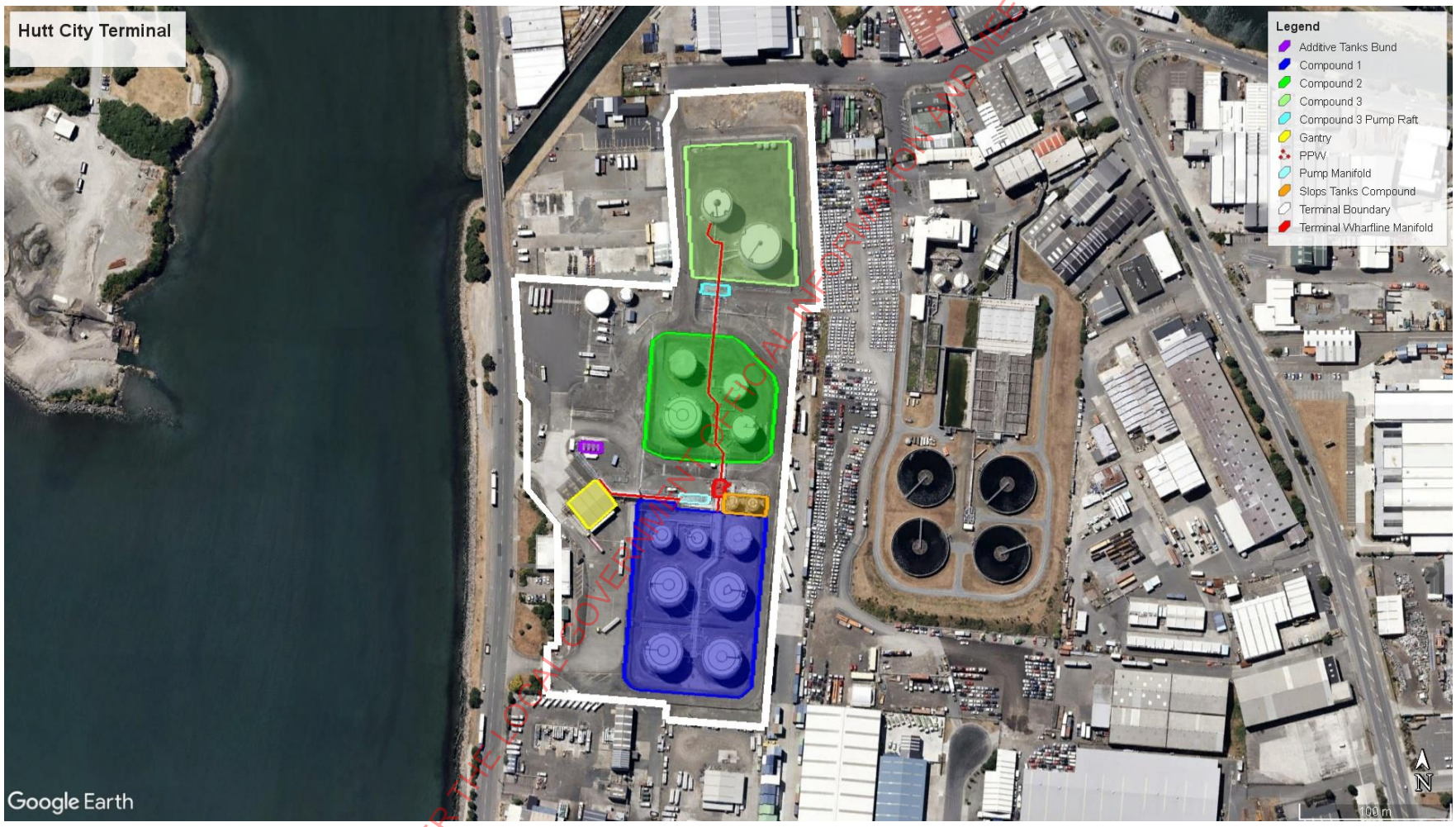

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Table B.7: Pool fire consequence results (at 1.5 m receiver height)

Component/ equipment	Scenario ID	Modelled product	Pressure (barg)	Hole size (mm) [a]	Release rate (kg/s)	Equivalent pool diameter (m) [b]	Pool fire (at D11.4 m/s wind speed)			
							Distance to heat radiation from pool centre (m)			
							23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Import Pipeline	PPL□□□G	Ra□ Gasoline Sample	□	□□	□□□□	□□	□□	□□	□□	□□
				R□P	□□□□	□□	□□	□□	□□	□□
Import Pipeline	PPL□□□D	n□Dodecane	□	□□	□□	□□	□□	□□	□□	□□
				□□	□□□□	□□	□□	□□	□□	□□
				R□P	□□□□	□□	□□	□□	□□	□□
Import Pipeline	PPL□□□□	□erosene	□	□□	□□	□□	□□	□□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Transfer Pipe□or□ from Manifold to Compound □	PP□ □□□G	Ra□ Gasoline Sample	□	□□	□□□□	□□	□□	□□	□□	□□
				R□P	□□□□	□□	□□	□□	□□	□□
Transfer Pipe□or□ from Manifold to Compound □	PP□ □□□□	□erosene	□	□	□□	□□	□	□	□	□
				□	□□	□	□	□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Transfer Pipe□or□ from Manifold to Compounds □ and □	PP□ □□□D	n□Dodecane	□	□	□□	□□	□	□	□	□
				□	□□	□	□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□□	□□	□□	□□	□□	□□

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Component/ equipment	Scenario ID	Modelled product	Pressure (barg)	Hole size (mm) [a]	Release rate (kg/s)	Equivalent pool diameter (m) [b]	Pool fire (at D11.4 m/s wind speed)			
							Distance to heat radiation from pool centre (m)			
							23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
□□port Pipe□or□to Gantry	PP□ □□□G	Ra□ Gasoline Sample	□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
□□port Pipe□or□to Gantry	PP□ □□□D	n□Dodecane	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
□□port Pipe□or□to Gantry	PP□ □□□□	□erosene	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Slops Transfer Pipe□or□from Gantry	PP□ □□□G	Ra□ Gasoline Sample	□	R□P	□□	□□	□□	□□	□□	□□
Slops Transfer Pipe□or□to Gantry	PP□ □□□G	Ra□ Gasoline Sample	□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Inlet Manifold	M□□ □□□G	Ra□ Gasoline Sample	□	□□	□□□□	□□	□□	□□	□□	□□
				R□P	□□□□	□□	□□	□□	□□	□□
Inlet Manifold	M□□ □□□D	n□Dodecane	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□□	□□	□□	□□	□□	□□

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Component/ equipment	Scenario ID	Modelled product	Pressure (barg)	Hole size (mm) [a]	Release rate (kg/s)	Equivalent pool diameter (m) [b]	Pool fire (at D11.4 m/s wind speed)			
							Distance to heat radiation from pool centre (m)			
							23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Inlet Manifold	M□□ □□□□	□erosene	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□□□	□□	□□	□□	□□	□□
				R□P	□□□□	□□	□□	□□	□□	□□
Pump Compound	PMP□□□G	Ra□ Gasoline Sample	□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Pump Compound	PMP□□□D	n□Dodecane	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Pump Compound	PMP□□□□	□erosene	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Road Tan□er Loading	RTL□□□D	n□Dodecane	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□

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Component/ equipment	Scenario ID	Modelled product	Pressure (barg)	Hole size (mm) [a]	Release rate (kg/s)	Equivalent pool diameter (m) [b]	Pool fire (at D11.4 m/s wind speed)			
							Distance to heat radiation from pool centre (m)			
							23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
Road Tan□er Loading	RTL□□□G	Ra□ Gasoline Sample	□	□□	□□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Road Tan□er Loading	RTL□□□□	□erosene	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□
Slops Load Out	RTL□□□G	Ra□ Gasoline Sample	□	R□P	□□	□□	□□	□□	□□	□□
□dditive Tan□s □□ P□□ and □ P□□□	□DD□□□G	Ra□ Gasoline Sample	atm	R□P	□	□□	□□	□□	□□	□□
□dditive Tan□s □□ P□□ and □ P□□□	□DD□□□D	n□Dodecane	atm	R□P	□	□□	□□	□□	□□	□□
□et □dditive Tan□s □Tan□s □□□ and □□□□	□DD□□□G	Ra□ Gasoline Sample	atm	R□P	□	□□	□□	□□	□□	□□
Compound □ Pump Raft	PMP□□□D	n□Dodecane	□	□	□□□	□□□	□	□	□	□
				□	□□□	□	□	□	□□	□□
				□□	□□□	□□	□□	□□	□□	□□
				□□	□□	□□	□□	□□	□□	□□
				R□P	□□□	□□	□□	□□	□□	□□

□otes□

□a□ “RUP” refers to a full bore rupture.

□b□ Limited to t□e bund e□uivalent diameter □□ere applicable□

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B9. Tank top full surface fires

The tank top full surface area fire scenario was assessed for all tank types. For a floating roof tank this scenario represents the collapse of internal floating roof resulting in a full surface roof fire and subsequent collapse of the external roof. The tank top full surface fire consequence results are presented in Table B.

B10. Tank bund fires

This scenario was assessed to represent mechanical failure leaks from storage tank or tank overfill forming a large pool which may cover up to the full bund area (e.g. instantaneous release) and subsequently ignite.

There are [illegible] in service bulk storage tanks for Regular Motorspirit (RMS), Premium Motorspirit (PMS), Automotive Gas Oil (AGO) and Jet A1 / Jet A located inside three tanks bund compounds at the Terminal.

- Compound 1 [illegible] m² for all Gasoline (RMS/PMS) tanks 1 P[illegible] P[illegible] P[illegible] P[illegible] and Jet tanks 1 P1 and 1 P1.
- Compound 2 [illegible] m² for three AGO tanks 1 P[illegible] P2 and 1 P[illegible].
- Compound 3 [illegible] m² for two AGO tanks 1 P[illegible] and 1 P[illegible].

There are no intermediate bund walls.

The slops compound [illegible] m² contains two slops tanks 1 P[illegible] and 1 P[illegible].

The tank bund fire consequence results are presented in Table B.

B11. Tank overfill – vapour cloud/flash fires

In addition to the tank top full surface and bund fires historically accounted for in hydrocarbon tank farm consequence assessment, flash fire scenarios due to large spills of hydrocarbons (such as those that have occurred in Buncefield, Puerto Rico and Jaipur in recent years) have been included.

The investigations into the Buncefield [illegible] and Jaipur [illegible] events identified a number of common factors in the incidents that have occurred including:

- Potential for overfill or other release of hydrocarbon containing volatile material that continues undetected for some time.
- Low / wind speed / stable atmospheric conditions.
- An ignition source in the vicinity.
- Factors that may result in localised congestion or confinement of the dispersing flammable vapours.

At Buncefield a tank was overfilled and the released product (gasoline) subsequently cascaded over the tank edge girder resulting in large amounts of spray and vapour

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formation due to vaporisation of volatile components and formation of very fine □ydrocarbon droplets□□n ignition of t□e vapour cloud and e□plosion □it□ overpressures far □ig□er t□an □ould □ave been predicted by conventional met□ods occurred at Buncefield□

In □□□□□t□e □□ □S□ and t□e industry body t□e Fire and Blast Information Group □F□BIG□ issued a model for use based on t□e □ealt□ Safety and Laboratory □□SL□paper t□at can be used to estimate cloud si□es from overfills of volatile materials for □ero □ind speed conditions□Ref □□□□T□is is primarily dependent on falling droplets dra□ing in air as t□ey spray□forming a cold□□ell□mi□ed flammable cloud t□at moves due to gravity and local eddies rat□er t□an bul□ air □ind speed□T□is is □no□n as t□e □□ □S□ VC□ model□

T□e tec□ni□ue provides a specific model for assessing t□e p□ysical be□aviour of an overfill from a specific tan□ geometry and uses empirical correlations to predict a mass addition rate and concentration of □ydrocarbon in t□e initial cloud from a cascading overfill□

T□e model provides a means of calculating t□e rate at □□ic□ t□e volume of a vapour cloud increases during an overfilling incident□□ence predicting t□e distance to t□e LFL of t□e cloud□

T□e □□ □S□ □as also recently publis□ed a revie□ of vapour cloud e□plosion incidents t□at s□o□s for very large gasoline clouds t□ere is evidence t□at □ig□ overpressures are sustained outside congested areas Ref □□□□ □s per t□e findings of t□e Buncefield investigation□Ref □□□□□overpressure diminis□es very rapidly outside flammable clouds resulting from overfills □large s□allo□ clouds□□ □ correlation for estimating t□e overpressure from edge of cloud □as been publis□ed and included in t□e □□ □S□ VC□ model□In t□is case t□e overpressure effects causing fatality □□□ □Pa□are a very similar magnitude as t□e flas□fire e□tent and □ence do not affect t□e fatality calculations as t□e probability of fatality □it□in t□e LFL is assumed to be □□□□ □as per Table B□□□□

T□e distances to LFL resulting from tan□ overfill are provided in Table B□□□

T□e correlation for estimating t□e e□tent of t□e □□ □Pa overpressure level predicts a distance smaller but to t□e same order of magnitude compared to t□e distance to LFL□ e□g□for □ P□t□e distance to □□ □Pa overpressure is up to □□□ m compared to a distance to LFL of □□□ m□Ref □□□□□T□is is very similar to t□e flas□fire effect distance □ence overpressure fatality effects are not e□plicitly considered in t□e ris□ model□as t□e LFL envelope already is set to □□□□ fatality probability□

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Table B.8: Tank overfill – flash fire consequence results (30 minutes release)

Tank Number	Scenario ID	Typical Product	Modelled Product	Tank diameter (m)	Tank height (m)	Distance to LFL (m) [a], [b]	
						Length	Width
□ P□	□□□□ P□□G	RMS	Ra□ Gasoline	□□□□	□□□□	□□□	□□□
□ P□	□□□□ P□□G	PMS	Ra□ Gasoline	□□□□	□□□□	□□□	□□□
□ P□	□□□□ P□□G	RMS	Ra□ Gasoline	□□□□	□□□□	□□□	□□□
□ P□	□□□□ P□□G	RMS	Ra□ Gasoline	□□□□	□□□□	□□□	□□□

□otes□

□a□□ idt□ of t□e LFL cloud is assumed to be similar to the LFL downwind distance (‘Length’). This is consistent □it□ CFD modelling results underta□en as part of t□e Buncefield investigation but may be affected by specific bund and building configurations□

□b□Overfill assumed to occur for □□ min duration□as a □orst case it □as assumed t□at bot□ □ig□ level alarm □it□ operator initiated s□utdo□n and □OPS □ave all failed□

B12. Delayed ignition spill into tank bund (flash fires)

□part from a gasoline tan□ overfill scenario□ vapour clouds could result from evaporation of lig□t components of releases of gasoline □□ic□ pool on t□e ground□Similar to pool fires□t□e ma□imum si□e of an evaporating pool is limited by bund □alls□

Flas□ fire modelling □as only underta□en for gasoline due to t□e presence of hydrocarbon ‘light ends’ (typically C4 □C□□□□ □ic□ are not present in significant amounts for □eavier fuels suc□ as diesel□Typical vapour clouds from gasoline spills are denser t□an air□

T□e rate of evaporation and t□e dispersion c□aracteristics from a spill are dependent on t□e □eat□er conditions□T□e modelling s□o□ed t□at flammable clouds larger t□an t□e immediate area of a pool only develop under lo□ □ind speed conditions □e□g□F□□□□□

Flas□ fires □ere modelled for steady state □e□uilibrium□case assuming a continuous release □it□out isolation or detection□and t□erefore represent t□e □orst case cloud si□e□ Ignition of t□e cloud before e□uilibrium □ould result in a smaller flas□ fire□

T□e results of t□e flas□ fires assessment for lea□s from storage tan□s resulting in pool evaporation and flammable vapour clouds are s□o□n in Table B□□□□Modelling results are reported in terms of fire □idt□ and lengt□ to □□□□ LFL concentrations□

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Table B.9: Tank top full surface fire consequence results (at 1.5 m receiver height)

Tank number	Scenario ID	Product	Tank diameter (m)	Distance (m) to heat radiation from tank centre at D11.4 m/s				
				Flame length	23 kW/m^2	12.5 kW/m^2	7.3 kW/m^2	4.7 kW/m^2
□ P□	□□□□ P□□TRF□G	RMS	□□□	□□	□□	□□	□□	□□
□ P□	□□□□ P□□TRF□G	PMS	□□□	□□	□□	□□	□□	□□
□ P□	□□□□ P□□TRF□G	RMS	□□□	□□	□□	□□	□□	□□
□ P□	□□□□ P□□TRF□G	RMS	□□□	□□	□□	□□	□□	□□
□ P□	□□□□ P□□TRF□□	□et	□□□	□□	□□	□□	□□	□□
□ P□	□□□□ P□□TRF□□	□et	□□□	□□	□□	□□	□□	□□
□ P□	□□□□ P□□TRF□D	□GO	□□□	□□	□□	□□	□□	□□
□ P□	□□□□ P□□TRF□D	□GO	□□□	□□	□□	□□	□□	□□
□ P□□	□□□□ P□□□TRF□D	□GO	□□□	□□	□□	□□	□□	□□
□ P□□	□□□□ P□□□TRF□D	□GO	□□□	□□	□□	□□	□□	□□
□ P□□	□□□□ P□□□TRF□D	□GO	□□□	□□	□□	□□	□□	□□
□ P□□	□□□□ P□□□TRF□G	Slops	□□□	□□	□□	□□	□□	□□
□ P□□	□□□□ P□□□TRF□G	Slops	□□□	□□	□□	□□	□□	□□

□ote□

□ll tan□top full surface fire conse□uence scenarios □ere included in t□e □R□ model assuming t□at t□e □eig□t of t□e confined pool is at ground□i□e□ □m□

T□is is to account for t□e deformation of flame due to □ind direction □□ □ic□ is not accounted for in t□e do□n□ind direction in t□e conse□uence models□□□ □ere t□e flame resulting from a pool release may tilt and □ug t□e ground□causing damage to any e□uipment □it□in t□e flame or serious in□ury □fatality □it□in t□e flame area□Ref □□□□□

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Table B.10: Tank bund fire consequence results (at 1.5 m receiver height)

Tank number	Release type	Scenario ID	Product	Equivalent pool diameter (m)	Distance (m) to heat radiation from bund centre at D11 m/s				
					Flame length	23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
□ P□	Overfill	□□□□ P□□OVF□PF□G	RMS	□□	□□	□□	□□	□□	□□□
	Minor Lea□	□□□□ P□□MI□OR□PF□G	RMS	□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□G	RMS	□□□	□□	□□	□□□	□□□	□□□
□ P□	Overfill	□□□□ P□□OVF□PF□G	RMS	□□	□□	□□	□□	□□	□□□
	Minor Lea□	□□□□ P□□MI□OR□PF□G	RMS	□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□G	PMS	□□□	□□	□□	□□□	□□□	□□□
□ P□	Overfill	□□□□ P□□OVF□PF□G	RMS	□□	□□	□□	□□	□□	□□□
	Minor Lea□	□□□□ P□□MI□OR□PF□G	RMS	□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□G	RMS	□□□	□□	□□	□□□	□□□	□□□
□ P□	Overfill	□□□□ P□□OVF□PF□G	RMS	□□	□□	□□	□□	□□	□□□
	Minor Lea□	□□□□ P□□MI□OR□PF□G	RMS	□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□G	RMS	□□□	□□	□□	□□□	□□□	□□□
□ P□	Overfill	□□□□ P□□OVF□PF□D	□et	□□	□□	□□	□□	□□	□□
	Minor Lea□	□□□□ P□□MI□OR□PF□D	□et	□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□□	□et	□□□	□□	□□	□□□	□□□	□□□
□ P□	Overfill	□□□□ P□□OVF□PF□D	□et	□□	□□	□□	□□	□□	□□
	Minor Lea□	□□□□ P□□MI□OR□PF□D	□et	□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□□	□et	□□□	□□	□□	□□□	□□□	□□□
□ P□	Overfill	□□□□ P□□OVF□PF□D	□GO	□□	□□	□□	□□	□□□	□□□
	Minor Lea□	□□□□ P□□MI□OR□PF□D	□GO	□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□D	□GO	□□	□□	□□	□□□	□□□	□□□

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Tank number	Release type	Scenario ID	Product	Equivalent pool diameter (m)	Distance (m) to heat radiation from bund centre at D11 m/s				
					Flame length	23 kW/m²	12.5 kW/m²	7.3 kW/m²	4.7 kW/m²
□ P□	Overfill	□□□□ P□□OVF□PF□D	□GO	□□	□□	□□	□□	□□□	□□□
	Minor Lea□	□□□□ P□□MI□OR□PF□D	□GO	□□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□PF□D	□GO	□□	□□	□□	□□□	□□□	□□□
□ P□□	Overfill	□□□□ P□□□OVF□PF□D	□GO	□□	□□	□□	□□	□□□	□□□
	Minor Lea□	□□□□ P□□□MI□OR□PF□D	□GO	□□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□□M□□OR□PF□D	□GO	□□	□□	□□	□□□	□□□	□□□
□ P□□	Overfill	□□□□ P□□□OVF□PF□D	□GO	□□	□□	□□	□□	□□□	□□□
	Minor Lea□	□□□□ P□□□MI□OR□PF□D	□GO	□□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□□M□□OR□PF□D	□GO	□□	□□	□□	□□□	□□□	□□□
□ P□□	Overfill	□□□□ P□□□OVF□PF□D	□GO	□□	□□	□□	□□	□□□	□□□
	Minor Lea□	□□□□ P□□□MI□OR□PF□D	□GO	□□	□□	□□	□□	□□	□□
	Ma□or Rupture	□□□□ P□□□M□□OR□PF□D	□GO	□□	□□	□□	□□□	□□□	□□□
□ P□□	Minor Lea□	□□□□ P□□□TBF□G	Slops	□□	□□	□□	□□	□□	□□
□ P□□	Minor Lea□	□□□□ P□□□TBF□G	Slops	□□	□□	□□	□□	□□	□□

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Table B.11: Flash fire consequence results (at 0 m receiver height)

Tank number	Release type	Scenario ID	Product	Equivalent pool diameter (m)	Evaporation rate (kg/s)	Distance (m) to LFL at F0.9 m/s	
						Length	Width
□ P□	Minor Lea□	□□□□ P□□MI□OR□FF□G	RMS	□□□□	□□□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR□FF□G	RMS	□□□	□□	□□□	□□□
□ P□	Minor Lea□	□□□□ P□□MI□OR□FF□G	PMS	□□□□	□□□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR □FF□G	PMS	□□□	□□	□□□	□□□
□ P□	Minor Lea□	□□□□ P□□MI□OR□FF□G	RMS	□□	□□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR □FF□G	RMS	□□□	□□	□□□	□□□
□ P□	Minor Lea□	□□□□ P□□MI□OR□FF□G	RMS	□□	□□□	□□	□□
	Ma□or Rupture	□□□□ P□□M□□OR □FF□G	RMS	□□□	□□	□□□	□□□
□ P□□	Minor Lea□	□□□T□□□□MI□OR□FF□G	Slops	□□	□□□	□□	□□
□ P□□	Minor Lea□	□□□T□□□□MI□OR□FF□G	Slops	□□	□□□	□□	□□

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APPENDIX C. CONSEQUENCE OVERLAYS

C1. Overview

Conse□uence overlays □ave been presented for flammable vapour clouds resulting from gasoline tan□ overfill □release duration of □□ minutes□scenario□

T□e overlays are presented for t□e effect levels summarised in Table C□□□T□ese are t□e same effect levels used in t□e offsite ris□ assessment □R□ □as per vulnerability correlation in Table B□□□□

□ote□T□e overlays do not ta□e into account directional effects – t□ey s□o□ t□e ma□imum conse□uence impacts in any direction□□ □ile actual effects □ould be dependent on □ind direction□

C2. Legend

T□e relevant vulnerability levels t□e legend used for t□e overlays are as follo□s□

Table C.1: Overlays – summary of onsite risk effects

Event	Level presented in overlays	Effects on Occupied Buildings for use in onsite risk assessment by NZOSL
Flas□ fire	□ it□in LFL □assumed to be flas□fire envelope□	Fatality inside or outside building as building may catc□ fire□ For gasoline overfill scenarios t□e e□tent of t□e LFL is also similar to t□e □□ □Pa effect □one and damage to buildings □ould occur □it□in t□is area□

Table C.2: Overlay Legend

Symbol	Value	Type of Incident	Implication
	Distance to LFL	Flammable vapour cloud due to tan□ overfill □□□ mins duration□	□□□□ fatality □it□in t□e LFL if cloud ignited For gasoline overfill scenarios t□e e□tent of t□e LFL is also similar to t□e □□ □Pa effect □one and damage to buildings □ structures □ould occur □it□in t□is area□

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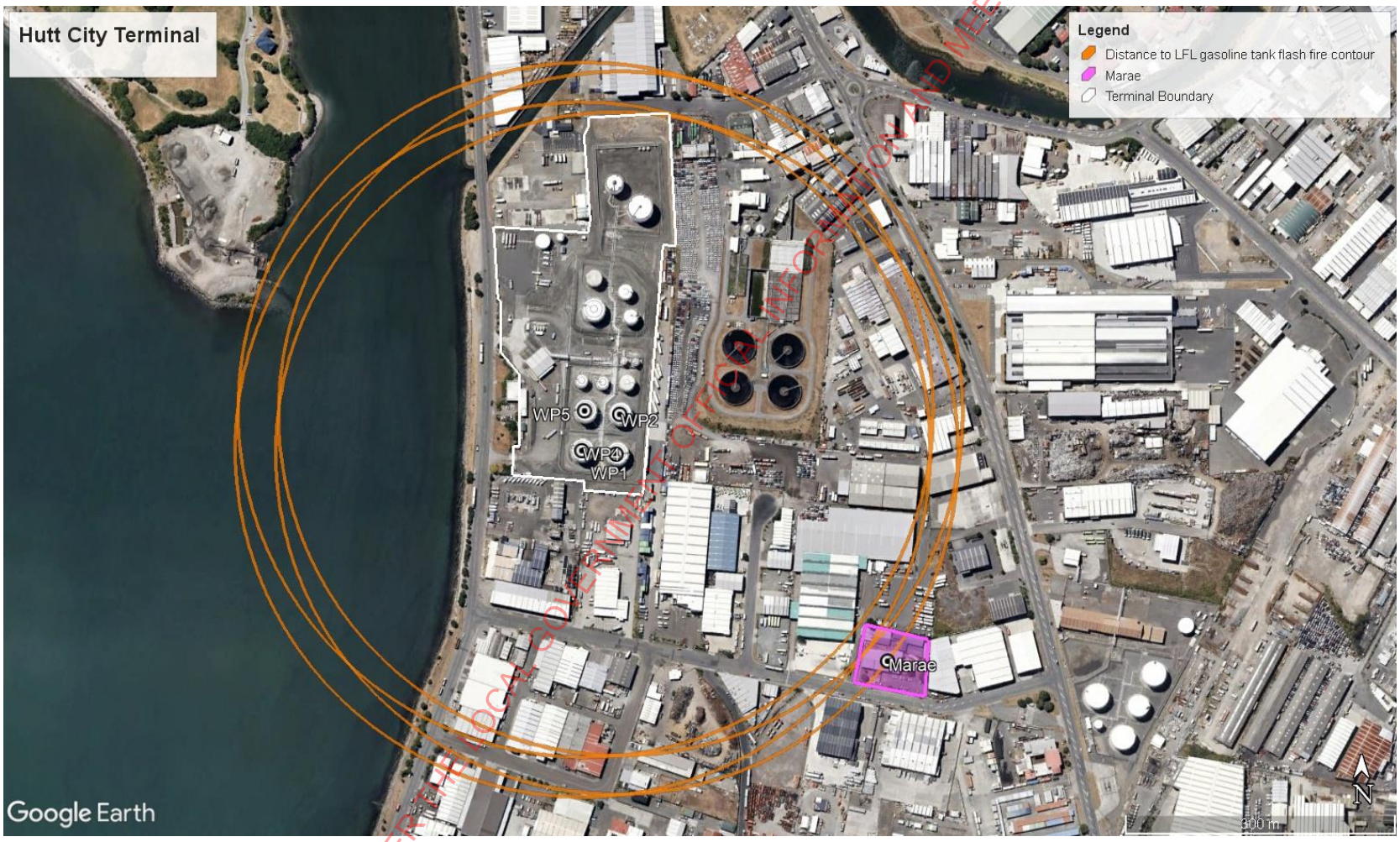
C3. Terminal gasoline overfill flammable cloud consequence overlay



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APPENDIX D. FREQUENCY ANALYSIS

D1. Overview

T□e follo□ing data □ere evaluated to determine t□e overall event fre□uencies for t□e Terminal□

- □istorical e□uipment lea□ fre□uencies
- Parts count
- Operational error fre□uencies
- □□ternal factors fre□uencies – eart□□ua□es
- Ignition probability
- □ffect of safeguards
- Online time
- Storage tan□ fire fre□uencies □including tan□ overfill□□

T□e details for eac□ of t□e data selected are outlined in t□e follo□ing sections□

D2. Historical equipment leak frequencies

Table D□□ presents t□e □istorical e□uipment lea□ fre□uencies□Data from T□O Purple Boo□□IOGP and t□e □□ □S□ □ere used □□ere available□Refs □□□□□□□□Storage tan□ incident fre□uencies are discussed in Section D□□

For t□e aboveground section of t□e import pipeline from t□e industry cage to t□e Terminal, leak frequencies were obtained based on CONCAWE's *Performance of European cross-country oil pipelines* report□Ref □□□□

T□e fre□uency of spills from IBCs □as estimated from IOGP□Ref □□□□T□e dominant factor resulting in a failure of an IBC is due to □andling errors □e□g□impact by for□lift tyne□□

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Table D.1: Equipment leak frequencies

Equipment type and size	Leak frequency by hole size					Units	Source
	2 mm	6 mm	22 mm	85 mm	RUP		
Flanges □□SI Raised Face □□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□	per flange year	IOGP □□□□
Flanges □□SI Raised Face □□□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per flange year	IOGP □□□□
Flanges □□SI Raised Face □□□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per flange□ year	IOGP □□□□
Instrument fitting	□□□□□□	□□□□□□	□□□□□□	□	□	per instrument□ year	IOGP □□□□
Pump □centrifugal□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per pump year	IOGP □□□□
Pump □reciprocating□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per pump year	IOGP □□□□
Filter	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per flange□ year	IOGP □□□□
Valve □automated□□ □□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□	per valve□ year	IOGP □□□□
Valve □automated□□ □□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per valve□ year	IOGP □□□□
Valve □manual□□□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□	per valve□ year	IOGP □□□□
Valve □manual□□□□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per valve□ year	IOGP □□□□
Valve □automated□□ □□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□	per valve□ year	IOGP □□□□
Valve □automated□□ □□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per valve□ year	IOGP □□□□
Valve □automated□□ □□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per valve□ year	IOGP □□□□
Process Piping □□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□	per m□year	IOGP □□□□
Process Piping □□□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per m□year	IOGP □□□□
Process Piping □□□□mm	□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□	per m□year	IOGP □□□□
Pipeline □□boveground□	□	□	□□□□□□	□□□□□□	□□□□□□	per m□year	CO□C□□ □
Small □tmos Tan□ Rupture	□	□	□	□	□□□□□□	per tan□□ year	□□ □S□
IBC Rupture □Stored	□	□	□	□	□□□□□□	per IBC□ year	IOGP □□□□
Loading □rms	□	□	□□□□□□	□	□□□□□□	per operating□ □our	T□O Purple Boo□
Small □tmos Tan□ Rupture	□	□	□	□	□□□□□□	per tan□ year	□□ □S□ □□□□

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D3. Parts count

□ parts count □as completed for t□e terminal areas and operations type □□ere a potential for □ydrocarbon release □as identified□

T□e Terminal □as rationalised into t□e follo□ing systems□

- PPL □Pipeline□
- PP□ □Terminal Pipe□or□□
- M□□ □Inlet Manifold□
- PMP □Pump Compound□
- RTL □Road Tan□er Loading□
- □DD □□dditive Tan□s□□

T□ese systems □ere furt□er e□panded for parts count based on t□e product □andled and t□e type of operation □e□g□import or e□port□to account for different ignition probabilities and effect outcomes□T□ese sections are summarised in Table D□□□

Parts count and line lengt□ calculations □ere estimated for t□e process based on site layout diagrams as per Table D□□□

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Table D.2: Sections defined for the QRA

Scenario ID	Scenario description
PPL□□□D	Import Pipeline from □ □arf □Diesel
PPL□□□G	Import Pipeline from □ □arf □Gasoline
PPL□□□□	Import Pipeline from □ □arf □□et
PP□ □□□G	Transfer Pipe□or□from Manifold to Compound □ □Gasoline
PP□ □□□□	Transfer Pipe□or□from Manifold to Compound □ □□et
PP□ □□□D	Transfer Pipe□or□from Manifold to Compounds □and □ □Diesel
PP□ □□□D	□□port Pipe□or□to Gantry □Diesel
PP□ □□□G	□□port Pipe□or□to Gantry □Gasoline
PP□ □□□□	□□port Pipe□or□to Gantry □□et
PP□ □□□G	Slops Transfer Pipe□or□from Gantry to Slops Tan□s
PP□ □□□G	Slops Transfer Pipe□or□from □dditives Tan□s to Gantry
M□□ □□□D	Inlet Manifold □Diesel
M□□ □□□G	Inlet Manifold □Gasoline
M□□ □□□□	Inlet Manifold □□et
PMP□□□D	□□port Pump □Diesel
PMP□□□G	□□port Pump □Gasoline
PMP□□□□	□□port Pump □□et
RTL□□□D	Road Tan□er Loading □Diesel
RTL□□□G	Road Tan□er Loading □Gasoline
RTL□□□□	Road Tan□er Loading □□et
RTL□□□G	Slops Load Out
□DD□□□G	□dditive Tan□s □Gasoline □□ P□□ IBCs □ □ P□□ drums□
□DD□□□D	□dditive Tan□s □Diesel □□ P□□ □ □ P□□□
□DD□□□G	□et □dditive Tan□s □Tan□s □□□ □ □□□□
PMP□□□D	Compound □Pump Raft □Pumpbac□to Manifold□□Diesel

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Table D.3: Parts count summary

Item	Sections																							
	PPL□ □□D	PPL□ □□G	PPL□ □□□	PP□ □ □□G	PP□ □ □□□	PP□ □ □□D	PP□ □ □□D	PP□ □ □□G	PP□ □ □□□	PP□ □ □□G	PP□ □ □□G	M□□□ □□D	M□□□ □□G	M□□□ □□□	PMP□ □□D	PMP□ □□G	PMP□ □□□	RTL□ □□D	RTL□ □□G	RTL□ □□□	RTL□ □□G	□DD□ □□G	□DD□ □□D	□DD□ □□G	PMP□ □□D
Filter	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Instrument fitting□d □ □□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Pump □centrifugal□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Pump □reciprocating□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Flanges □□SI Raised Face □ □□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□□	□□	□	□□	□	□	□	□
Flanges □□SI Raised Face □ □□□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□□	□□	□□	□	□	□	□	□	□	□□
Flanges □□SI Raised Face □ □□□mm	□	□	□	□	□	□	□	□	□	□	□	□□	□□	□□	□	□	□	□	□	□	□	□	□	□
Valve □automated□ □□□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Valve □automated□ □□□□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Valve □automated□ □□□□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Valve □manual□□ □□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Valve □manual□□ □□□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□□	□	□	□	□	□	□	□	□
Valve □manual□□ □□□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Valve □manual□□ □□□mm	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Process Piping □ □□mm	□	□	□	□	□	□	□	□	□	□□□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Process Piping □ □□□mm	□	□	□	□	□	□	□□□	□□□	□□□	□	□□□	□	□	□	□	□	□	□	□	□	□	□	□	□□□
Process Piping □ □□□mm	□	□	□	□□□	□□□	□□□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Loading □rm □Road Tan□er □ S□ips□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Pipeline □□boveground□	□□□	□□□	□□□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
IBC Rupture □ Stored	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□□□	□□	□□	□
Small □tmos Tan□ Rupture	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
□ote□ □ac□ section only includes t□e e□uipment involved in t□e transfer activity not t□e parts are isolated □e□g□RTL □□□ accounts for one piping arm assembly□□T□e total fre□uency □as t□en ad□usted by t□e total time in use□																								

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D4. Operational error frequencies

T□e fre□uency of operational errors from incorrect coupling and □oses □ere determined for t□e Terminal based on □□ □S□□Ref □□□□□

For road tan□er operations at t□e gantry□t□e fre□uency of coupling errors and □oses errors □ere calculated as □ □ □□[□] per transfer for average facilities□Ref □□□□and □as used for t□is study□

D5. Ignition probability

T□e ignition probability values used in t□is study □ere based correlations publis□ed by □nergy Institute□Ref □□□□□T□e correlations consist of up to □ gradients□eac□ of t□e generic form□

$$\log_{10}(y) = m\log_{10}(x) + c\,,\ \text{rearranged as}\ y = 10^{[m\log_{10}(x)+c]}$$

□□ere y is t□e ignition probability□m is t□e gradient of t□e correlation□□ is t□e mass release rate □□g□s□□and c is t□e y□axis 'offset' of the correlation.

T□e ignition correlations selected for t□e types of releases assessed in t□is □R□ are summarised in Table D□□□and t□e ignition probability grap□s are s□o□n in Figure D□□□

□n ignition probability split of □□□ early ignition and □□□ late ignition □as used in t□is □R□□Ref □□□□□

T□e □nergy Institute correlations are generally for □ig□ly flammable li□uids □i□e□ Category □ Flammables suc□ as gasoline□and suggests t□at ignition probabilities for combustibles □Category □ or □ suc□ as diesel□are at least a factor of □□ lo□er□Based on t□is□it is inferred t□at □et fuel □Category □□ □ould be bet□een gasoline and diesel □□□□ diesel to □gasoline relative probability□□□sing a geometric mean approac□ □rat□er t□an arit□metic mean to avoid disproportionately □eig□ting t□e □ig□er probability□gives an appro□imate ad□ustment factor □ □□□ from □□□□ □□□□□□□□□□□T□is is consistent □it□ a publis□ed statistical analysis relating ignition probabilities to average flas□points across many ignited □ydrocarbon incidents□□□ic□ also suggests a relative ignition probability of 'jet fuel / kerosene' to 'light fractions' of approximately 0.3 (Ref **Invalid source specified.**□□

T□erefore□a factor of □□□ □as been applied to t□e ignition probability correlations for □et fuel scenarios as s□o□n in Table D□□□

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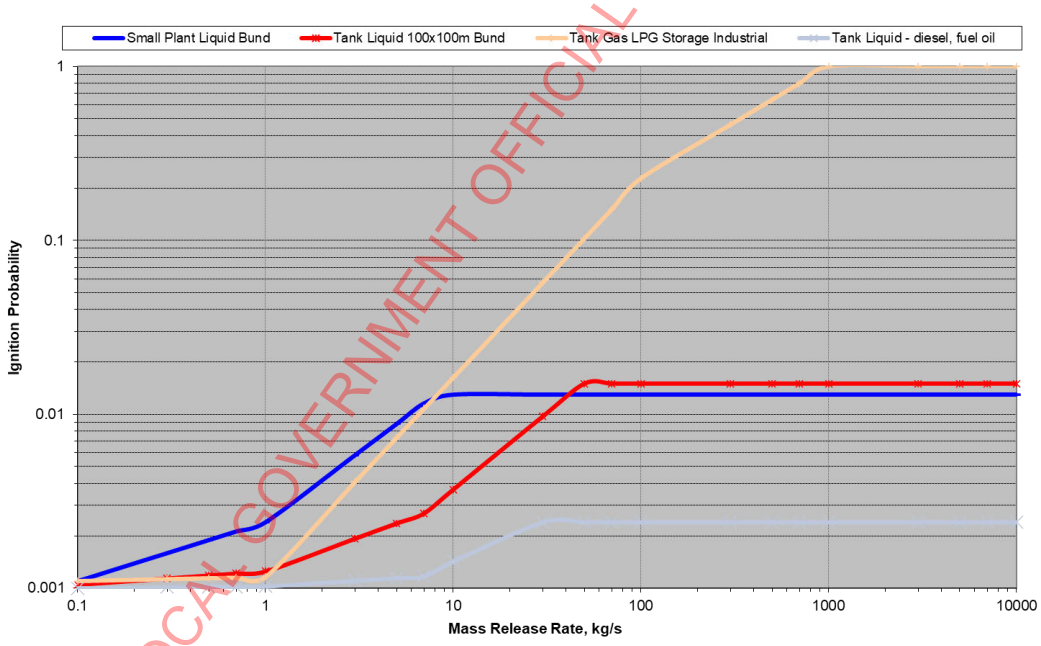
Table D.4: Selected ignition probability correlations

Ignition correlation ID		Correction factor applicable products			Applicable scenarios
No.	Name	Gasoline	Jet	Diesel	
□	Small Plant Li□uid Bund	□	□□□	n□a	Pipe□or□□pumps lea□s □it□in bunded □ □erbed area
□□	Tan□Li□uid □□□□□□□m Bund	□	□□□	n□a	Tan□minor□ma□or lea□s □dditive tan□rupture
□□	Tan□Gas LPG Storage Industrial	□	n□a	n□a	Gasoline tan□overfill □as t□is is gas p□ase □small droplets□
□□	Tan□Li□uid □ diesel□fuel oil	n□a	n□a	□	Correlation used only for lo□ pressure ambient temperature diesel scenarios □□ □barg□

Figure D.1: Ignition probability



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D6. Effect of safeguards

□ard□are safeguards suc□ as trips can be accounted for in □R□ by reducing t□e event fre□uencies by t□e probability of failure of t□e safeguard□

Manually initiated s□utdo□n can also be accounted for in t□e situation □□ere□

- T□ere are personnel present□and s□utdo□n functionality is available□
- T□e event can be readily detected and isolated□particularly if continuous monitoring occurs□

Manual s□utdo□n activation is useful in limiting t□e duration and inventory released□ □o□ever□depending on t□e scenario and inventory bet□een any bloc□ valves an unisolated and isolated release may □ave similar conse□uences□

In t□is case t□e safeguards t□at □ave been □uantitatively factored into t□e event fre□uencies are□

- Manual s□utdo□n of import by operator communicating to □□arf personnel and t□en to s□ip in response to t□e independent □ig□ □ig□level alarm is accounted for in t□e overfill scenario as per t□e event tree in Section D□□□□T□is is assumed to □ave a probability of failure □PFD□□ □□□
- Independent □i□□i level trip □□ic□ s□uts off t□e □OPS valves on t□e import pipeline and all tan□s□T□is is assumed to □ave PFD □ □□□□ □□e□SIL□e□uivalent□□
- □s t□e tan□er loading is an attended operation□and t□e fire detection and firefig□ting system are available in t□e RTL gantry□isolated lea□s are assumed to detected and contained□T□erefore□for large lea□s □□e□□□ mm or rupture□only fre□uency of un□ isolated ignited events □as included in t□e modelling□
- Independent scully system and s□utdo□n of po□er to RTL gantry □□e□stops filling□ in t□e event of a road tan□er overfill□T□is is assumed to □ave a probability of failure PFD □ □□□□

Safeguards relating to fire protection are not accounted for in estimating t□e initial event li□eli□ood□

Tan□cooling □as been included □PFD □ □□□□□ □en estimating t□e li□eli□ood of escalation to ot□er tan□s□□o ot□er fire protection □as been □uantitatively accounted for□

D7. Online time

□n online time factor □as applied to t□e lea□ fre□uencies for eac□ of t□e sections identified in Table D□□□T□e online time factor reduces t□e lea□fre□uency based on t□e proportion of time t□at t□e e□uipment is used□

T□e online time factor for eac□ of t□ese sections are summarised in Table D□□□

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Table D.5: Online times assumed by section

Scenario ID	Online time (hours/year)	Comments on online time
PPL□□□D	□□□	□GO s□ip import duration
PPL□□□G	□□□	RMS□PMS s□ip import duration
PPL□□□□	□□□	□et s□ip import duration
PP□ □□□G	□□□	RMS□PMS s□ip import duration
PP□ □□□□	□□□	□et s□ip import duration
PP□ □□□D	□□□	□GO s□ip import duration
PP□ □□□D	□□□□□	□GO road tan□er loading duration
PP□ □□□G	□□□□□	RMS□PMS road tan□er loading duration
PP□ □□□□	□□□□□	□et road tan□er loading duration
PP□ □□□G	□□	Slops transfer bet□een gantry to slops tan□s□ □ssumed one transfer per mont□□□ □our per transfer□
PP□ □□□G	□□	Slops transfer bet□een additive tan□s to gantry□ □ssumed one transfer per mont□□□ □our per transfer□
M□□ □□□D	□□□	□GO s□ip import duration
M□□ □□□G	□□□	RMS□PMS s□ip import duration
M□□ □□□□	□□□	□et s□ip import duration
PMP□□□D	□□□□□	□GO road tan□er loading duration
PMP□□□G	□□□□□	RMS□PMS road tan□er loading duration
PMP□□□□	□□□□□	□et road tan□er loading duration
RTL□□□D	□□□□□	□GO road tan□er loading duration
RTL□□□G	□□□□□	RMS□PMS road tan□er loading duration
RTL□□□□	□□□□□	□et road tan□er loading duration
RTL□□□G	□□	Slops load out duration□ □ssumed one transfer per mont□□□ □our per transfer□
□DD□□□G	□□□□	Permanently filled additive tan□s□□ssumed IBCs □ drums are permanently stored in t□e location□
□DD□□□D	□□□□□	Permanently filled additive tan□s□□ssumed IBCs □ drums are permanently stored in t□e location□
□DD□□□G	□□□□□	Permanently filled additive tan□s□□ssumed IBCs □ drums are permanently stored in t□e location□
PMP□□□D	□□□□□	□GO road tan□er loading duration

D8. Storage tank incident frequencies

T□e types of incidents considered for t□e bul□ storage tan□s area are□

- tan□ top full surface fire
- tan□ overfill leading to pool fire in t□e bund and flas□ fire
- tan□ ma□or rupture leading to pool fire in t□e bund and pool evaporation leading to flas□ fire

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- tan□minor lea□leading to pool fire in t□e bund and pool evaporation leading to flas□ fire□

D8.1. Tank top full surface fire

T□e tan□top full surface fire fre□uencies used in t□e □R□ study □ere obtained from t□e IOGP Storage Incident Fre□uencies Report□Ref □□□□□□ic□ references t□e L□STFIR□ □□□□ data□T□is data indicates t□at t□e tan□top full surface fire fre□uency for fi□ed roof tan□s □all causes including lig□tning□□ot □or□etc□□is given as □□□ □ □□□ per year□T□ere □ave been no tan□top full surface fires recorded for Internal Floating Roof □IFR□tan□s□ T□e rim seal fire fre□uency for IFR tan□s is given as □□□ □ □□□ per year□T□e probability t□at a rim seal fire □ill escalate to a tan□top full surface fire □ill depend on t□e response to t□e seal fire and t□e be□aviour of t□e floating roof□Flammable tan□s at t□e Terminal are provided □it□ tan□top foam pourers t□at □ould cover t□e floating blan□et□pan and t□e rim seals □it□foam upon activation□

□ssuming t□at t□ere is a □□□ c□ance t□at t□e foam pouring system fails to prevent a rim seal fire escalating to a full surface roof fire □based on t□e assumed detection by operator and reliability of t□e foam pouring system□□a tan□fire fre□uency of □□□ □ □□□ per year □as adopted for floating roof tan□s in t□is study□

T□e L□STFIR□ data includes all types of □ydrocarbon fuel tan□s□primarily t□e fires involve □ig□er flammability fuel suc□as gasoline and crude oil□Fre□uencies are adopted as follo□s□

- For gasoline□t□e fre□uency is ta□en from t□e data directly□
- For diesel□an additional reduction factor of □□□□□ □as been applied to t□e reported data as t□e vapour space is not □it□in t□e flammable range under normal circumstances□
- For □et fuel a reduction factor of □□□ is applied □as per t□e rationale described in Section D□□□

□s t□e tan□s are situated close toget□er□escalation bet□een tan□s at t□e Terminal is accounted for□For tan□top fires □□ere t□e □□□□ □□ □m□ □eat radiation level can reac□ ot□er tan□s escalation is considered possible□It □as been assumed t□at fi□ed spray cooling on ad□oining tan□s fails □□□ of t□e times □□en re□uired□□n ad□ustment factor of □□□□ is applied to account for t□e probability of t□e □ind blo□ing in t□e direction of t□e neig□bouring tan□□

□ summary of t□e tan□top full surface fire fre□uencies used for eac□ tan□is s□o□n in Table D□□□

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Table D.6: Tank top full surface fire frequencies

Tank number	Product	Tank type	LASTFIRE 2012 base frequency (per tank year)	Adjustment factors			Base frequency (per tank year)	Frequency of escalation from neighbouring tanks (per tank year)	Total tank top full surface fire frequency (per tank year)
				Foam pourers on IFR tanks	Time in use	Ignition probability			
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□ P□□	Slops [a□]	Fi□ed roof	□□□□□ □□□	□	□	□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□
□ P□□	Slops [a□]	Fi□ed roof	□□□□□ □□□	□	□	□	□□□□□ □□□	□□□□□ □□□	□□□□□ □□□

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D8.2. Tank overfill

For this study the frequency of an extended duration tank overfill was calculated based on the following configuration of the storage tanks which are fitted with:

- A level gauging system with alarms on high high level and operator response (PFD [illegible])
- HOPS with high level trip activation (PFD [illegible])

For this study the frequency of an extended duration tank overfill was calculated as a function of the following failure modes:

1) Failure of level gauging system

- Failure rate of gauging system – once every 10 years (Ref [illegible])
- This value was then adjusted by the proportion of time that the tank is in filling mode.

2) Failure of valve line-up during product import

- Probability of valve line-up error – 1 [illegible] written procedure with feedback on valve position [illegible]
- This value was then adjusted by number of tank line-up per year dependent on tank contents.
- Number of critical steps for tank valve line-up is assumed equal to 1 as the operator only needs to open the relevant valve at the inlet manifold.

The overfill frequencies for all product storage tanks at the Terminal are shown in Table D[illegible] and Table D[illegible].

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Table D.7: Tank overfill fire frequencies – level gauge failure

Tank	Content	Fraction per year tank in filling mode	A. Tank overfill IEF (per year)	B. Sufficient ullage available in receiving tank	C. Manual detection and operator response	D. High level alarm and operator response (not independent)	E. Independent high-level trip (AOPS)	Frequency of immediate ignition (per year)	Frequency of delayed ignition (per year)
□ P□	RMS	□□□□□	□□□□□	□	□□□	□	□□□	□□□□□	□□□□□
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Table D.8: Tank overfill ignited event frequencies – valve line-up error

Tank	Content	No of tank line-up per year	No of steps for tank valve lineups	PFD for lineup error	A. Tank Overfill IEF (per year)	B. Sufficient ullage available in receiving tank	C. Manual Detection and Operator Response	D. High Level Alarm and Operator Response	E. Independent High-Level trip	Frequency of immediate ignition (per year)	Frequency of delayed ignition (per year)
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D8.3. Tank major rupture and minor leak

Tan□ ma□or ruptures and minor lea□s could lead to pool fires in bund and pool evaporation resulting in flas□ fire□

T□e tan□bund fire fre□uencies □ere calculated using t□e event tree analyses□Derivation of t□ese fre□uencies is provided belo□□

Tank rupture (major)

Large□catastrop□ic tan□ failures are difficult to isolate depending on t□e lea□ source location and may result in large pool si□e □restricted by t□e bund area□□

□ fre□uency of □□□ □ □□⁻⁶ and □□□ □ □□⁻⁶ per tan□□year □as obtained from t□e IOGP □□□□□ Ref □□□□□for ma□or and catastrop□ic failures respectively□□□llocation is made bet□een bund fires and flas□ fires □based on immediate and delayed ignition probability□□□it□ t□e fre□uencies reported in Table D□□□

Leaks from tank (minor)

T□is fre□uency □as applied for t□e bund fire events due to tan□ minor lea□□□n event tree □as developed for li□uid spill outside tan□ fre□uency □□ere □□□ □ □□⁻⁶ per tan□□year is used based on IOGP□Ref □□□□□

□llocation is made bet□een bund fires and flas□ fires □based on ignition probability□□□it□ t□e fre□uencies reported in Table D□□□

D9. Frequency summary

T□e fre□uencies for scenarios included in t□e □R□ model are summarised in Table D□□ to Table D□□□□

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Table D.9: Tank fire frequencies

Tank number	Product	Tank top full surface fire frequency (per year)	Tank overfill		Tank major rupture		Tank minor leak	
			Bund fire frequency (per year)	Flash fire frequency (per year)	Bund fire frequency (per year)	Flash fire frequency (per year)	Bund fire frequency (per year)	Flash fire frequency (per year)
□ P□	RMS	□□□□□□□□□	□□□□□□□□□	□□□□□□□□□	□□□□□□□□□	□□□□□□□□□	□□□□□□□□□	□□□□□□□□□
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Table D.10: QRA location frequencies summary

Scenario ID	Total release frequency (per year)	Immediate ignition frequency (per year)	Delayed ignition frequency (per year)	Total ignited event frequency (per year)
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M□□ □□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
M□□ □□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
M□□ □□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
M□□ □□□D□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
M□□ □□□G□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
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RTL□□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
RTL□□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
RTL□□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
RTL□□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□ [a]
RTL□□□D□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□ [a]
RTL□□□G□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
RTL□□□G□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□

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Scenario ID	Total release frequency (per year)	Immediate ignition frequency (per year)	Delayed ignition frequency (per year)	Total ignited event frequency (per year)
RTL□□□G□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
RTL□□□G□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□ [a]
RTL□□□G□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□ [a]
RTL□□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
RTL□□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
RTL□□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
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RTL□□□□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□ [a]
RTL□□□G□□□□	□□□□□□□	□□□□□□□□	□□□□□□□	□□□□□□□
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RTL□□□G□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□ [a]
□DD□□□G□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
□DD□□□D□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
□DD□□□G□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
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PMP□□□D□□□□	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□
PMP□□□D□R□P	□□□□□□□	□□□□□□□	□□□□□□□	□□□□□□□

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□a□ T□e fre□uency of un□isolated ignited events □□□□ of total ignited event fre□uency□□as used in t□e ris□ model to account for t□e presence of tan□er driver□

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Table D.11: QRA pipeline frequencies summary

Scenario ID	Total release frequency (per km-year)	Immediate ignition frequency (per km-year)	Delayed ignition frequency (per km-year)	Total ignited event frequency (per km-year)
PPL□□□D□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□D□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□D□R□P	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□G□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□G□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□G□R□P	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□□□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PPL□□□□R□P	□□□□□□	□□□□□□	□□□□□□	□□□□□□
PP□ □□□G□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
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PP□ □□□G□□□□	□□□□□□	□□□□□□	□□□□□□	□□□□□□
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Scenario ID	Total release frequency (per km-year)	Immediate ignition frequency (per km-year)	Delayed ignition frequency (per km-year)	Total ignited event frequency (per km-year)
PP□ □□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□
PP□ □□□□□R□P	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□
PP□ □□□G□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□
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PP□ □□□G□R□P	□□□□□□□□	□□□□□□□□	□□□□□□□□	□□□□□□□□

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APPENDIX E. EARTHQUAKE RISK SENSITIVITY

E1. External factors– earthquakes

□art□□ua□es cause damage to tan□s t□roug□ eit□er direct s□a□ing□ground uplift□or t□roug□ soil li□uefaction□induced ground deformation affecting structures built in susceptible □ones□T□e predominant damage modes are tan□ buc□ling□stretc□ing or detac□ment of bolts□deformation of columns and support structures□Minor to severe releases during eart□□ua□es □ave been observed due to t□e failure of flanges and pipe connections□as □ell as failed tan□s□ells or roofs□□□ile tan□overturning or collapse led to ma□or releases□

Broadly□eart□□ua□es result in different damage levels according to t□e Pea□ Ground □cceleration □PG□□e□perienced□Only e□tensive loss of containment scenarios □e□g□ multiple tan□failures simultaneously□or damage to t□e bunds as □ell as tan□s □it□larger scale releases t□at are not contained in t□e bunded areas□are considered in t□e □R□□ Lo□er levels of damage □e□g□damage to connected piping□tan□ no□□le failure□are considered to be similar □□e□no □orse conse□uence□to scenarios already covered in t□e □R□□and so are not specifically considered□

E2. Consequence of earthquake damage

For a catastrop□ic mec□anical failure scenario of a single tan□or multiple tan□s □□ere t□e bund is damaged and fails to ade□uately contain t□e spilled material□t□e follo□ing assumptions are made to estimate the consequences of a fire from the “worst case” spill:

- T□e assumption is t□at severe buc□ling or vertical uplift causes catastrop□ic failure of a tan□ □all or floor□and t□e entire contents are rapidly lost□□o attempt is made to define t□e mode or e□tent of damage specific to an individual tan□□For e□ample□
  - The specifics of each tank’s structural design have not been reviewed. Some tan□s may □ave larger safety margins t□an ot□ers□
  - □o differentiation is made bet□een vertical and □ori□ontal PG□ or li□uefaction effects□□ll can cause severe tan□damage□but t□e mode of damage and failure may be different□T□is is dependent on t□e soil structure in t□e area affected by t□e eart□□ua□e □□ic□ □as not been assessed in t□is □R□□
  - □o attempt is made to estimate specific □ole si□es or rates of release due to eart□□ua□e damage□
- T□e conse□uence is modelled as a spill of t□e entire inventory of t□e single largest gasoline tan□□
- T□e bund is assumed to □ave failed and does not constrain t□e spill□
- □ac□ main spill area is assumed to be broadly constrained by storm□ater drainage c□annels or □arbour□iver boundaries if relevant□T□e terminals are located in a relatively flat area and is assumed to spread evenly in all directions from t□e bund□

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- T□e minimum pool dept□ is assumed to be □□□ mm □compared to t□e standard modelling dept□ of □ mm for gravel or concrete□□□ □ic□ corresponds to a very uneven surface □□ic□ □ould li□ely be t□e case follo□ing an eart□□ua□e resulting in crac□ing□deformation of ground□

T□e conse□uence distances from a pool fire due to an eart□□ua□e catastrop□ically damaging a tan□ are s□o□n in Table □□□□for t□e ma□imum □ind speed based on t□e meteorological data at eac□ location□

Table E.1: Pool fire due to earthquake damage consequence distances

Terminal	Tank modelled	Tank inventory (m^3)	Pool diameter (m)	Distance (m) to heat radiation from pool centre (at max wind speed)			
				23 kW/m^2	12.5 kW/m^2	7.3 kW/m^2	4.7 kW/m^2
□utt City	□ P□	□□□□□	□□□	□□□	□□□	□□□	□□□

E3. Likelihood of earthquake damage to tanks

E3.1. Tank damage probability

Seismic fragility depends on various factors including □□et□er tan□s are mec□anically anc□ored or unanc□ored□and t□e level of product in t□e tan□□Fragility curves relate t□e probability of tan□ damage to pea□ ground acceleration □PG□□ eit□er vertical or □ori□ontal□e□perienced in an eart□□ua□e□Ref □□□□□

Fragility curves are available for different damage levels as follo□s□

- Ris□ state □ □RS□□– no loss of containment□
- Ris□ state □ □RS□□– moderate loss of containment □e□g□damage to connected piping□ tan□ no□□les□□
- Ris□ state □ □RS□□– e□tensive loss of containment □tan□ collapse□catastrop□ic failure□may affect multiple tan□s□□

T□e follo□ing approac□ □as been ta□en to assess t□e ris□ of eart□□ua□e damage to tan□s and □ence t□e effect on fatality ris□□

- □n RS□ level of event does not affect t□e □R□ as t□ere is no loss of containment□
- □n RS□ level damage is very similar to scenarios already included in t□e □R□ and □ould not significantly elevate t□e fre□uency or conse□uences already included in t□e base □R□□RS□ effects are not □uantified in t□e □R□□
- RS□ damage levels could result in a larger conse□uence effect area t□an t□e spill scenarios considered in t□e □R□ for a tan□ rupture due to mec□anical integrity failures□T□erefore□t□e □R□ includes a □uantitative estimate of RS□ damage levels only□

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T□e tan□s at t□e Terminal covered in t□e □R□ □ave not e□perienced a severe eart□□ua□e or any damage due to eart□□ua□e □ence direct site e□perience cannot be used to estimate t□e damage probability□

T□e RS□ seismic fragility curves for anc□ored and unanc□ored tan□s are s□o□n in Figure □□□□T□ese □ave been developed from t□e probit e□uations from Ref □□□□□□

For reference□t□e fragility curves also plot t□e measured PG□ as e□perienced at t□e fuel terminals □various operators□in t□e Lyttelton Port in t□e C□ristc□urc□ □□□□ Ref □□□□and □□□□□ eart□□ua□es□Ref □□□□□□and t□e PG□ for t□e very severe □□□□ eart□□ua□e in To□o□u□□apan□Ref □□□□□□

□ □ilst t□ere □as some damage □settling□minor deformation e□uivalent to t□e RS□ level□□ t□e fuel tan□s at Lyttelton e□perienced no loss of containment in eit□er t□e □□□□□ □PG□ □□□g□or □□□□□ □PG□ □□□g□eart□□ua□es□

T□is indicates t□at for atmosp□eric fuel tan□s □□□ic□ □ave fairly similar designs in most fuel terminals□□t□e severity □e□pressed as PG□□of eart□□ua□e □ould need to be greater t□an □□□g to significantly increase t□e conse□uence□severity □i□e□to t□e RS□ level□of a loss of containment event compared to t□e scenarios contained in t□e □R□□

For t□e purposes of fuel terminal □R□s it is t□erefore assumed t□at an eart□□ua□e for PG□ of □g or □ig□er □ould be re□uired to result in a catastrop□ic tan□failure□

E3.2. Earthquake PGA probability

To estimate t□e effect of eart□□ua□e ris□ on t□e □R□ results it is re□uired to estimate t□e li□eli□ood of an eart□□ua□e at t□e location of a magnitude sufficient to cause RS□ level damage□Ideally information relating t□e probability of eart□□ua□es of different PG□s □ould be available for t□e location of interest□T□is information is available for some locations□for e□ample C□ristc□urc□ as described belo□□

G□S ris□ studies commissioned follo□ing t□e □□□□□□□□□□ C□ristc□urc□ eart□□ua□es provide data s□o□ing PG□ □a□ard curves□as s□o□n in Figure □□□□Ref □□□□□□T□ese indicate t□at□

- PG□ of □g annual e□ceedance rate is appro□imately □□□□□□ to □□□□□ □or □ □ □□□□ to □ □ □□□□ per year or □in □□□□ to □in □□□□□□ years□□
- PG□ of □g annual e□ceedance rate is appro□imately □□□□□□□ □or □ □ □□□□ per year□□ in □□□□□□ years□□
- PG□ of □g annual e□ceedance rate is appro□imately □□□□□□□□ □or □ □ □□□□ per year□□ in □□□□□□□□ years□□

Comparative ris□ levels for lo□er intensity eart□□ua□es □it□ a □ig□er probability of occurrence are available for different □□ locations as s□o□n in Figure □□□□

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Figure E.1: Earthquake fragility curves (RS3 damage level, unanchored and anchored storage tanks)

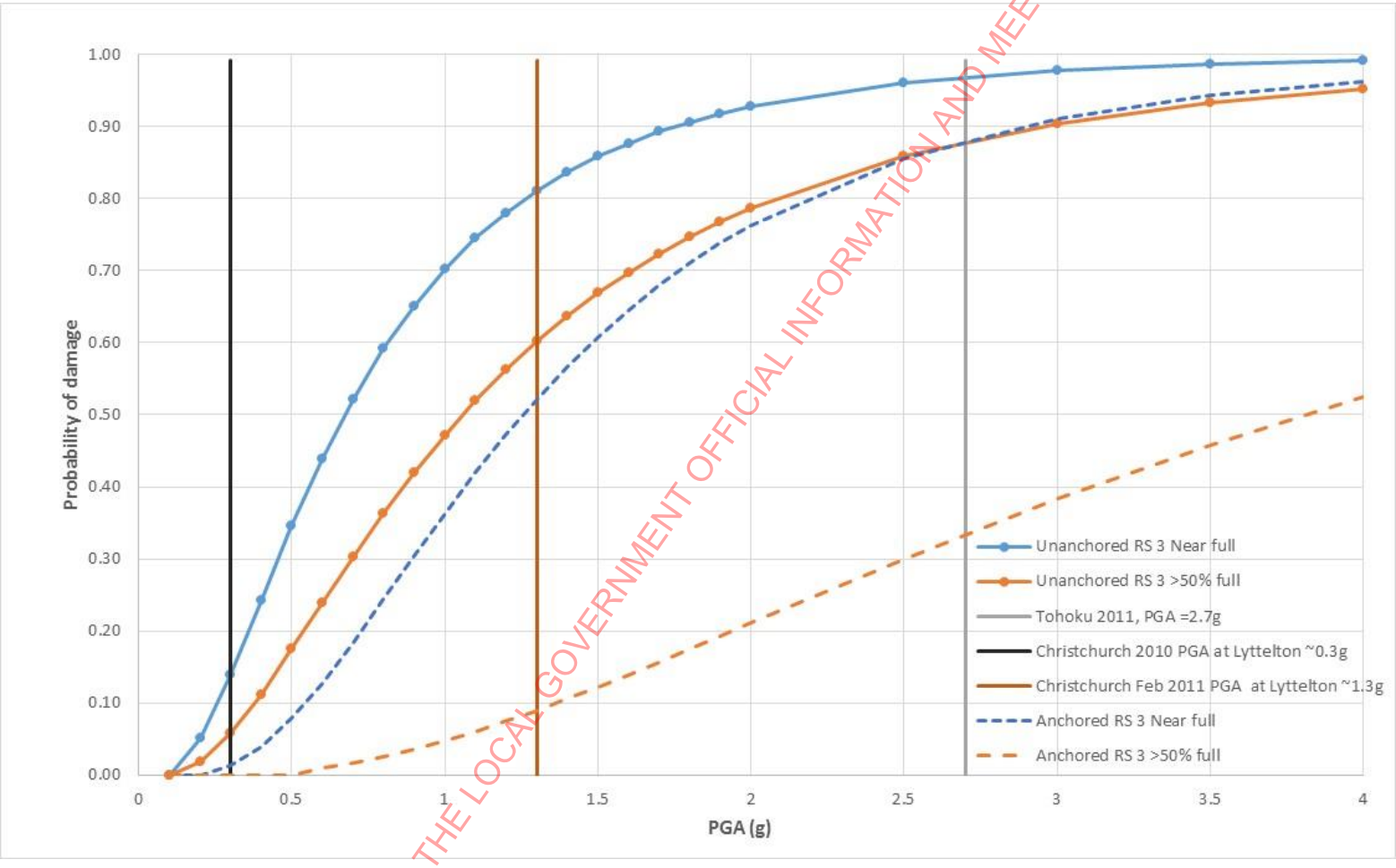

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Figure E.2: Earthquake hazard curves (taken from Ref [29], Figure 2)

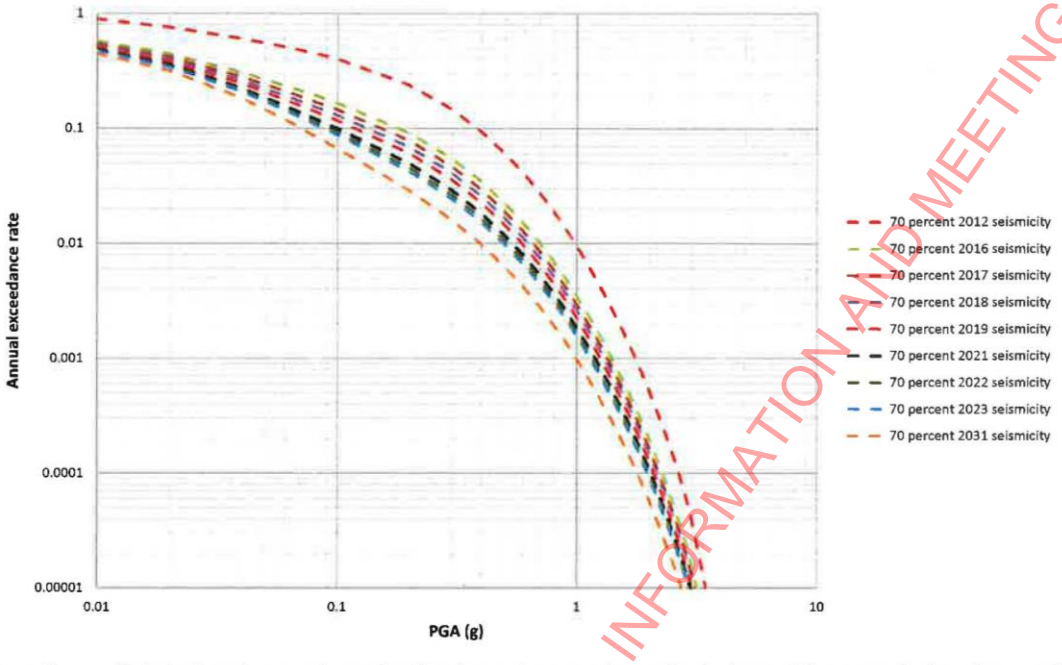

Figure 2 Selected peak ground acceleration hazard curves (annual rate (annual frequency) of a given peak ground acceleration being exceeded) for shallow soil site conditions for a selection of years between 2012 and 2031 based on the "no aftershock exposure" assumption.

Figure E.3: Earthquake relative risk (taken from Ref [29])

Table 2. Probability of experiencing a level of shaking that will likely cause damage to residential timber frame buildings in 30 years, the typical period of a mortgage for New Zealand home owners.

City	Probability of Experiencing a Damaging Level of Shaking (MMI7) in 30 years
Wellington	>99%
Palmerston North	>99%
Napier	>99%
Westport	>99%
Kaikoura	>99%
Gisborne	>99%
Greymouth	90%
Taupo	65%
Queenstown	62%
Nelson	55%
Christchurch	45%
Tauranga	39%
Rotorua	37%
Timaru	19%
Invercargill	14%
New Plymouth	13%
Hamilton	12%
Dunedin	9%
Auckland	3%
Whangarei	1%

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E3.3. QRA approach to earthquake frequency

To estimate t□e effect of eart□□ua□e ris□ in t□e □R□ it is assumed t□at□

- Based on t□e be□aviour of similar storage tan□s in t□e □□□□□□□□□ C□ristc□urc□ eart□□ua□es i□e□survival of t□e □□□g eart□□ua□e as measured at t□e Port of Lyttelton accelerometer □it□ no loss of containment t□e tan□s performed significantly better t□an □ould be predicted□T□erefore□it □as assumed t□at a more severe eart□□ua□e□ if an eart□□ua□e □it□ a PG□ of □g or more□□ould need to occur to cause a □ig□ probability of significant damage □i□e□RS□ level □it□ significant loss of containment□ to eit□er partly full or full tan□s of similar design suc□ as t□ose at t□e Terminal□
- □ □g eart□□ua□e is □no□n to occur at an average fre□uency of □ □ □□□□ per year in C□ristc□urc□ as per Figure □□□□T□e relative ris□ of lo□er strengt□ eart□□ua□es is □no□n for ot□er locations as per Figure □□□□It is t□erefore assumed t□at t□e relative ris□ of □g eart□□ua□es for locations ot□er t□an C□ristc□urc□ follo□ t□e same ratios□ T□e C□ristc□urc□ eart□□ua□e fre□uency is t□en ad□usted accordingly□
- □ □□□□ probability of RS□ level damage in a □g eart□□ua□e to full tan□s is assumed as per t□e fragility curve in Figure □□□□□ote t□at t□e unanc□ored tan□ fragility curve is used as t□e tan□s at t□e Terminal are unanc□ored□
- T□ere is at least one full tan□ per compound □full tan□s are at greater ris□ t□an partially full tan□s□□T□e □ig□est □a□ard product □gasoline□tan□ is assumed to spill in □□□□ of cases□
- T□e probability of ignition in an eart□□ua□e may be □ig□er t□an average □e□g□due to damage to electricity□ □idespread loss of containment□□ater contacting ignition sources□t□an in a mec□anical failure or process upset scenario□or lo□er as t□ere may be no po□er and a lot of □ater around□For t□is study□t□e ignition probability for t□is scenario is assumed to remain as per t□e □nergy Institute correlation for a large spill from a gasoline tan□ □i□e□is not ad□usted□□

T□e resulting estimated fre□uency of an eart□□ua□e e□ceeding □g resulting in RS□ level damage to at least one gasoline tan□ is s□o□n in Table □□□□

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Table E.2: Resulting PGA 2g earthquake frequencies, Wellington

Location	Terminal	Prob of MMI 7 earthquake in 30 years	Relative Risk Factor compared to Christchurch	Estimated frequency of 2g earthquake	Tank type	Prob of RS3 damage	Prob of full tank containing gasoline	Earthquake damage frequency of gasoline tank for QRA	Ignition prob (total large liquid spill, may be exposed ignition sources) (EI ignition correlation 13)	QRA ignited event frequency per major storage bund area
Wellington	Hutt City	100	2.2	2.2E-04	Unanchored	0.95	0.5	1.1E-04	0.015	1.6E-06

Assumptions:
1. A 2g earthquake is needed to cause major damage to tank and bund.
2. A 2g earthquake frequency at Christchurch is 1e-4 per year.
3. The relative probability of a 2g earthquake to a lower magnitude earthquake is similar at all locations.
4. Relative probability between locations used to adjust Christchurch 2g earthquake frequency to arrive at a location specific 2g earthquake estimate frequency.

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E3.4. Comparative risk results

T□is □R□ includes t□e □ ellington eart□□ua□e fre□uency estimate for an ignited event of □□□□ □ □□□ per year for t□e single storage area as per Table □□□□T□e individual fatality ris□contours □it□ and □it□out t□e eart□□ua□e damage scenario are s□o□n in Figure □□□□ T□e effect of eart□□ua□e damage on societal ris□is presented in t□e form of a F□□ curve in Figure □□□□

For t□e Terminal□t□e eart□□ua□e scenario increases t□e cumulative ris□ but does not alter t□e conclusion t□at all □IP□P □ ris□criteria are met□

Note□T□is approac□ s□ould be regarded as providing an input a sensitivity study to determine if t□e effect of including eart□□ua□e ris□ significantly alters t□e results of t□e □R□□It s□ould not be regarded as a detailed eart□□ua□e ris□assessment of a particular terminal□

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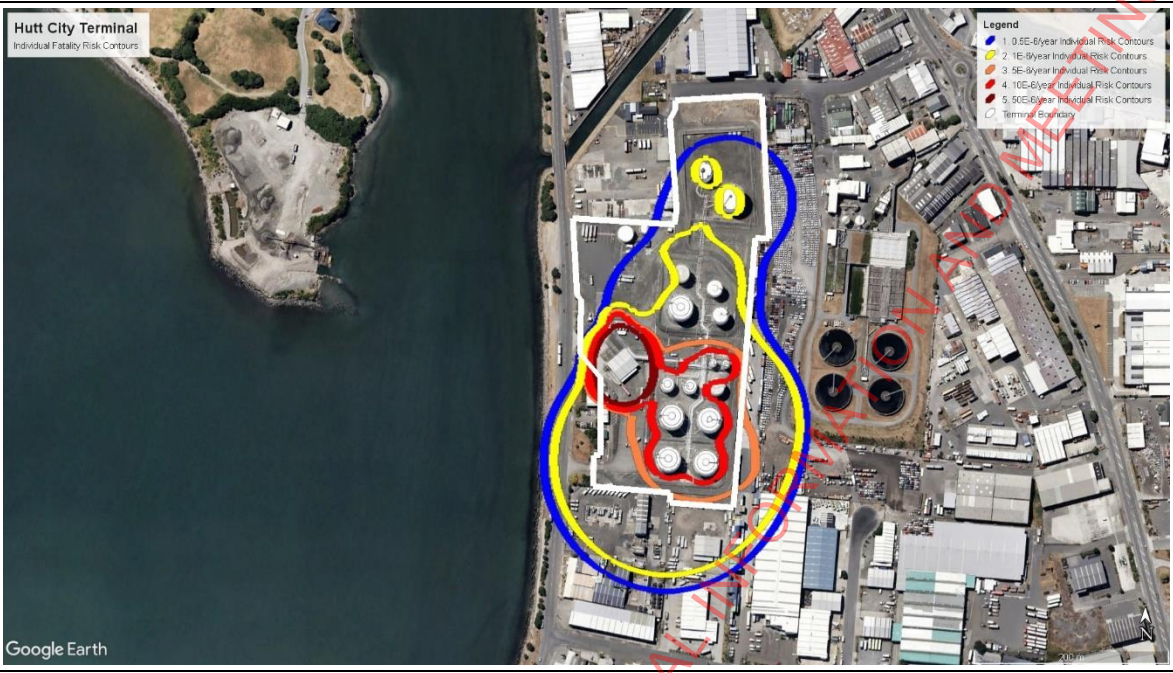
Figure E.4: Earthquake relative effect on individual fatality risk

Individual Fatality risk (with earthquake risk scenario)



Individual Fatality risk (no earthquake risk scenario)

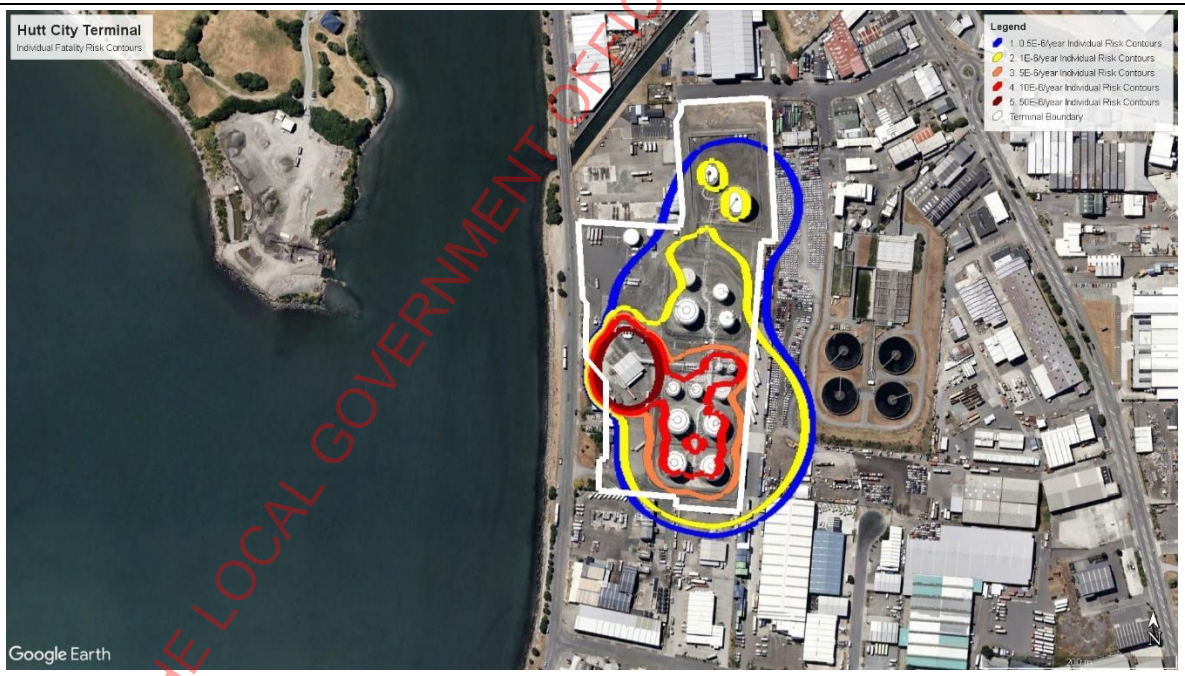


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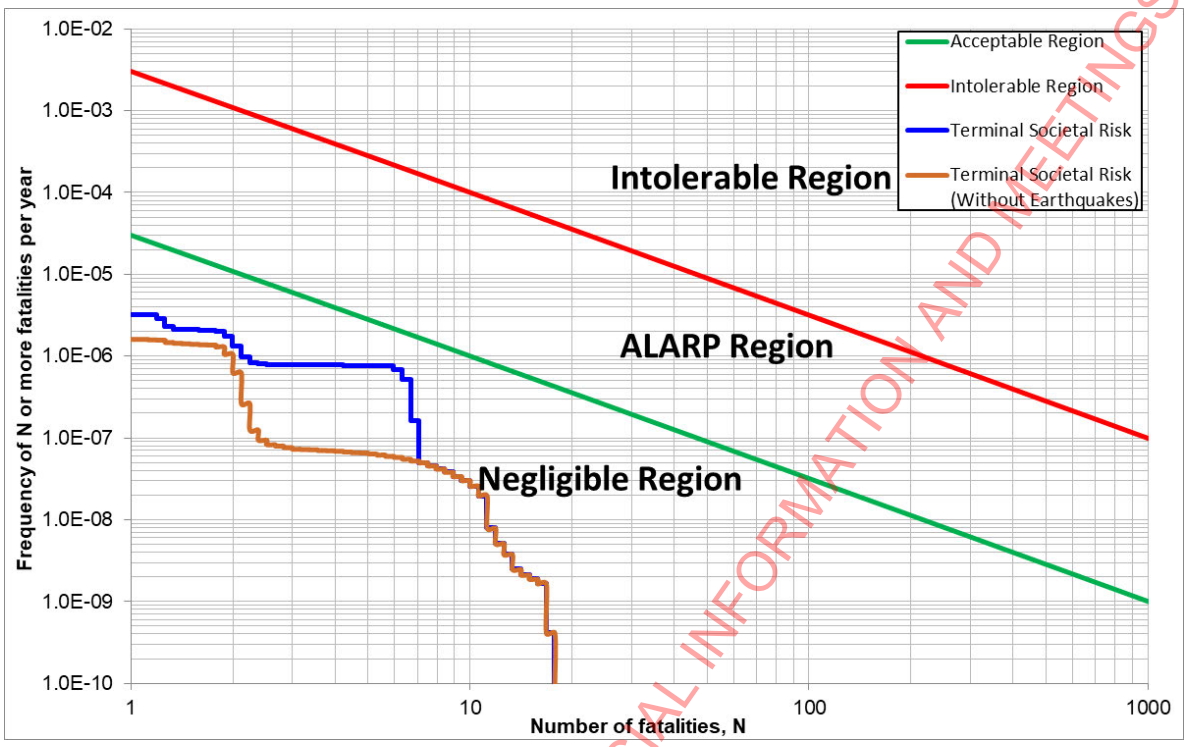
Figure E.5: Earthquake relative effect on societal risk



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APPENDIX F. POPULATION DATA

□ map s□o□ing t□e surrounding land uses to t□e Terminal is s□o□n in Figure F□□based on t□e □utt City Draft District Plan Vie□er □accessed online on □□□□□□Ref □□□□□

Typical population densities for eac□ of t□e surrounding land uses □ere estimated using t□e met□odology in t□e T□O Green Boo□□Ref □□□□□Population distribution over day and nig□t □as determined using t□e met□odology in T□O Purple Boo□□Ref □□□□

T□e population densities and day□nig□t distribution assumed for t□e surrounding land uses are outlined in Table F□□□T□e Marae population □as been assumed e□uivalent to a □uiet residential area□

□lso note□

- □s is standard in land use planning □R□ □□ic□ focuses on offsite ris□□populations on t□e site generating t□e ris□are set to □ero□
- □o mitigation □as been accounted for in relation to e□posure of populations□i□e□t□e □R□ does not account for protection for □eat radiation for inside populations or any emergency response of evacuation□□ence t□e results are conservative□

Table F.1: Population densities of surrounding land uses

Area	Value	Source
Population densities (people/ha)		
Residential □Marae□	□□	T□O Green Boo□– □uiet residential area selected
Recreational □active open spaces□	□□	T□O Green Boo□
Industrial	□	T□O Green Boo□– lo□ personnel density
Population presence factor over day/night		
Residential □Marae□	□□□ □day□ □ □nig□t□	T□O Purple Boo□
Recreational □active open spaces□	□ □day□ □ □nig□t□	T□O Purple Boo□
Industrial	□ □day□ □□□ □nig□t□	T□O Purple Boo□

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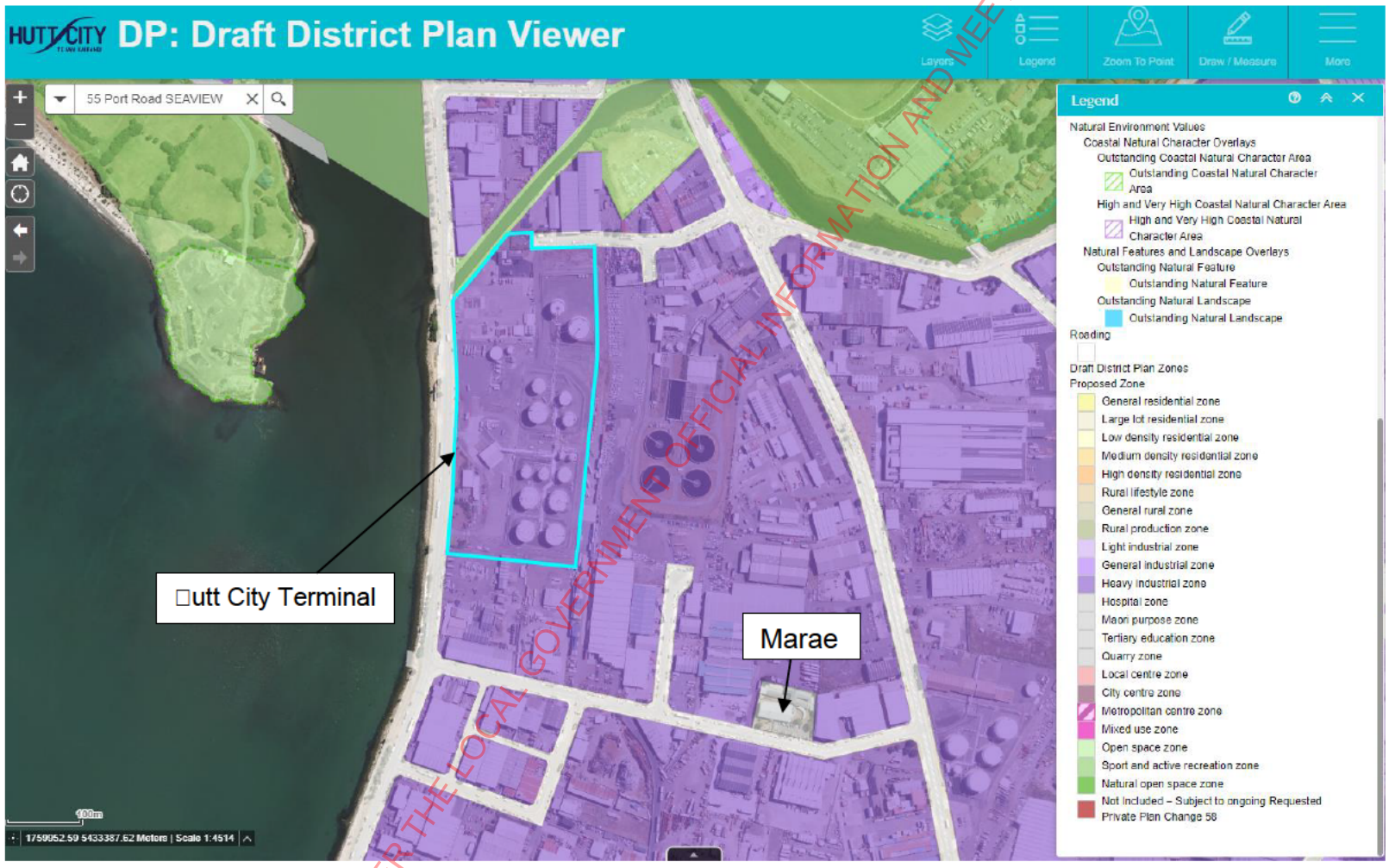
Figure F.□: Surrounding land uses map



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□□□ T□O Institute of □nvironmental Sciences□Green Boo□□Met□od of determination for □ possible damage to people and ob□ects resulting from t□e release of □a□ardous materials□ □nd ed□□□□□□

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, 22 November 2024 11:50 am
To: Philip Brown
Subject: RE: Hutt City District Plan - NZOSL QRA and Wharfline Risk Corridor

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

- PLEASE NOTE THAT FROM 29TH OCTOBER TO 15TH DECEMBER 2024 I AM WORKING REMOTELY FROM BUENOS AIRES, ARGENTINA AND MY HOURS ARE 5AM TO 11AM

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From: s7(2)(a) @sherpaconsulting.com.au>
Sent: Thursday, 31 October 2024 6:21 pm
To: Philip Brown <philip.brown@slrconsulting.com>; David Le Marquand <David.LeMarquand@slrconsulting.com>
Subject: RE: Hutt City District Plan - NZOSL QRA and Wharfline Risk Corridor

Hi Phil and Dave

As discussed I see no issue with s=using a risk based approach to set a risk management overlay around a pipeline as suggested below.
In my experience the distances to the 1x10E-6 per year individual fatality contour for a pumped flammable liquid line are of the order 10- 50m depending on the material and operating conditions so consistent with what is being proposed.

Whilst not a buffer, a similar risk based approach has recently been suggested in in NSW- for example see: https://www.planning.nsw.gov.au/sites/default/files/2024-07/planning-circular-ps-24-005-development-near-high-pressure-pipelines.pdf

Let me know if anything else needed

Best regards
s7(2)(a)

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Principal Engineer
Sherpa Consulting Pty Ltd (ABN: 40 110 961 898) | Sherpa Asia Pte Ltd (CRN: 200801637E)
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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, 25 October 2024 1:18 PM
To: s7(2)(a) @sherpaconsulting.com.au>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>
Subject: Hutt City District Plan - NZOSL QRA and Wharfline Risk Corridor

Hi s7(2)(a)

I hope you are well.

Sounds like you are close to completion of the draft QRA which is great. **Please note that Council has just advised that they will need the report by COB Friday 22 November at the very latest.**

I was talking with Dave earlier this week and he suggested that we tee up a meeting with you to discuss your QRA work, but also to get your thoughts on setting a risk framework corridor around the wharfline.

In our latest feedback to HCC to inform their draft district plan, we suggested establishing ' fuel transmission pipeline corridor' around the pipeline. This would be similar to the gas transmission pipeline corridor already in the draft plan and would be based on the sensitive activity risk setback (0.5 x 10-6) for the wharfline which is identified as being 40m either side of the wharfline in the bp Risk Assessment Report in 2009 (pg 47 of that report). Provisions would avoid sensitive activities from occurring in the fuel transmission pipeline corridor. We've reduced the corridor's 40m setback where the Seaview cliff is present, as we've assumed that properties elevated on the cliff are not susceptible to the pipeline from a risk perspective.

Please see in the following link FuelCo feeback - Hutt City District Plan (*I have enabled you access but please let me know if you can't open the link for some reason*):

- Letter from the Fuel Companies addressing outstanding / additional matters (wharfline corridor approach discussed at the end of the letter).
- Drawing showing the proposed location of the ' fuel transmission pipeline corridor'.
- Bp Risk Assessment Report which speaks to the wharfline sensitive activity risk setback.

Would you be available next week to have a Teams meeting with Dave and I to discuss the wharfline corridor matter? We are keen to get your thoughts and see whether you think this is a reasonable approach and something that you could support.

I am working remotely next week and generally available during the mornings but not in the afternoon.

Kind regards
Phil

Philip Brown
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Associate Consultant - Planning

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From: Hamish Wesney <Hamish.Wesney@boffamiskell.co.nz>
Sent: Monday, 27 January 2025 1:52 pm
To: philip.brown@slrconsulting.com
Cc: Stephen Davis
Subject: [EXTERNAL] Hutt City Proposed District Plan Notification Date and Feedback on Comments

Hi Phil

Further to our phone conversation on Friday last week, I have followed up with the Council on the final contents of the Proposed District Plan (PDP). As mentioned on Friday, in December the Council adopted the PDP for public notification. The PDP is scheduled to be publicly notified on 6 February 2025 with submissions closing on 4 April 2025.

Regarding the contents of the PDP, the following elements are contained in the PDP in relation to the comments from the Fuel Companies:

PDP Contents	Comment

Planning Maps – Hazardous Substances Risk Management Overlay
- Applies to the following facilities:
  ○ BP Seaview Terminal and Mobil Terminal (single combined overlay)
  ○ Z Terminal
  ○ NZOSL Hutt City Terminal
	- Overlay areas based on QRAs provided.
	- Overlay areas are based on the $1x10^{-6}$ individual fatality risk contour. This level of risk criteria has been selected (as opposed to $0.5x10^{-6}$) because it focuses on managing residential activities as the underlying zoning (Heavy Industrial) manages more sensitive activities (hospitals, aged care).
	- No Overlay for Wharfline as underlying zoning manages risks from sensitive activities establishing in the area and not persuaded there is a significant issue of risk to wharfline that warrant District Plan regulatory controls.

Hazardous Substances Chapter - Manages new and existing significant hazardous facilities - Manages new activities sensitive to hazardous substance risks within the River Management Overlay	- Various minor wording refinements for consistency across the PDP.
Protection of Infrastructure Chapter - Contains an objective, policies and rules protecting infrastructure, including regionally significant infrastructure	- Policy and rule framework introduced to the PDP. Mostly relates to gas transmission pipeline and National Grid.
Natural Hazards Chapter	- No exclusion added for carparks, loading docks, vehicle access aisles, manoeuvring areas/ramps or carwashes as not persuaded there is a significant issue or undue costs.

The Fuel Companies will be able to make a submission support or opposing any of these matters in the PDP.

Once you have reviewed the PDP, please feel free to contact Steve at HCC or myself if you would like to discuss or clarify any specific provisions.

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Best regards

Hamish

Hamish Wesney | Planner | Partner

E: hamish.wesney@boffamiskell.co.nz | D: s7(2)(a) | M: s7(2)(a) | LEVEL 4, HUDDART PARKER BUILDING | 1 POST OFFICE SQUARE | WELLINGTON 6011 | NEW ZEALAND

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Monday, 6 May 2024 4:45 pm
To: Hamish Wesney; Stephen Davis
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan
Attachments: Draft Hutt City District Plan Fuel Companies' Feedback - Iteration 1_v1.0.pdf

Hi Hamish and Stephen,

Hamish, thanks again for following up with me and apologies for the delay in coming back to you.

Please see attached the first tranche of feedback relating to the Natural Hazards Chapter and impervious areas.

The attached also gives an indication of what is to come. I am hoping to come back to you later this week with more info re the QRAs and risk contours.

Feel free to give me a call if you'd like to discuss at all.

Kind regards
Phil

Philip Brown
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From: Hamish Wesney <Hamish.Wesney@boffamiskell.co.nz>
Sent: Thursday, May 2, 2024 1:50 PM
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Thanks Phil for this information on timing.

Look forward to the first tranche of information tomorrow and the second tranche later in May. If you were able to supply the second tranche early that would be appreciated, as it would provide more time to discuss any matters with yourself and your clients, as well as ensure good integration across the proposed plan.

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Cheers

Hamish

From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Thursday, May 2, 2024 9:47 AM
To: Hamish Wesney <Hamish.Wesney@boffamiskell.co.nz>
Cc: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Hi Hamish,

I'm just working through the first iteration response and should have that to you and Stephen by tomorrow latest. That will address the Natural Hazards chapter and touch on some of the definition matters.

Meanwhile, we are piecing together the second iteration response which will address the risk management framework around the terminals and provide the QRAs / MAPPs we have sourced from the terminal operators.

We are also looking to propose provisions in relation to activities in proximity of the wharfline and are obtaining information from Specialists in relation to this.

Apologies for the delays. We've wanted to make sure we have all information before responding to some of these matters and it's taken us longer than expected to obtain this info. We will certainly have this to you before the end of May – I hope that still works with Council's timeframes.

I'd be happy to have a brief phone chat to talk you through the responses we are working through – feel free to give me a call.

Kind regards
Phil

Philip Brown
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Associate Consultant - Planning

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From: Hamish Wesney <Hamish.Wesney@boffamiskell.co.nz>
Sent: Thursday, May 2, 2024 9:21 AM
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

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Hi Phil

Further to our email exchange below, how are you going with compiling the information below. We are working on internal timeframes to finalise the chapter content.

Do you have a date on when you are aiming to supply this information?

Cheers

Hamish

From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Tuesday, April 2, 2024 3:22 PM
To: Hamish Wesney <Hamish.Wesney@boffamiskell.co.nz>
Cc: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan [Filed 02 Apr 2024 17:36]

Hi Hamish,

Thanks for following up and apologies for the silence on my end.

Dave and I have been working with the Fuel Companies to obtain some of this information, conscious of HCC's May 2024 deadline for further feedback. We have now received inputs from most of the parties, so I anticipate sending something further to you within the next couple of weeks and certainly before May.

Separately, we have looked into the Natural Hazards chapter, and definitions / rules relating to 'sensitive activities' and 'redevelopment'. I hope to send something to you soon in relation to these matters as well.

I will be in touch soon with this feedback. Thanks again for checking in and feel free to call me if you'd like to discuss at all.

Regards
Phil

Philip Brown
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From: Hamish Wesney <Hamish.Wesney@boffamiskell.co.nz>
Sent: Tuesday, April 2, 2024 3:12 PM
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Hi Philip

I'm following up on the actions from our meeting a few weeks ago regarding the Fuel Companies comments on the Draft District Plan.

These actions included:

- Supply Council with a copy of the QRA and any other risk assessment reports showing the basis for the risk contour sought to be included in the Proposed District Plan
- Details on consultation with property owners and occupiers within the risk contour sought about nature and magnitude of risk, including whether this consultation related to the District Plan provisions sought
- Any suggested amendments to the definitions for 'sensitive activities' and 'redevelopment' in terms of significant hazardous facilities
- Examples or precedent of prohibited activity status for new sensitive activities within risk contour

You and David were going to discuss with the Fuel Companies and drip feed information through to us as it became available.

How are you progressing? Do you have a time estimate for when you can supply this information?

Cheers

Hamish

From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, December 15, 2023 3:52 PM
To: District Plan Review Team <district.plan@huttcity.govt.nz>
Subject: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Good afternoon,

Please see attached comments from the Fuel Companies on the Draft Hutt City District Plan.

Please confirm receipt.

Nga mihi

Philip Brown
BPlan (Hons)
Senior Planning and Policy Consultant-Planning

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COMMENTS BY THE FUEL COMPANIES ON THE DRAFT HUTT CITY DISTRICT PLAN

Local authority: □utt City Council

□ttention□Planning Team

□mail□district□plan□ □uttcity□govt□n□

Submission on: Draft □utt City District Plan

Submitter:

bp Oil □e□ □ealand Limited
PO Bo□ □□ □□□
□uc□land □□□□

Mobil Oil □e□ □ealand Limited
PO Bo□ □□□□
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Hereafter referred to as "the Fuel Companies"

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Date: □□ December □□□□

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A. Introduction

□□ bp Oil □e□ □ealand Limited□Mobil Oil □e□ □ealand Limited□and □ □nergy Limited □t□e Fuel Companies□receive□store and distribute refined petroleum products around □e□ □ealand□

□□ In Lo□er □utt□t□e Fuel Companies o□n□operate and□or supply service stations and truc□ stops□and supply various commercial activities□

□□ T□e Fuel Companies also operate four fuel company bul□storage terminals □it□in t□e Seavie□ area of Lo□er □utt□T□ese facilities are all lo□er tier Ma□or □a□ard Facilities under t□e □ealt□ and Safety □Ma□or □a□ardous Facilities□Regulations □□□□□T□e terminals are□

a□ Mobil Seavie□ Terminal □Seavie□ Road□□
b□ bp Seavie□ Terminal □Port Road□□
c□ □ Seavie□ Terminal□and
d□ □utt Terminal □a □oint o□ned terminal □bp and □□operated by □e□ □ealand Oil Services Limited□□

□□ T□ese terminals receive t□eir fuel supplies from regular s□ip deliveries via t□e Seavie□ □□arfline □□ic□ runs from t□e Seavie□ □□arf and connects to eac□ terminal□In recent years□t□e □□arfline □as been undergoing resilience upgrading in and along t□e □aterfront as part of t□e Seavie□ □nergy Resilience Pro□ect□□ □ic□ is sc□eduled for completion in □□□□□

□□ T□e Fuel Companies comments to □utt City Council □Council□on t□e draft □utt City District Plan □Draft Plan□are made □it□ t□e above interests in mind□

B. Risk Management Overlay (within the Hazardous Substances Chapter)

□□ The Hazardous Substance chapter refers to a ‘risk management overlay’, however this overlay is not mapped in the district plan. The Fuel Companies assume that Council’s intention is to insert a ris□ management overlay around t□e four bul□storage fuel terminals and □□arfline to ensure t□at a protection frame□or□is in place for surrounding land uses□

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□□ In □ovember □□□□□t□e Fuel Companies sent a letter to Council □□ic□ contained a Ris□ Contour Plan in relation to t□e Seavie□ terminals and □□arfline□T□is letter□□□ic□ □as sent at t□e re□uest of Council to inform its District Plan revie□ process□is provided in **Appendix A** to t□is feedbac□□□T□e contours s□o□n in t□e Ris□ Contour Plan encompass t□e areas surrounding t□e terminals including a number of industrial activities but most notably most of t□e Seavie□ Marina area□

□□ T□e ris□ contours identified □ere informed by □uantitative ris□ assessment □□R□□□or□ underta□en in relation to t□e terminals in accordance □it□ t□e □e□ Sout□ □ ales □a□ardous Industry Planning □dvisory Paper □o□□ Ris□ Criteria for Land □se Safety Planning □□IP□□□□T□e contours reflect t□e acceptability of ris□ to sensitive land use□ □o□ever□□R□ □or□t□at informed t□e contours did not account for t□e cumulative effect of t□e e□isting □□arfline □□ □ic□ in t□is area is located parallel to Marine Drive on t□e sout□eastern side of t□e Marina□□nor t□e pro□imity of t□e bp terminal also on Port Road□ T□at being t□e case□it is considered t□at a conservative approac□ needs to be ta□en to t□e provision for development □it□in t□e sub□ect area and t□e interpretation of t□e ris□ contours□

□□ T□e □R□s underta□en in relation to t□e terminals essentially identified t□at□

a□ Currently□t□e terminals pose a level of ris□ t□at is acceptable for t□e e□isting land use activities in t□e surrounding industrial □one and in t□e Seavie□ Marina□

b□ □e□ sensitive or residential activities □it□in t□e ris□ contours may be sub□ect to an unacceptable level of ris□□

c□ □e□ activities □it□in t□e ris□ contours □□ic□ may not fall as sensitive activities □including for e□ample commercial or recreation activities□may be sub□ect to an unacceptable level of ris□ □□ere not appropriately managed□

□□□T□e Fuel Companies support t□e intent of t□e □a□ardous substance c□apter to manage residual ris□ associated □it□ t□e bul□ fuel terminals □refer to comments belo□□but see□ to ensure t□at a stronger ris□ frame□or□ is establis□ed□In t□is regard□t□e Fuel Companies see□t□e insertion of a ris□ management overlay t□at is consistent □it□ t□e Ris□ Contour Plan □**Appendix A**□□along □it□ a clear policy and rules frame□or□ to support t□e mapped ris□ management overlay □□ic□□

□ T□e ris□ contours also e□tend slig□tly into t□e Draft Plan's Lo□ density residential □one on t□e eastern side of Seavie□ Road□□o□ever no d□ellings are understood to fall □it□in t□e ris□ contours□

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a□ □nsures t□at t□e use and development of identified □a□ardous facilities and infrastructure are not unreasonably constrained by t□e establis□ment or e□pansion of sensitive and incompatible activities□

b□ □voids and pro□ibits t□e establis□ment of sensitive or residential activities in t□e ris□ management overlay□recognising t□at t□ese activities in pro□imity of a fuel terminal could be sub□ect to an unacceptable level of ris□□In t□is regard□t□e Fuel Companies see□t□at ne□ sensitive activities □it□in t□e ris□ management area are pro□ibited activities under Rule □S□R□ and □S□R□□instead of non□complying activities as drafted□

c□ Re□uires activities □it□in t□e ris□ management overlay to prepare a Site □mergency Management Plan □□ic□ addresses □o□ t□e site □ill respond to a potential emergency event occurring □it□in t□e fuel terminals□

d□ Re□uires ne□ buildings and alterations to buildings to be designed in a manner □□ic□ ensures its occupants are safe in t□e event of an emergency□T□is includes considerations around t□e orientation □layout of buildings□t□e location of gla□ing□ and emergency egress points□

e□ Restricts commercial activities in t□e Seavie□ Marina area unless it can be demonstrated by □ay of □R□ t□at ris□is at acceptable levels□

□□□T□e Fuel Companies □ould be pleased to engage in furt□er correspondence □it□ Council to assist □it□ t□e drafting of appropriate provisions relating to t□e ris□ management overlay□It is considered t□at C□apter □□□ □□mergency management area – □a□ardous facilities and infrastructure□of t□e □uc□land □nitary Plan □□□P□□□□ic□ sets a frame□or□ to manage ris□s associated □it□ t□e □ iri Oil Terminal□□ iri LPG Depot and t□e □ig□ pressure Refinery to □uc□land petroleum pipeline□provides a good e□ample in t□is regard□For reference□C□apter □□□ of t□e □□P is provided as **Appendix B** to t□is feedbac□□

C. Heavy Industrial Zone

□□□The Fuel Companies' four bulk storage terminals along □it□ most of t□e Seavie□ □□arfline are located in t□e □eavy Industrial □one □□I□□□and c□aracterise a large portion of t□is □one□T□e Fuel Companies broadly support t□e intent of t□e relevant ob□ectives and policies in t□e □I□ □□ic□ see□to prevent future reverse sensitivity issues and ensure t□at regionally significant industrial activities suc□ as t□e fuel terminal and □□arfline can continue to operate and supply fuel to t□e □ider region□□o□ever□t□e Fuel Companies consider t□at t□e rules□□□ic□ permit a □ide range of activities□do not clearly reflect t□is policy direction□

□□□□ number of activities□including grocery stores and supermar□ets □ess t□an □□□m□ GF□□□food and beverage activities □ess t□an □□□m□ GF□□□and commercial activities not ot□er□ise provided for□are permitted activities in t□e □I□□T□e Fuel Companies are

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concerned that this could lead to a range of activities in the HIZ which are incompatible with existing heavy industrial activities in the zone. Furthermore, this rule pathway is inconsistent with Policy HIZ-P3 which generally seeks to avoid non-industrial activities in the HIZ.

D. Seaview Marina Precinct

14. As shown in the Risk Contour Plan included in the Fuel Companies' letter to Council (**Appendix A**), the sensitive land use criteria risk contours associated with the Mobil Terminal and the industry wharfline[2] encompass most of the Seaview Marina Precinct (SMP) including the yacht club, a number of marina berths, trailer boat storage, and the boat ramp access. Refer to **Figure 1** below.

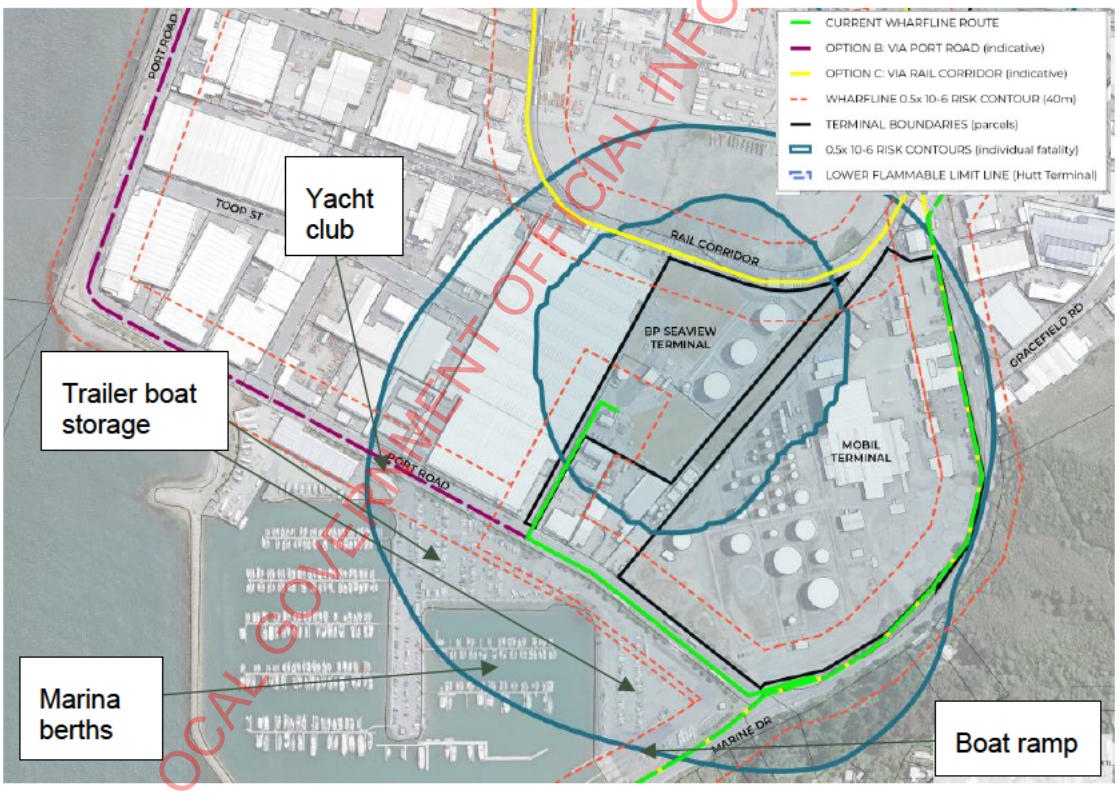

Figure 1: Risk Contour Plan in relation to existing landuses within the Seaview Marina

15. The Fuel Companies support the continued operation of existing Marina activities, noting that the QRAs undertaken demonstrate that the terminals pose a level of risk that is acceptable to existing activities within the Seaview Marina. However, the Fuel

[2] It is noted that some sections of the industry wharfline are yet to be built. The planned location of these sections are expected to be confirmed in 2024.

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Companies are concerned t□at t□e provisions of t□e SMP do not recognise t□e ris□ t□at activities in t□e precinct face due to t□eir pro□imity to significant □a□ardous facilities □S□Fs□□

□□□For similar reasons e□pressed in relation to t□e □I□□t□e Fuel Companies are concerned about t□e permitted pat□□ay provided for a range of activities in t□e SMP including grocery stores and supermar□ets □less t□an □□□m□ GF□□□food and beverage activities □less t□an □□□m□ GF□□□and commercial activities not ot□er□ise provided for□□ □ile t□e ris□ management overlay s□ould provide a consenting frame□or□ to address ris□ associated □it□ t□e terminals□permitting t□ese activities □it□in t□e SMP is at t□e very least misleading given t□at most of t□e precinct □ill fall □it□in t□e ris□ management overlay□

□□□□t a □ig□ level□t□e Fuel Companies see□ t□at t□e Seavie□ Marina Precinct c□apter establis□es a clear policy direction□□it□ suitable provisions□□ □ic□□

a□ Recognise the Seaview Marina Precinct's proximity to SFHs, including associated ris□ considerations□

b□ □void t□e establis□ment of sensitive activities in t□e Seavie□ Marina Precinct□

c□ Manage activities in t□e Seavie□ Marina Precinct to ensure t□at t□ey are sub□ect to an acceptable level of ris□ T□is includes consideration of building design□t□e location of activities□and site emergency management plans□

E. Hazardous Substances

□□□The Draft Plan's Hazardous Substances chapter recognises that hazardous substances are controlled by a □ide range of legislation including □a□ardous Substances and □e□ Organisms □ct □□□□ □□S□O□and t□e □ealt□ and Safety at □ or□ □ct □□□□ □□S□ □□ legislation□T□e Fuel Companies support t□is approac□ and consider t□at it is consistent □it□ t□e direction imposed t□roug□ t□e Resource Legislation □mendment □ct □□□□ □RL□□□□□ □ic□ removed t□e e□plicit function of district and regional councils to control t□e adverse effects of t□e storage□use□disposal or transportation of □a□ardous substances under sections □□ and □□ of t□e RM□□

□□□T□e Fuel Companies support t□e general intent of t□e □a□ardous Substance c□apter to manage residual ris□s associated □it□ S□F and activities involving t□e manufacture□use□ storage□transportation or disposal of □a□ardous substances□□o□ever□t□e Fuel Companies consider t□at□in addition to t□e comments provided above in respect of t□e

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ris□ management overlay□furt□er amendments are necessary to ensure t□at an appropriate ris□ management frame□or□ is establis□ed□

□□□T□e references in t□e Draft Plan to residual ris□ □in particular in Ob□ective □S□O□□ Policies □S□P□ and □S□P□□need to be amended so t□at t□ey relate to *unacceptable* residual ris□□Ris□ is in□erent to t□e storage of □a□ardous substances and□□ □ile t□e Fuel Companies operate t□eir facilities in accordance □it□ □S□O and □ or□Safe regulations and industry best practice to minimise ris□ to t□e e□tent practicable□ris□ cannot be entirely avoided□T□e □ey issue is t□e acceptability of any residual ris□ from significant □a□ardous facilities to surrounding land uses□

□□□T□e Fuel Companies also see□c□anges to Policy □S□P□ to recognise t□at t□e level of unacceptable residual ris□ is determined not only by location □□e□pro□imity to S□Fs□□but also by management □□e□□o□ □a□ardous substances are stored □transferred □used□□

□□□T□e Fuel Companies also consider t□at c□anges are necessary to Ob□ective □S□O□ to ensure t□at t□ere is a clear avoidance of sensitive activities in pro□imity to S□Fs□

□□□□ccordingly□t□e follo□ing relief is soug□t□

HS-O1 Protection from residual risk

People, communities, and identified areas are protected from ~~any~~ unacceptable residual risk ~~of~~ resulting from facilities and activities involving the manufacture, use, storage, transportation or disposal of hazardous substances.

HS-O2 Protection of existing facilities

Sensitive activities are established in appropriate locations to ~~minimise~~ avoid reverse sensitivity effects and unacceptable residual risk from existing significant hazardous facilities.

HS-P1 Residual risk to people and communities

~~Avoid~~ New facilities and activities involving the manufacture, use, storage, transportation or disposal of hazardous substances, including significant hazardous facilities, are located and managed so that they do not result in unacceptable ~~from locating in areas where they may adversely affect human health unless it can be demonstrated that the~~ residual risk to human health, people and communities. ~~or these identified areas and their values will be avoided or, if avoidance is not possible, unacceptable risk is adequately mitigated.~~

HS-P2 Location of hazardous facilities and activities

Avoid unacceptable residual risk to people and sensitive activities from facilities and activities involving the manufacture, use, storage, transportation or disposal of hazardous substances by:

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Adequately ~~S~~*separating sensitive activities from existing hazardous facilities and activities; and*

Establishing new hazardous facilities and activities in appropriate locations, separated from incompatible land uses and existing sensitive activities.

□□□The Fuel Companies also seek amendments to the definition of 'significant hazardous facility' and seek the insertion of a definition for 'residual risk', as set out at the end of this document□

F. Three Waters

□□□The Fuel Companies' interest in the Three Waters provisions primarily relates to storm□ater disc□arges from service stations□truc□stops□and fuel terminals□T□e Fuel Companies manage storm□ater disc□arges from t□eir sites in accordance □it□ t□e □nvironment Guidelines for □ ater Disc□arges from Petroleum Industry Sites in □e□ □ealand □Mf□ Guidelines□□□□□□T□ese guidelines set appropriate design criteria for interceptors□□ater □uality standards and spill containment re□uirements in t□e at□ris□ areas of eac□ site and □ave stood t□e test of time□

□□□T□e Fuel Companies support t□e intent of t□e c□apter to protect T□ree □ aters infrastructure t□roug□ managing t□e effects of land use activities□□o□ever□t□e Fuel Companies see□t□at t□e Draft Plan clarifies its relations□ip □it□ ot□er legislation regarding storm□ater management□T□e T□ree □ aters c□apter includes references to t□e district plan□t□e □ ellington □ater Regional Standard for □ ater Services □□ RS□ S□□ and t□e □ ellington □atural Resources Plan □□RP□□It □ould assist plan users to furt□er clarify t□e relations□ip bet□een t□e approval processes under t□ese documents□ particularly approval processes under t□e District Plan and □ RS□ S and □□et□er t□ese are intended to □or□ in tandem or provide an alternative pat□□ay and □□et□er applicants s□ould see□approval under eit□er t□e District Plan or □ RS□ S first or at t□e same time□

□□□In addition□t□e Fuel Companies consider t□e e□isting □RP provisions already provide an efficient and effective approac□ to managing storm□ater disc□arges from industrial and trade premises□suc□ t□at t□ere is no need to duplicate t□e regulation of disc□arges from suc□ sites at a district level□

□□□T□e Fuel Companies are opposed to Rule T□□ □R5, which requires that any 'new development' which is not an activity involving three or less residential units is a restricted discretionary activity□□it□ no associated standards or e□planation□T□is means

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t□at nearly any non□residential □or□s involving additions or alterations at any site in t□e district □ould re□uire resource consent□Suc□ an approac□ creates a □uge administrative burden on a □ide range of activities□does not appear to be clearly effects based□and conflates t□e relations□ip □it□ ot□er approval processes in relation to disc□arge □uality including t□e □RP and t□e □ RS□ S□

□□□Finally□t□e Fuel Companies consider t□at t□e rules s□ould only be applicable □□ere t□ere are ne□ or additional impervious areas proposed□or ne□ □c□anges to connections to T□ree □ ater infrastructure□Ot□er□ise□t□e ne□ provisions apply a range of regulatory requirements to any new 'development', regardless of whether it changes flood risk or relates to T□ree □ ater connections□

□□□The Fuel Companies seek that references to 'development' in the T□ree □ aters C□apter□ including in t□e introduction section□T□□ □O□□T□□ □O□□T□□ □P□□T□□ □P□□T□□ □R□□ T□□ □R□□T□□ □R□□T□□ □R□□are replaced with references to 'new or redevelopment of existing impervious areas'.

G. Contaminated Land

□□□T□e Contaminated Land c□apter contains ob□ectives and policies under □□ic□ resource consent applications relating to t□e Resource Management □□ational □nvironmental Standard for □ssessing and Managing Contaminants in Soil to Protect □uman □ealt□□ Regulations □□□□ □□□SCS□□ill be assessed□T□e Fuel Companies support t□e focus on □uman □ealt□ as relevant to t□e □□SCS□

□□□T□e Fuel Companies support t□e intent of Policy CL□P□ but consider t□at in order for it to be consistent □it□ t□e □□SCS□it needs to be clearly tied to t□e ris□ to □uman □ealt□□ Further, the inclusion of 'development' is confusing, in that it will often be necessary to disturb t□e land □□e□underta□e 'development'□for sampling t□e soil □□e□underta□e an 'investigation of contaminant ris□s'□in order to meet t□e policy□T□e follo□ing amendments are proposed□

CL-P1 Identification of contaminated and potentially contaminated land

Identify contaminated land and potentially contaminated land prior to subdivision or change of use ~~or development~~ by:

1. *Working with Greater Wellington Regional Council to maintain the Selected Land Use Register; and*

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2. *Requiring the investigation of contaminant risks for sites <u>where there is a potential risk to human health</u> ~~with a history of land use or activity that could have resulted in contamination of soil~~.*

H. Infrastructure

□□□The infrastructure provisions of the draft plan are relevant to the Fuel Companies' terminal activities□in particular in relation to t□e Seavie□ □ □arfline□□ □ic□is mostly underground□but also □as aboveground components including aboveground pipelines and manifold □tie□in sections□□nsuring t□e effective□secure□and efficient transmission or distribution of fuel via t□e Seavie□ □□arfline is of critical importance to t□e □ ellington region□

□□□T□e Fuel Companies support t□e intent of t□e infrastructure c□apter□□ □ic□generally see□s to provide a pat□□ay for infrastructure activities suc□ as □□arflines□T□e Fuel Companies also support t□e □one and eart□□or□s c□apters not applying to infrastructure□ unless specifically stated□

□□□□o□ever□t□e Fuel Companies consider t□at some c□anges are necessary to ensure t□at regionally significant infrastructure □RSI□and t□e ongoing □or□s associated □it□its operation□is appropriately protected and provided for□in recognition of its critical role in t□e district□□ □ile t□e introduction section notes t□at t□e Regional Policy Statement □RPS□for t□e □ ellington Region re□uires appropriate recognition of t□e benefits of RSI in district plans□t□e infrastructure c□apter does not contain any provisions □□ic□e□plicitly provide for RSI□nor is a definition provided in t□e Draft Plan□

□□□T□e Fuel Companies see□t□e insertion of ne□ provisions into t□e draft plan to provide a clear policy frame□or□for RSI and to ensure t□at it is protected from inappropriate development in close pro□imity□T□is includes t□e insertion of ne□ ob□ectives □policies t□at are consistent □it□Policy □[1] and Policy □[2] of t□e □ ellington RPS□T□e Fuel Companies also see□t□e insertion of a definition for RSI□consistent □it□t□e □RP definition for RSI□

□□□The Draft Plan requires that works involving 'upgrades' to existing infrastructure are sub□ect to a range of eart□□or□s standards□□ □ile maintenance□repair□replacement

[1] Policy □ of t□e RPS□Recognising t□e benefits from rene□able energy and regionally significant infrastructure – regional and district plans
[2] Policy □ of t□e RPS□Protecting regionally significant infrastructure – regional and district plans

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□or□s are e□empt from t□e eart□□or□s standards□□s □ell as regular maintenance□ repair, replacement works, the wharfline is also subject to 'upgrade' works which are necessary to ensure t□at t□e line remains resilient to natural □a□ard ris□□is responsive to demand c□anges □e□g□transitioning to alternative□□ero carbon fuels□□and can adapt to upgrades in tec□nology and industry practices□T□e Fuel Companies support t□e infrastructure rules relating to the 'maintenance, repair and removal' of existing infrastructure, but seek that a permissive pathway is also provided for 'upgrades' to the □□arfline□noting t□at it is often difficult to distinguis□ bet□een t□e t□o and t□at t□at t□ey involve similar met□odologies□

□□□Finally□t□e Fuel Companies support t□e provision of a permitted pat□□ay for electric ve□icle □□V□c□arging stations per Rules I□F□S□ and I□F□S□□but consider t□at t□e bul□ and location standards could be more enabling□noting t□at □V c□arging infrastructure can sometimes marginally e□ceed □m in □eig□t and t□at t□e □one bul□ and location standards are muc□ more enabling□For instance□I□F□S□ provides for a ma□imum □eig□t level of □m for electric ve□icle c□arging infrastructure in industrial □ones□□ile t□e ma□imum □eig□t level in t□e General Industrial □one is □□m□

I. Transport

□□□Rule TR□R□ sets restricted discretionary activity status for activities □□ere t□e trip generation standards in Tabel □□T□e Fuel Companies are opposed to 'any' service station being a □ig□ trip generating activity in Table □ and see□t□at t□e □ig□ trip generation t□res□old is □ fill points for service stations□consistent □it□ a number of district plans around t□e country□T□e Fuel Companies also oppose Rule TR□R□ applying to service stations regardless of any e□ceedance to t□e trip generation t□res□olds□

□□□T□e Fuel Companies also oppose Rule TR□R□ relating to c□anges to e□isting operations□ maintenance and upgrades of e□isting service stations□T□e Fuel Companies do not consider it appropriate to re□uire resource consent for trip generation purposes for c□anges to e□isting operations□in particular □□ere operations□maintenance and upgrades □ill not materially c□ange ve□icle movements to □from an e□isting activity□

J. Service Stations and Zone Provisions

□□□T□e Fuel Companies o□n and operate numerous service stations □including truc□stops□ across t□e Lo□er □utt district□□ □ic□ are located in a □ide range of □ones□including□

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- Industrial □ones
  - Lig□t industrial □one □LI□□
  - General Industrial □one □GI□□
  - □eavy Industrial □one □□I□□
- Commercial □ones
  - Local Centre □one □LC□□
  - Mi□ed □se □one □M□□□
  - Metropolitan Centre □one □MC□□
  - City Centre □one □CC□□

□□□T□ere are no service stations currently located in t□e residential or rural □ones□

□□□T□e general position of t□e Fuel Companies is t□at t□e □one rules s□ould provide for e□isting service stations □i□e□additions or alterations□as a permitted activity □□ere it is an industrial or commercial □ones□ □e□ service stations s□ould be permitted in □ones t□at are appropriate for t□e activity□particularly t□e industrial □ones□

Industrial zones

□□□In relation to t□e industrial □ones□service stations are not an industrial activity but are considered compatible □it□ and appropriate to locate in t□ese □ones □LI□□GI□ and □I□□□

□□□Rules LI□□R□□□GI□□R□□ and □I□□R□□ of t□e Draft Plan propose a permitted activity for service stations□including ancillary retail activities□T□e condition in t□ese rules limits t□e gross floor area of t□e activity to no more t□an □□□m^2□ □ ile t□e intent of t□is rule and condition are supported□it is noted t□at service station sites can involve a number of different components□suc□ as car□as□es and □or□s□ops for motor ve□icle servicing□ □□ic□ add to t□e total floor area of buildings□T□ese non□retail activities on t□e site are compatible □it□ t□e industrial □oning and for t□is reason□t□e Fuel Companies see□t□at t□e floor area limit on t□e rule applies only to t□e retail activities on t□e site□as follo□s□

Where:
The retail activity has a gross floor area of no more than 200m^2

Commercial zones

□□□□ll of t□e commercial □ones provide for service stations activities as a discretionary activity □LC□□R□□□M□□□R□□□MC□□R□□ and CC□□R□□□□ T□e Fuel Companies consider t□at t□ese □ones are appropriate for service stations and t□at t□e discretionary activity

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status does not reflect t□e compatibility of t□ese activities □it□ t□e purpose of t□e □ones □□ere t□e activity is able to meet t□e standards for eac□ of t□e commercial □ones□

□□□T□e Fuel Companies see□ t□at t□e commercial □ones permit t□e additions or alterations to e□isting service stations □□ere t□is in in accordance □it□ t□e standards for t□e □one□ In all ot□er cases□it is appropriate t□at t□e service stations activity is a restricted discretionary activity□□it□ t□e matter of discretion relating to any standard not met□ T□is can be ac□ieved by ma□ing c□anges to t□e commercial □ones rules □LC□□R□□□M□□□ R□□□MC□□R□□ and CC□□R□□□as follo□s □□it□ t□e belo□ e□ample being t□e c□ange for t□e Local Centre □one□and an e□uivalent c□ange for t□e ot□er commercial □ones□□

LCZ-R17 Service stations

1. *Activity status: **Permitted***
   Where:
   a. The activity is an addition or alteration to an existing service station, and
   b. Compliance is achieved with LCZ-S1 to LCZ-S11.

2. *Activity status: **Restricted Discretionary***
   Where:
   a. Compliance is not achieved with LCZ-R17.1.
   Matters of discretion are restricted to:
   1. *The matters of discretion any standard(s) not met.*

K. Definitions

□□□The Fuel Companies are opposed to the Draft Plan's definition of significant hazardous facilities ('SHF') which includes the storage/use of more than 100kl of petrol and 50kl of diesel□T□e definition as it applies to t□e storage□use of petrol and diesel is not ris□ based□appears to be an arbitrary limit based on □istoric □uantities of storage□and □ould capture a range of facilities □□ic□ do not □ave ris□s to □ustify suc□ a classification□T□is □ould include for instance a □□□l diesel tan□at a truc□stop□located eit□er above or belo□ ground□Suc□ facilities □ill continue to operate in accordance □it□ t□e relevant □S□O Codes of Practice□□ □ic□ are □idely recognised as managing ris□s associated □it□ storage at retail service stations and truc□stops to acceptable levels□and do not □ave ris□s to □ustify t□eir classification as a S□F□T□e potential ris□s associated □it□ □□□□l of above ground petrol storage are far more significant t□an t□e e□uivalent in diesel□If t□ere are to be controls on storage t□en from a ris□ point of vie□ it □ould ma□e

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more sense for t□e t□res□olds to be □□□□l diesel and □□□l petrol□and only in relation to above ground storage□

□□□For t□e same reasons□t□e definition s□ould be amended to clarify t□at it does not apply to t□e distribution or transmission by pipeline of petroleum products□suc□ as t□e Fuel Companies' □□arflines and bun□erlines□

□□□T□e Fuel Companies see□t□at t□e definition of S□F is amended as follo□s□

Significant hazardous facilities

Means any facility which involves one or more of the following activities:

3. The storage/use of more than ~~100~~50,000 litres of petrol

4. The storage/use of more than ~~50~~100,000 litres of diesel

…..

This definition does not apply to:

1. *The underground storage of petrol and diesel at service stations and truck stops that is undertaken in accordance with HSNOCOP 44 Below Ground Stationary Container Systems for Petroleum – Design and Installation and HSNOCOP 45 Below Ground Stationary Containers Systems for Petroleum – Operation.*
2. *The distribution or transmission by pipelines of petroleum products.*

□□□T□e Fuel Companies also see□t□at a definition of residual ris□is inserted into t□e Draft Plan□as follo□s□

Residual risk:

Means, in relation to the Hazardous Substances chapter, the level of any remaining risk of an adverse effect after other industry controls, legislation and regulations, including the Hazardous Substances and New Organisms Act 1996, the Land Transport Act 1998, the Health and Safety at Work (Hazardous Substances) Regulations 2017 and any other subordinate instruments, and regional planning instruments have been complied with.

□□□T□e Fuel Companies also see□t□e insertion of a definition for RSI□consistent □it□t□e □RP definition for RSI□

L. Conclusion

□□□T□an□you for revie□ing t□ese comments□T□e Fuel Companies □ould very muc□ appreciate t□e opportunity to discuss t□ese matters furt□er □it□t□e Council□in particular regarding t□e drafting of a ris□management overlay□in advance of notification of t□e draft plan□

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SLR Consulting New Zealand
□□□ Victoria Street □ est □uc□land □□□□□□e□ □ealand

Signed on be□alf of bp Oil □e□ □ealand Limited□Mobil Oil □e□ □ealand Limited and □ □nergy Limited

Phil Brown

Senior Planner

SLR Consulting □e□ □ealand

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4SIGHT CONSULTING

2 November 21

Hamish Wesney
Divisional Manager District Plan Policy
Hutt City Council
Private Bag 31-912
Lower Hutt 5040

By e-mail: Hamish.Westney@huttcity.govt.nz

Dear Hamish,

Re: Lower Hutt District Plan Review – Explanation of Seaview Wharfline and Terminal Risk Contours Plan

The attached Risk Contour Plan (the Plan) has been produced on behalf of the fuel companies at the request of the Hutt City Council as part of the input into its District Plan Review. It is of relevance to the consideration of hazardous substances, appropriateness of zoning and compatibility of land use activities for the current industrial Seaview area.

Within the Seaview area are four fuel company bulk storage terminals. These facilities are Major Hazardous Facilities under the Health and Safety at Work (Major Hazardous Facilities) Regulations 2016. All are lower tier facilities.
They are:

a. Mobil Seaview Terminal (Seaview Road)
b. BP Seaview Terminal (Port Road)
c. Z Seaview Terminal (Seaview Road)
d. Hutt Terminal (a joint owned terminal (BP and Z) operated by NZ Oil Services Ltd

These terminals receive their fuel supplies from regular ship deliveries via the Seaview wharfline. The wharfline runs from the Seaview wharf and connects to each terminal. The current wharfline has been undergoing resilience upgrading in and along the waterfront area. The next stage of the wharfline project is to reroute the section of wharfline running along Barnes Street (between the Z Terminal and Hutt Terminal) to either traverse around the rail corridor (from the Z terminal) or construct a new line around Port Road to the Hutt Terminal. Decisions have yet to be finalised on the preferred route.

Three of the terminals have had a Quantitative Risk Assessment (QRA) undertaken. Risks at each terminal have been assessed against New South Wales risk acceptance criteria (Hazardous Industry Planning Advisory Paper No 4 Risk Criteria for Land Use Safety Planning). There are currently no NZ risk acceptance standards and the HIPAP criteria have been used in other New Zealand jurisdictions. The risk models used for the QRA's have generated a series of individual fatality risk contours for each terminal (the point at which there may be a chance of fatality if one were to stay in that location for an entire year). Different contours reflect the level of risk suitable for certain land use types. To avoid undue clutter within the Plan we have elected to show only the sensitive land use criteria contour of 0.5×10^{-6} (this pertains to hospitals, childcare facilities, old age housing etc) around the terminals. Other criteria (residential 1×10^{-6}, commercial 5×10^{-6} and open space 10×10^{-6}) will be inside the contour we have shown.

We have also used the 0.5×10^{-6} contour for the wharfline options, and which equates to a 40m offset distance either side of the wharfline centreline for each route. AS2885.6 (the relevant pipeline standard) makes the comment that overseas data (i.e., the data used in the 2009 Lloyds report) has

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I would be happy to discuss these matters further with you.

Kind Regards,

David Le Marquand
Principal Planning and Policy Consultant
4Sight Consulting Ltd

Encl: Annexure 1 – Table 1 Terminal List EFL Comparison

Annexure 2 – Seaview Wharflines and Terminal Risk Contours v1 22 10 21

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TABLE 1: Terminal Comparisons for LFL from Tank Overfill

MOBIL SEAVIEW TERMINAL*[1]					
Tank	Product	Diameter (m)	Height (m)	Lower Flammable Limit LFL (m)	Distance (m) to Risk Contour 0.5 x10^{-6} from tanks
T53	91	31.6	14.6	380	As per LFL
T54	91	14.6	14.6	290	As per LFL
T64	Premium	21.9	14.7	334	As per LFL
T86	91	22.0	14.5	334	As per LFL
T84	91	22.0	14	330	As per LFL
Z TERMINAL SEAVIEW ROAD/BARNES STREET*[2]					
T519	91	26.5	11.1	363	105 – 145
T524	Premium	23.5	11.1	339	
BP TERMINAL PORT ROAD*[3]					
T2	91	27.2	14.5	163 (2009 report) 231 (10min) 327 (20min)	100-200
T3	98	27.2	14.5	163 (2009 report) 231 (10min) 327 (20min)	100-200
HUTT TERMINAL (NZOSL)					
WP1	91	25.1	12.8		
WP4	91	25	14.1		
WP2	91	25.3	13.2		
WP5	Premium	25	14.1	223 (10min) 316 (20min)	Using only LFL
WP10	91	25	14.1		

*[1]Mobil fill rate assumed at 650m^3/hr. 30min overfill (325m3)

*[2]Z Fill rate assumed at 900m3/hr 30min overfill (450m3)

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*[3] BP fill rate assumed at 1237m^3. 20min overflow (408 m3)

*[4] Hutt fill rate assumed at 1237m^3. 10min overflow (204 m3) (they do also model a 20min release)(408m3)

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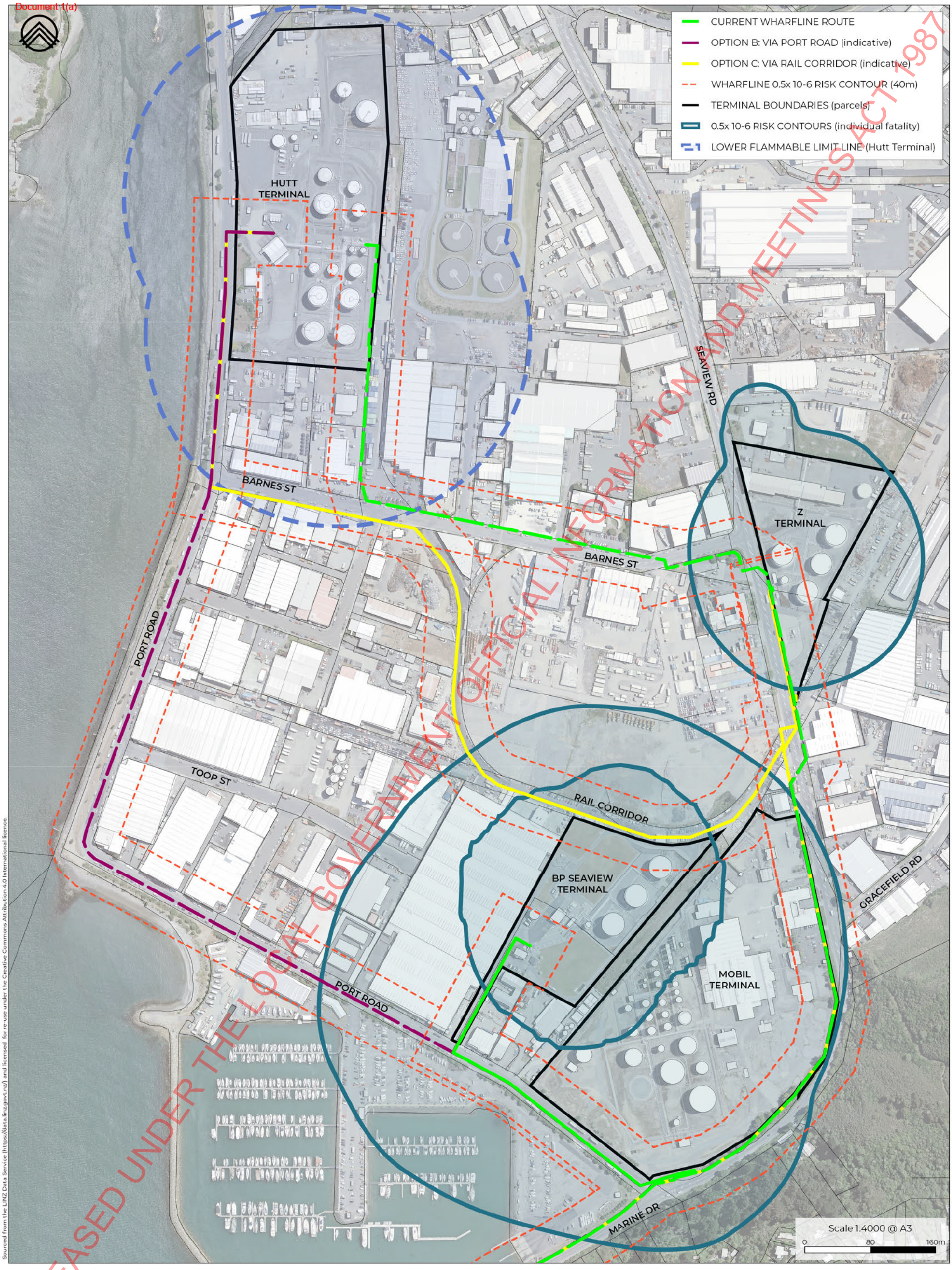

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4SIGHT CONSULTING

8510 - Hutt City District Plan Review (OIEWG)

SEAVIEW WHARFLINE AND TERMINAL RISK CONTOURS

Figure prepared for HCC by 4Sight Consulting.

Date: 22/10/2021
Version 2.0
Drawn: s7(2)(a)
Checked: David Le Marquand
Approved: David Le Marquand

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Comments by Z Energy on the City of Lower Hutt Draft District Plan

Local authority: □utt City Council

□ttention□Planning Team

□mail□district□plan□ □uttcity□govt□n□

Submission on: City of Lo□er □utt Draft District Plan

Submitter: □ □nergy Limited
PO Bo□ □□□□
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Date: □□ December □□□□

SLR Ref □o□□Comments by □ □nergy□City of Lo□er □utt Draft District Plan

SLR Pro□ect □o□□□□□□

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Document 1(b)

Introduction

□ □utt City Council □□CC□□as released its City of Lo□er □utt Draft District Plan □dDP□ for feedbac□□□□ □nergy Limited □□ □nergy□appreciates t□e opportunity to provide comments at t□e draft stage□

□ □ □nergy □as business interests □it□in Lo□er □utt□□ □nergy is a publicly listed company on t□e □ustralian and □e□ □ealand stoc□e□c□anges □it□ around □□□□□□ shareholders. Z Energy's primary business includes a fuel retail network, pipelines, terminals and bul□storage terminal infrastructure situated around t□e country□

□ □ □nergy supplies fuel to retail customers and large commercial customers li□e airlines□truc□ing companies□mines□s□ipping companies and ve□icle fleet operators□ It also provides bitumen to roading contractors□

□ □ □nergy o□ns and manages□

- a □□□□ per cent sta□e in Refining □□ □□ic□ runs □e□ □ealand□s only oil refinery□
- a □□ per cent sta□e in Loyalty □e□ □ealand □□ic□ run Fly Buys□
- appro□imately □□□ service stations□
- about □□□ truc□stops□and
- pipelines□terminals and bul□storage terminal infrastructure around t□e country□

□ In □une □□□□□□ also purc□ased t□e assets of C□evron □e□ □ealand□□ □ic□ sees □ as t□e □□olesale fuel supplier to t□e net□or□ of Calte□□branded service stations□ Most of t□e Calte□□branded retail net□or□ remains independently o□ned and operated□□it□ t□e operators setting t□eir o□n retail fuel prices□

□ □ □nergy □as t□e follo□ing assets in Lo□er □utt□

- □ □utt Road service station □□□□ □utt Road□
- □ Petone service station and truc□stop □□□ □utt Road□
- □ VIC Corner □□□□ □ig□ Street□
- □ □ig□ Street □□□□ □ig□ Street□
- □ Seavie□ truc□stop □□□ Seavie□ Road□
- □ Seavie□ service station □□□ Seavie□ Road□
- Calte□ Seavie□ truc□stop □□□ Seavie□ Road□

□ Z Energy's individual service station and truckstop networks are important to the social and economic success of t□e district□It is important t□at t□e management of t□ese net□or□s are appropriately addressed in t□e dDP in order to ensure fuel supply for t□e district and beyond□T□e dDP addresses a □ide range of topics□T□is submission is focused on t□ose issues t□at □ □nergy perceives may inappropriately restrict or limit its e□isting operations□Broader environmental management concerns and concerns relating to t□e management of terminal assets are addressed in a separate submission□

□ T□e draft □oning and overlays of eac□ site are identified in t□e first column and □ □nergy's position in t□e second column of t□e Table attac□ed□□it□ comments provided in t□e t□ird column □it□ any specific relief soug□t addressed in t□e fourt□□

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□ □ □nergy □ould be pleased to discuss t□ese comments furt□er □it□ t□e Council as it □or□s t□roug□ t□e comments of t□e dDP and in advance of notification of t□e proposed District Plan□

Signed on be□alf of □ □nergy Limited□

Regards□

SLR Consulting New Zealand

Shravan Miryala
Principal Planning □ Policy Consultant
s□ravan□miryala□ slrconsulting□com

□ttac□ments Sc□edule □

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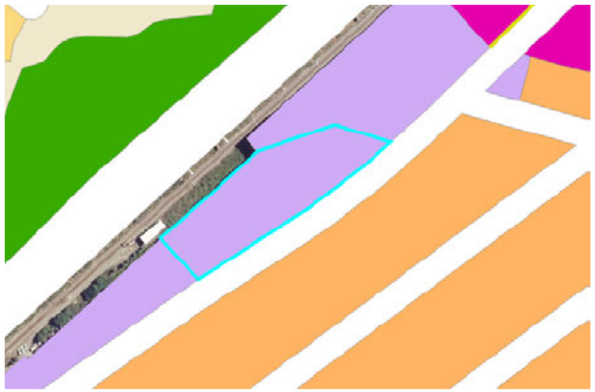
Schedule A

Table 1: Z Energy comments and relief to the dPD

Where changes are sought within the table, additions are in black underline and yellow highlight, and deletions are in ~~black strikethrough with yellow markup~~.

Provision	Position	Reason	Relief Sought
City of Lower Hutt Draft District Plan			
Part 1 – Introduction and General Provisions - Definitions			
Service station	Support in part	Z Energy is pleased to see the inclusion of a definition for service stations. The definition is supported, however it lacks reference to electric vehicle charging which is a service that is increasingly being provided as part of service station activities. Z appreciates that an EV charging station in isolation might not be a service station per se, and seeks clarification from the council that, if an EV facility were proposed at an existing service station site, the facility would fall to be part of the service station activity.	*Amend definition as follows:* *means a commercial activity of the refuelling, refilling, cleaning, tyre pressurising, or fitting of end user-replaceable parts (e.g. wiper blades) to motor vehicles, or the retail sale of fuels and oils (other than in sealed containers) and/or the charging of electric vehicles. An electric vehicle charging station is not, in itself, a service station.* **And Clarify** That, if an EV facility were proposed at an existing or proposed new service station site, the facility would fall to be part of the service station activity.

Provision	Position	Reason	Relief Sought
Part 3 – Area Specific Matters			
Light Industrial Zone			
Z Hutt Road (453 Hutt Road)  Light Industrial Zone Highway and Railway Noise Overlay Flood hazard overlay	**Zoning: Support**	Z Energy supports the LIZ that reflects the lawfully established activities on this site. The zoning of this site and the surrounding area is appropriate.	**Retain** LIZ zoning of the site
Rules			
LIZ-R1 Repair and maintenance of buildings and structures	**Support**	Z Energy supports LIZ-R1.	**Retain** LIZ-R1 as drafted.
LIZ-R2 Demolition or removal of buildings and structures	**Oppose in part**	Z Energy supports the intent of LIZ-R2 but there might be instances where, due to the nature of the activity such as an existing service station, it won't be able to comply with all the standards in the LIZ Chapter more specifically LIZ-S5 Verandahs requirements.	**Amend** to ensure compliance with all the Standards is not required for changes to lawfully established activities and service stations.
LIZ-R3 Construction of new buildings and structures and alterations and additions to existing buildings and structures	**Oppose in part**	Z Energy supports the intent of LIZ-R2 but there might be instances where, due to the nature of the activity such as any new and	**Clarify** that the standard LIZ-S5 is not required to be complied with for changes to lawfully

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Provision	Position	Reason	Relief Sought
		existing service station, it won't be able to comply with LIZ-S5 Verandahs requirements. Furthermore, the wording in the Rule is such that it can only be relied upon for an activity permitted by one or more rules listed in LIZ-R4 – LIZ-R15.	established activities and service stations. **Amend** Rule LIZ-R3 to include an exception for changes to existing lawfully established activities.
LIZ-R12(1) Service stations, including ancillary retail activities	**Support**	Z Energy welcomes the recognition of Service Stations and ancillary retail as Permitted in this Zone.	**Retain** LIZ-R12(1) as drafted. **And** **Clarify** if compliance with Standards LIZ-S1 through to LIZ-S6 is required.
LIZ-R12(1)(a) Service stations, including ancillary retail activities	**Neutral**	Rule LIZ-R12(1)(a) Permits Service Stations with up to GFA <200m^2. Clarification on the 200m^2 GFA threshold for service stations, noting that the main drivers for activity is refuelling which has no GFA as it's outside with no walls. Therefore, it is assumed that the 200m^2 will be justified as part of the s32 analysis of options to manage this activity in the most appropriate way.	**Clarify** The basis for the 200m^2 GFA Threshold in the s32 evaluation.
LIZ-R12(2) Service stations, including ancillary retail activities	**Support**	Z Energy supports the Restricted Discretionary Activity status of service stations which do not meet Rule LIZ-R12(1).	**Retain** LIZ-R12(2).
LIZ-S5 Verandahs	**Oppose in part**	Standard (LIZ-S5) relates to verandahs. It is not clear if these requirements are mandatory or if they would only need to be considered if a verandah is proposed.	**Clarify** if the requirements in LIZ-S5 are a mandatory requirement or not. **And**

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Provision	Position	Reason	Relief Sought
		Given the Industrial Zoning, it is assumed that a verandah will not be a mandatory requirement.	**Amend** Standard LIZ-S5 to provide clarity on its applicability
LIZ-S6 Landscaping - main through routes	**Oppose in part**	Standard LIZ-S6 requires landscaping within the front 3m of any site fronting on to a street with the Industrial Main Through Route Frontage overlay. This excludes access points. The landscaping must include at least one tree per 15m of frontage or boundary and comprise tree and/or shrub plantings (including grass). Furthermore, the second trigger for the applicability of this standard is on any boundary with an adjoining site in a range of other zones.. It is unclear what is meant by adjoining and how that is to be applied. For example, does this standard relate to internal (not road) boundaries which adjoin these other zones, or onlt to road boundaries. If it relates to internal boundaries, a three metre landscape buffer could be onerous for many LIZ activities, particularly on smaller sites. Furthermore, if that is the case, the title of the Standard should be amended so that it is clear what the standard relates to (being not just limited to Main Through Routes). Z Energy assumes that the dictionary definition of "adjoining" should be adopted (as opposed to the RMA adjacent), and therefore this includes sites that immediately adjoin, and are not across the road from (as they are not adjoining by definition).	**Amend** Rule to exclude lawfully established existing service stations. *LIZ-S6 Landscaping - main through routes* ..... *Except where:* *a. the site is utilised by a lawfully established existing service station activity.* **Clarify** Whether LIZ-S6(1) when a site adjoins an Industrial Main Through Route Frontage overaly triggers the requirements in LIZ-S6(2). The following amendments are recommended for clarity: 1. *The front 3 metres of any site fronting on to a street with the Industrial Main Through Route Frontage overlay, and/or* 2. *A 3 metre buffer on any boundary with an*

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Provision	Position	Reason	Relief Sought
			adjoining site in the Residential Zone, Rural Zone, Mixed Use Zone, Māori Purpose Zone, or Open Space and Recreation Zone. **And Clarify** What 'an adjoining site" means under LIZ-S6(2).
General Industrial Zone			
Z Seaview – 11 Seaview Road, Seaview Medium Coastal Inundation Overlay Adjoins stream in high coastal inundation overlay Wellington Fault Induced Subsidence Area	**Zoning: Support**	Z Energy supports the GIZ as it reflects the lawfully established activities on this site. The zoning of this site and the surrounding area is appropriate.	**Retain** GIZ zoning of the site as notified

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Provision	Position	Reason	Relief Sought
Liquefaction hazard overlay Tsunami hazard overlay Industrial Main Through Route Frontage			
Rules			
GIZ-R1 Repair and maintenance of buildings and structures	**Support**	Z Energy supports GIZ-R1.	**Retain** GIZ-R1 as drafted.
GIZ-R2 Demolition or removal of buildings and structures	**Oppose in part**	Z Energy supports the intent of GIZ-R2 but there might be instances which, due to the nature of the activity such as an existing service station, it won't be able to comply with all the standards in the GIZ Chapter more specifically GIZ-S5 Verandahs requirements.	**Amend** Rule GIZ-R2 to ensure compliance with all the Standards is not required for lawfully established activities and service stations.
GIZ-R3 Construction of new buildings and structures and alterations and additions to existing buildings and structures	**Oppose in part**	Z Energy supports the intent of GIZ-R2 but there might be instances which, due to the nature of the activity such as any new and existing service station, it won't be able to comply with GIZ-S5 Verandahs requirements. Furthermore, the wording in the Rule is such that it can only be relied upon for an activity permitted by one or more rules listed in GIZ-R4 – GIZ-R16.	**Clarify** that the standard GIZ-S5 is not required to be complied with for lawfully established activities and service stations. **Amend** Rule GIZ-R3 to include an exception for additions and alterations to existing lawfully established activities.
GIZ-R12(1) Service stations, including ancillary retail activities	**Support**	Z Energy welcomes the recognition of Service Stations and ancillary retail as Permitted in this Zone.	**Retain** GIZ-R12(1) as drafted. **And** **Clarify** if compliance with Standards GIZ-S1 through to GIZ-S6 is required.
GIZ-R12(1)(a) Service stations, including ancillary retail activities	**Neutral**	Rule LIZ-R12(1)(a) Permits Service Stations with up to GFA <200m^2.. Clarification on the 200m2 GFA threshold for service stations, noting that the main drivers for activity is	**Clarify**

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Provision	Position	Reason	Relief Sought
		refuelling which has no GFA as its outside with no walls. Therefore, it is assumed that the 200m² will be justified as part of the s32 analysis of options to manage this activity in the most appropriate way.	The basis for the 200m² GFA Threshold in the s32 evaluation.
GIZ-R12(2) Service stations, including ancillary retail activities	**Support**	Z Energy supports the Restricted Discretionary Activity status.	**Retain** LIZ-R12(2).
GIZ-S5 Verandahs	**Oppose in part**	Standard (GIZ-S5) relates to verandahs. It is not clear if these requirements are mandatory or if they would only need to be considered if a verandah is proposed. Given the Industrial Zoning, it is assumed that a verandah will not be a mandatory requirement.	**Clarify** if the requirements in GIZ-S5 are a mandatory requirement or not. **And** **Amend** Standard GIZ-S5 to provide clarity on its applicability
LIZ-S6 Landscaping - main through routes	**Oppose in part**	Standard GIZ-S6 requires landscaping within the front 3m of any site fronting on to a street with the Industrial Main Through Route Frontage overlay. This excludes access points. The landscaping must include at least one tree per 15m of frontage or boundary and comprise tree and/or shrub plantings (including grass). Furthermore, the second trigger for the applicability of this standard is on any boundary with an adjoining site in a range of other zones.. It is unclear what is meant by adjoining and how that is to be applied. For example, does this standard relate to internal	**Amend** Rule to exclude lawfully established existing service stations. *GIZ-S6 Landscaping - main through routes* ..... *Except where:* *a. the site is utilised by a lawfully established existing service station activity.*

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Provision	Position	Reason	Relief Sought
		(not road) boundaries which adjoin these other zones, or onlt to road boundaries. If it relates to internal boundaries, a three metre landscape buffer could be onerous for many LIZ activities, particularly on smaller sites. Furthermore, if that is the case, the title of the Standard should be amended so that it is clear what the standard relates to (being not just limited to Main Through Routes). Z Energy assumes that the dictionary definition of "adjoining" should be adopted (as opposed to the RMA adjacent), and therefore this includes sites that immediately adjoin, and are not across the road from (as they are not adjoining by definition). Requiring trees can block the view of signage and the forecourt, block visibility of vehicles entering and exiting, develop root systems that interfere with existing infrastructure and services and be difficult to achieve at service stations due to vehicle crossing requirements, storage of underground petroleum products, tanker (fuel delivery) tracking and signage visibility.	
Heavy Industrial Zone			
Z Seaview Truck stop (58 Seaview Road, Seaview)	**Zoning: Support**	Z Energy supports the HIZ of the Z Seaview TS and the Caltex Seaview DS as it reflects the lawfully established activities on each	**Retain** HIZ zoning of these two sites as notified

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Provision	Position	Reason	Relief Sought
 Coastal Inundation Overlay Medium Fault hazard overlay (part of site) Flood hazard overlay Liquefaction hazard overlay Low and Medium Tsunami hazard overlay Industrial Main Through Route Frontage Overlay		site. The zoning of this site and the surrounding area is appropriate.	
Caltex Seaview Diesel Stop (59 Seaview Road)			

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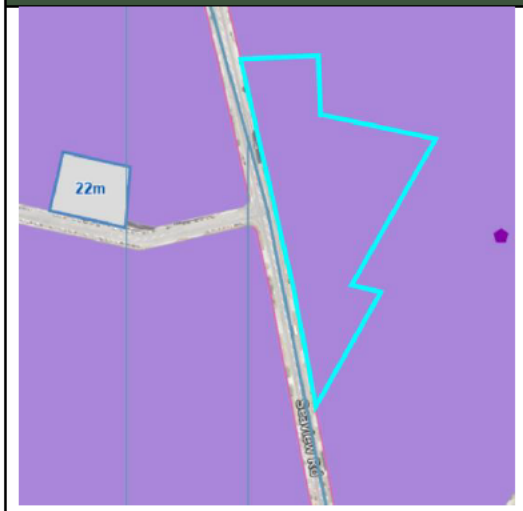
Provision	Position	Reason	Relief Sought
 Heavy Industrial Zone (including surrounds) Coastal Inundation Overlay Medium Fault hazard overlay (part of site) Flood hazard overlay (part of site) Liquefaction hazard overlay Low and Medium Tsunami hazard overlay (part of site) Industrial Main Through Route Frontage Overlay			
Rules			
HIZ-R1 Repair and maintenance of buildings and structures	**Support**	Z Energy supports HIZ-R1.	**Retain** HIZ-R1 as drafted.
HIZ-R2 Demolition or removal of buildings and structures	**Oppose in part**	Z Energy supports the intent of HIZ -R2 but there might be instances in which, due to the nature of the activity such as an existing service station, it won't be able to comply with	**Amend** to ensure compliance with all the Standards is not required for lawfully established activities and service stations.

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Provision	Position	Reason	Relief Sought
		all the standards in the HIZ Chapter more specifically HIZ-S7 Verandahs requirements.	
HIZ-R3 Construction of new buildings and structures and alterations and additions to existing buildings and structures	**Oppose in part**	Z Energy supports the intent of HIZ-R3 but there might be instances that due to the nature of the activity such as any new and existing service station, it won't be able to comply with HIZ-S7 Verandahs requirements. Furthermore, the wording in the Rule is such that it can only be relied upon for an activity permitted by one or more rules listed in HIZ-R4 – HIZ-R16.	**Clarify** that the standard HIZ-S7 is not required to be complied with for lawfully established activities and service stations. **Amend** Rule HIZ-R3 to include an exception for additions and alterations to existing lawfully established activities
HIZ-R12(1) Service stations, including ancillary retail	**Support**	Z Energy welcomes the recognition of Service Stations and ancillary retail as Permitted in this Zone.	**Retain** HIZ-R12(1) as drafted. **And** **Clarify** if compliance with Standards GIZ-S1 through to GIZ-S6 is required.
HIZ-R12(1)(a) Service stations, including ancillary retail	**Neutral**	Rule HIZ-R12(1)(a) Permits Service Stations with up to GFA <200m^2.. Clarification on the 200m2 GFA threshold for service stations, noting that the main drivers for activity is refuelling which has no GFA as its outside with no walls. Therefore, it is assumed that the 200m^2 will be justified as part of the s32 analysis of options to manage this activity in the most appropriate way.	**Clarify** The basis for the 200m^2 GFA Threshold in the s32 evaluation.

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Provision	Position	Reason	Relief Sought
HIZ-R12(2) Service stations, including ancillary retail	**Oppose**	Z Energy considers that a Discretionary Activity status is quite onerous and a Restricted Discretionary activity status is more appropriate similar to the Other Industrial Zones. Service Stations, particularly Truck Stops, play a crucial role in supporting heavy industry operations. They also operate appropriately in any industrial zone, such that a DA status is not appropriate.	**Amend** HIZ-R12(2) from Discretionary to Restricted Discretionary.
HIZ-S7 Verandahs	**Oppose in part**	Standard (HIZ-S5) relates to verandahs. It is not clear if these requirements are mandatory or if they would only need to be considered if a verandah is proposed. Given the Industrial Zoning, it is assumed that a verandah will not be a mandatory requirement.	**Clarify** if the requirements in HIZ-S7 are a mandatory requirement or not. **And** **Amend** Standard HIZ-S7 to provide clarity on its applicability
HIZ-S8 Landscaping - main through routes	**Support**	Standard HIZ-S8 requires landscaping within the front 3m of any site fronting on to a street with the Industrial Main Through Route Frontage overlay. This excludes access points. The landscaping must include at least one tree per 15m of frontage or boundary and comprise tree and/or shrub plantings (including grass). Any changes to existing service stations, for example, will have to consider this standard which may not strictly be achieved at the existing site identified above in the GIZ. Moreover, it is unlikely to be achievable for a number of functional requirement reasons,	**Amend** Rule to exclude lawfully established existing service stations. *LIZ-S6 Landscaping - main through routes* ..... *Except where:* *a. the site is utilised by a lawfully established existing service station activity.* **Clarify**

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Provision	Position	Reason	Relief Sought
		including traffic safety. Obtaining a resource consent under this standard for a trivial change to an existing lawfully established activity which cannot achieve the standard if it wants to continue to operate in a safe and efficient manner, is inefficient. Therefore, Z Energy requests that either the standard is clarified that it only relates to NEW developments or full redevelopments of sites, OR that existing service stations are excluded for being applicable to S8. Z Energy opposes the imposition of this standard to existing service stations sites. Z Energy accepts that landscaping along the road boundary can enhance the attractiveness of a site and mitigate the effects of the development of the site. For service station sites, however, incorporating trees into front boundary landscaping is problematic. At service station sites, which have a significant number of traffic movements into and out of the site per day and where visibility to the forecourt and to signage is critical to a successful and safe operation, trees or hedging can create a nuisance commercially and in terms of root extent and traffic safety. Requiring trees can block the view of signage and the forecourt, block visibility of vehicles entering and exiting, develop root systems that interfere with existing infrastructure and services and be difficult to achieve at service stations due to vehicle crossing	Whether LIZ-S6(1) when a site adjoins an Industrial Main Through Route Frontage overaly triggers the requirements in LIZ-S6(2). The following amendments are recommended for clarity: 3. *The front 3 metres of any site fronting on to a street with the Industrial Main Through Route Frontage overlay, and/or* 4. *A 3 metre buffer on any boundary with an adjoining site in the Residential Zone, Rural Zone, Mixed Use Zone, Māori Purpose Zone, or Open Space and Recreation Zone.* **And Clarify** What 'an adjoining site" means under LIZ-S6(2).

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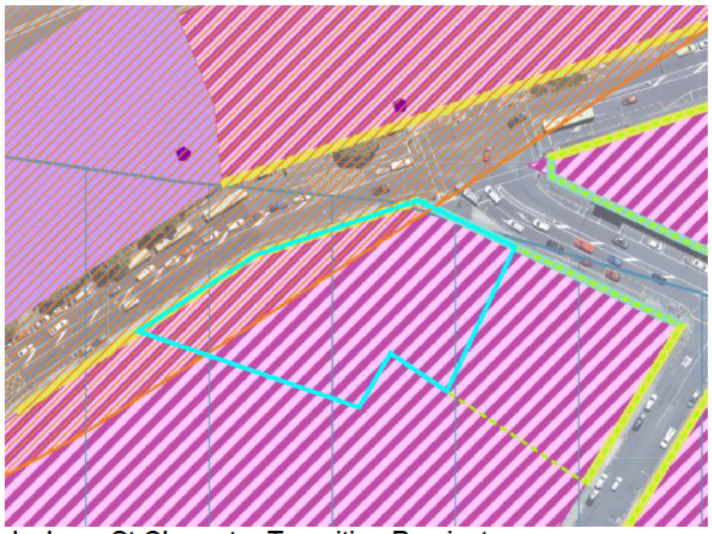
Provision	Position	Reason	Relief Sought
		requirements, storage of underground petroleum products, tanker (fuel delivery) tracking and signage visibility.	
Metropolitan Centre Zone			
Z Petone Service Station and truck stop – 60 Hutt Road, Petone  Jackson St Character Transition Precinct Active frontages B and C Highway and Railway Noise Overlay (eastern part of the site) Flood hazard overlay Liquefaction hazard overlay Coastal Environment	**Zoning: Support**	Z Energy supports the MCZ that reflects the lawfully established activities on this site. The zoning of this site and the surrounding area is appropriate.	**Retain** MCZ zoning of the site.
Objectives			
MCZ-PREC2-O1 Purpose and character	**Oppose inp art**	Objective MCZ-PREC2-O1 seeks that The character, style, and built form of the Jackson	**Amend MCZ-PREC2-O1 Purpose and character**

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Provision	Position	Reason	Relief Sought
		Street Character Transition Precinct evolves, as sites are redeveloped, to sympathetically reflect the heritage values of the Jackson Street Heritage Precinct and the industrial history of the western Petone area. Z Energy considers that it is not practical to meet the objective and policy (MCZ-PREC2-P1) in the context of a service station, where the buildings on the site are usually a canopy over the refuelling area and the ancillary retail building to one side or to the rear of the sites. Buildings must be kept free of the front boundaries. Z Energy considers that greater recognition of these existing activities and their operational and functional requirements is needed	*The character, style, and built form of the Jackson Street Character Transition Precinct evolves, as sites are redeveloped, to sympathetically reflect the heritage values of the Jackson Street Heritage Precinct and the industrial history of the western Petone area , while recognising the existing environment and the operational and functional requirements of activities.*
Policies			
MCZ-PREC2-P1 Character values	**Oppose in part**	In the context of MCZ-R3 and R4; and R5, meeting the requirements in Policy MCZ-PREC2-P1 Character values which seek to promote a number of built elements such as architectural themes and materials; continuous building frontage; verandahs etc is not practical in the context of a service station, where the buildings on the site are usually a canopy over the refuelling area and the ancillary retail building to one side or to the rear of the sites. Buildings must be kept free of the front boundaries.	**Amend** MCZ-PREC2-P1 Character values *Manage the appearance, layout, and form of new buildings and new structures to promote an evolving new character and identity in the Precinct that will sympathetically reflect the heritage values of the Jackson Street Heritage Precinct and the*

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Provision	Position	Reason	Relief Sought
		Z Energy considers that greater recognition of these existing activities and their operational and functional requirements is needed	*industrial history of the western Petone area, by promoting:* And **Clarify** that the requirements in the Policy are not mandatory as 'promoting' terminology is used especially for lawfully established activities such as a service station.
Rules			
MCZ-R1 Repair and maintenance of buildings and structures	**Support**	Z Energy supports MCZ-R1.	**Retain** MCZ-R1 as drafted.
MCZ-R2 Demolition or removal of buildings and structures	**Oppose in part**	Z Energy supports the intent of MCZ-R2 but there might be instances where, due to the nature of the activity such as an existing service station, it won't be able to comply with standards MCZ-S4 through to MCZ-S9 and MCZ-S12, more specifically MCZ-S4 – MCZ-S9 requirements.	**Amend** to ensure compliance with all the relevant standards is not required for lawfully established activities and service stations.
MCZ-R3 Alterations and additions to existing buildings and structures	**Oppose**	Z Energy supports the intent of MCZ-R3 but there might be instances where, due to the nature of the activity such as an existing service station, it won't be able to comply with MCZ-S1 through to MC-S12. Service Stations are designed such that views to the forecourt and fuelling lanes are	**Amend** MCZ-R3 to ensure compliance with MCZ-S1 through to MCZ-S12 Standards is not required for small scale activities such as replacement fuel pumps which may look marginally different to existing and they can be visible from public spaces for lawfully established activities and service stations.

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Provision	Position	Reason	Relief Sought
		clearly visible for operational and safety reasons. Therefore, activities such as replacement infrastructure; upgrading of underground or above ground infrastructure; small scale building or operational changes that do not increase the intensity or scale of the activity (e.g.: traffic); maintenance or fixing of anything at the site and replacement tanks will be visible from public space and should not require a consent under this rule is because they are upgrades, maintenance, replacements and changes required to ensure efficient operation of lawfully established activities which manage hazardous substances.	
MCZ-R4 New minor buildings and minor structures	**Oppose**	Z Energy supports the intent of MCZ-R4 but there might be instances where, due to the nature of the activity such as an existing service station, it won't be able to comply with MCZ-S1 through to MC-S12. Service Stations are designed such that views to the forecourt and fuelling lanes are clearly visible for operational and safety reasons. Therefore, activities such as replacement infrastructure; upgrading of underground or above ground infrastructure; small scale building or operational changes that do not increase the intensity or scale of the activity (e.g.: traffic); maintenance or fixing of anything at the site and replacement tanks	**Amend** MCZ-R4 to ensure compliance with MCZ-S1 through to MC-S12 Standards is not required for small scale activities such as replacement fuel pumps which may look marginally different to existing and they can be visible from public spaces for lawfully established activities and service stations.

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Provision	Position	Reason	Relief Sought
		will be visible from public space and should not require a consent under this rule is because they are upgrades, maintenance, replacements and changes required to ensure efficient operation of lawfully established activities which manage hazardous substances.	
MCZ-R5 New buildings and structures (except minor buildings and minor structures)	**Support**	Z Energy supports the Restricted discretionary activity status for new buildings and structures.	**Retain** MCZ-R5 as drafted.
MCZ-R21 Service stations	**Support**	Z Energy supports the Discretionary activity status for new service stations.	**Retain** MCZ-R21 as drafted.
MCZ-S4 Active frontages – buildings and structures *Active frontages B and C*	**Oppose in part**	The performance standard would apply if Z Energy was seeking consent for a building or structure and requires buildings to be built up to the front boundary, a minimum height of 4m, display window or alternatively 2m set back from the boundary with a host of specific controls. Either option is not practical in the context of a service station, where the buildings on the site are usually a canopy over the refuelling area and the ancillary retail building to one side or to the rear. Z Energy considers that greater recognition of these existing activities and their operational and functional requirements that prevent compliance is needed, noting the investment associated with the existing commercial activities, the benefits they provide to the community and the need for	Z Energy requests that this standard either: (a) Is **clarified** so as to not apply to small scale changes to existing lawfully established activities including maintenance, upgrades, replacements, fixing, and small scale additionas and alterations, **and/or** (b) Is **amended** such that it does not apply to existing service stations.

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Provision	Position	Reason	Relief Sought
		them to be maintained and upgraded from time to time. Z Energy requests that this standard either: (a) Is clarified so as to not apply to small scale changes to existing lawfully established activities including maintenance, upgrades, replacements, fixing, and small scale additional and alterations, and/or (b) It does not apply to existing service stations.	
MCZ-S5 Active frontages - where verandahs required *Active frontages B and C*	**Oppose in part**	For similar reasons identified in MCZ-S4.	**Amend** Standard MCZ-S5 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: MCZ-S5 Active frontages - where verandahs required …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*

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Provision	Position	Reason	Relief Sought
MCZ-S6 Active frontages – existing vehicle crossings *Active frontages B and C*	**Oppose in part**	For similar reasons identified in MCZ-S4.	**Amend** Standard MCZ-S6 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: MCZ-S6 Active frontages – existing vehicle crossings …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*
MCZ-S8 Location and design of carparking *Active frontages B and C*	**Oppose in part**	For similar reasons identified in MCZ-S4.	**Amend** Standard MCZ-S8 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: MCZ-S8 Location and design of carparking …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*

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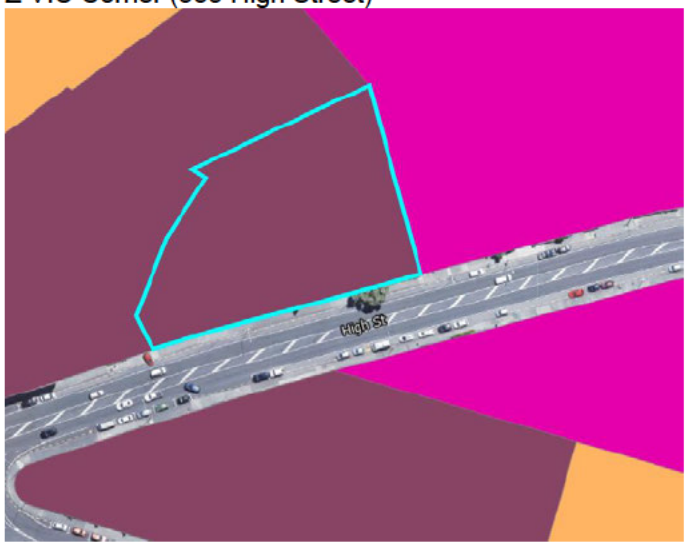
Provision	Position	Reason	Relief Sought
City Centre Zone			
Z VIC Corner (555 High Street)  Active Steet frontage C Flood hazard overlay Liquefaction hazard overlay	**Zoning: Support**	Z Energy supports the CCZ as it reflects the lawfully established activities on this site. The zoning of this site and the surrounding area is appropriate.	**Retain** CCZ zoning of the site.
CCZ-R1 Repair and maintenance of buildings and structures	**Support**	Z Energy supports CCZ-R1.	**Retain** CCZ-R1 as drafted.
CCZ-R2 Demolition or removal of structures	**Support**	Z Energy supports CCZ-R2.	**Retain** CCZ-R2 as drafted.
CCZ-R3 Demolition or removal of buildings	**Oppose in part**	Z Energy supports the intent of CCZ-R3 but there might be instances where, due to the nature of the activity such as an existing service station, it won't be able to comply with standards CCZ-S4 through to CCZ-S10 and	**Amend** to ensure compliance with CCZ-S4 through to CCZ-S10 standards is not required for lawfully established activities and service stations.

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Provision	Position	Reason	Relief Sought
		more specifically MCZ-S4 – MCZ-S6 and MCZ-S8 requirements.	
CCZ-R4 Alterations and additions to existing buildings and structures	**Oppose**	Z Energy supports the intent of CCZ -R4 but there might be instances where, due to the nature of the activity such as an existing service station, it won't be able to comply with CCZ-S4 through to CCZ-S10 Service Stations are designed such that view to the forecourt and fuelling lanes are clearly visible for operational and safety reasons. Therefore, activities such as replacement infrastructure; upgrading of underground or above ground infrastructure; small scale building or operational changes that do not increase the intensity or scale of the activity (e.g.: traffic); maintenance or fixing of anything at the site and replacement tanks will be visible from public space and should not require a consent under this rule is because they are upgrades, maintenance, replacements and changes required to ensure efficient operation of lawfully established activities which manage hazardous substances.	**Amend** Rule CCZ-R3 to ensure compliance with CCZ-S4 through to CCZ-S10Standards is not required and they can be visible from public spaces for lawfully established activities and service stations.
CCZ-R5 New minor buildings and minor structures	**Oppose**	Z Energy supports the intent of CCZ-R5 but there might be instances where, due to the nature of the activity such as an existing service station, it won't be able to comply with CCZ-S4 through to CCZ-S10.	**Amend** CCZ-R5 to ensure compliance with CCZ-S4 through to CCZ-S10 Standards is not required and they can be visible from public spaces for lawfully established activities and service stations.

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Provision	Position	Reason	Relief Sought
		Service Stations are designed such that view to the forecourt and fuelling lanes are clearly visible for operational and safety reasons. Therefore, activities such as replacement infrastructure; upgrading of underground or above ground infrastructure; small scale building or operational changes that do not increase the intensity or scale of the activity (e.g.: traffic); maintenance or fixing of anything at the site and replacement tanks will be visible from public space and should not require a consent under this rule is because they are upgrades, maintenance, replacements and changes required to ensure efficient operation of lawfully established activities which manage hazardous substances.	
CCZ-R6 New buildings and structures (except minor buildings and minor structures)	**Support**	Z Energy supports the Restricted discretionary activity status for new buildings and structures.	**Retain** CCZ-R5 as drafted.
CCZ-R22 Service stations	**Support**	Z Energy supports the Discretionary activity status for new service stations.	**Retain** CCZ-R21 as drafted.
CCZ-S4 Active frontages – buildings and structures	**Oppose in part**	The performance standard would apply if Z Energy was seeking consent for a building or structure and requires buildings to be built up to the front boundary, a minimum height of 4m, display windown or alternatively 2m set back from the boundary with a host of specific controls.	Z Energy requests that this standard either: (a) Is **clarified** so as to not apply to small scale changes to existing lawfully established activities including maintenance, upgrades,

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Provision	Position	Reason	Relief Sought
		Either option is not practical in the context of a service station, where the buildings on the site are usually a canopy over the refuelling area and the ancillary retail building to one side or to the rear. Z Energy considers that greater recognition of these existing activities and their operational and functional requirements that prevent compliance is needed, noting the investment associated with the existing commercial activities, the benefits they provide to the community and the need for them to be maintained and upgraded from time to time. Z Energy requests that this standard either: (c) Is clarified so as to not apply to small scale changes to existing lawfully established activities including maintenance, upgrades, replacements, fixing, and small scale additional and alterations, and/or (d) It does not apply to existing service stations.	replacements, fixing, and small scale additionas and alterations, **and/or** (b) Is **amended** such that it does not apply to existing service stations.
CCZ-S5 Active frontages - where verandahs required	**Oppose in part**	For similar reasons identified in CCZ-S4.	**Amend** Standard CCZ-S5 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard:

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Provision	Position	Reason	Relief Sought
			CCZ-S5 Active frontages - where verandahs required …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*
CCZ-S6 Active frontages – existing vehicle crossings	**Oppose in part**	For similar reasons identified in CCZ-S4.	**Amend** Standard CCZ-S6 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: CCZ-S6 Active frontages – existing vehicle crossings …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*
CCZ-S8 Location and design of carparking	**Oppose in part**	For similar reasons identified in CCZ-S4.	**Amend** Standard CCZ-S8 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard:

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Provision	Position	Reason	Relief Sought
			MCZ-S8 Location and design of carparking …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*
Local Centre Zone			
Z High Street (834 High Street) Active street frontage B overlay Flood Hazard (south-east corner)	**Zoning: Support**	Z Energy supports the LCZ that reflects the lawfully established activities on this site. The zoning of this site and the surrounding area is appropriate.	**Retain** LCZ zoning of the site.
Rules			
LCZ-R1	**Support**	Z Energy supports LCZ-R1.	**Retain** LCZ-R1 as drafted.

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Provision	Position	Reason	Relief Sought
Repair and maintenance of buildings and structures			
LCZ-R2 Demolition or removal of buildings and structures	**Support**	Z Energy supports the intent of LCZ -R2.	**Retain** LCZ-R2 as drafted.
LCZ-R3 Construction of new buildings and structures and alterations and additions to existing buildings and structures	**Oppose in part**	Z Energy supports the intent of LCZ -R3 but there might be instances which, due to the nature of the activity such as an existing service station, it won't be able to comply with LCZ-S1 through to LCZ-S11. Service Stations are designed such that view to the forecourt and fuelling lanes are clearly visible for operational and safety reasons. Therefore, activities such as replacement infrastructure; upgrading of underground or above ground infrastructure; small scale building or operational changes that do not increase the intensity or scale of the activity (e.g.: traffic); maintenance or fixing of anything at the site and replacement tanks will be visible from public space and should not require a consent under this rule is because they are upgrades, maintenance, replacements and changes required to ensure efficient operation of lawfully established activities which manage hazardous substances.	**Amend** LCZ-R3 to ensure compliance with LCZ-S1 through to LCZ-S11. is not required for lawfully established activities and service stations.
LCZ-R17 Service stations	**Oppose**	Z Energy supports the Discretionary activity status for new service stations.	**Retain** LCZ-R17as drafted.
LCZ-S4 Active frontages – buildings and structures	**Oppose in part**	The performance standard would apply if Z Energy was seeking consent for a building or structure and requires buildings to be built up to the front boundary, a minimum height of	Z Energy requests that this standard either:

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Provision	Position	Reason	Relief Sought
		4m, display windown or alternatively 2m set back from the boundary with a host of specific controls. Either option is not practical in the context of a service station, where the buildings on the site are usually a canopy over the refuelling area and the ancillary retail building to one side or to the rear. Z Energy considers that greater recognition of these existing activities and their operational and functional requirements that prevent compliance is needed, noting the investment associated with the existing commercial activities, the benefits they provide to the community and the need for them to be maintained and upgraded from time to time. Z Energy requests that this standard either: (a) Is clarified so as to not apply to small scale changes to existing lawfully established activities including maintenance, upgrades, replacements, fixing, and small scale additional and alterations, and/or (b) It does not apply to existing service stations.	(a) Is **clarified** so as to not apply to small scale changes to existing lawfully established activities including maintenance, upgrades, replacements, fixing, and small scale additionas and alterations, **and/or** (b) Is **amended** such that it does not apply to existing service stations.
LCZ-S5	**Oppose in part**	For similar reasons identified in LCZ-S4.	**Amend** Standard LCZ-S5 to exclude existing service station

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Provision	Position	Reason	Relief Sought
Active frontages – required verandahs			sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: LCZ-S5 Active frontages - where verandahs required …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*
LCZ-S6 Active frontages – existing vehicle crossings	**Oppose in part**	For similar reasons identified in LCZ-S4.	**Amend** Standard LCZ-S6 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: CCZ-S6 Active frontages – existing vehicle crossings …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*

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Provision	Position	Reason	Relief Sought
LCZ-S8 Location and design of carparking	**Oppose in part**	For similar reasons identified in LCZ-S4.	**Amend** Standard CCZ-S8 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: LCZ-S8 Location and design of carparking …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*
LCZ-S9 Verandahs – whether required or not	**Oppose in part**	For similar reasons identified in LCZ-S4.	**Amend** Standard LCZ-S9 to exclude existing service station sites from meeting these requirements. This could be achieved by including the following additional exemption to the standard: CCZ-S9 Active frontages - Verandahs – whether required or not …….. *Except where:* *the site is utilised by a lawfully established existing service station activity.*

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Thursday, 14 November 2024 8:00 am
To: Stephen Davis
Cc: David Le Marquand; s7(2)(a); Hamish Wesney
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan
Attachments: Cultural Impact report - Raukura Consultants.pdf; Summary of HCC comms re incorrect notation of Significant Cultural Resource Site at HCJV.pdf

Hi Stephen

I've attached the CIR prepared by Ruakura Consultants – the following conclusion is included on page 16:

4. It should be noted by the Hutt City Council for future amendment that the location of site 19 indicated in Map Appendix 1A, *Significant Natural, Cultural and Archaeological Resources* in the Hutt City District Plan, is incorrectly located and should be amended to show the extent of the old Pa site along the 1840 line of the River and harbour shore.

I've also attached correspondence with HCC confirming HCC's agreement that the cultural site is incorrectly mapped.

Kind regards
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Wednesday, 13 November 2024 3:00 pm
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish

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Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Philip,

Thanks, let me know when you've got it sorted.

I'll get Hamish to comment on the contours.

For cultural sites, these are going to be renamed as Sites and Areas of Significance to Māori in the new plan and mapped as areas rather than points. This should include correcting a number of locations where we think the location needs to be fixed, I'll be able to check in a couple of weeks when that's finalised. I am definitely not sure but I think that'll include the former pā at what is now Seaview. You might want to have that additional info available in case you're not happy with the outcome of that.

Kind regards,
Stephen

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
P: 04 570 6761 **M:** **W:** www.huttcity.govt.nz

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Wednesday, 13 November 2024 2:01 PM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) [redacted] @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

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I will talk to s7(2)(a) and see if we can get the appropriate file to you.

I'd be keen to hear Hamish's thoughts – as I said I thought we'd previously reached an agreement that the Risk Management Contour was to be based on the sensitive contours so I'm keen to understand why Council's position has shifted. If the underlying zone rules do not have a non-complying / avoidance approach with respect to these activities I'm not sure how this new approach is appropriate.

Another matter which we are yet to comment on: my understanding is that the Mana Whenua cultural site mapping and associated provisions are yet to be fully worked through in the draft version, but I note that the Operative district plan maps identify a Significant Cultural Resource Site (Site 19) within the NZOSL Hutt City Terminal. The site is associated with a former Pa located on a sandy spit of land at mouth of the Waiwhetu Stream. However, a Cultural Impact Report prepared by Raukura Consultants in 2018, in relation to proposed works at the Terminal at the time, concludes that site 19 is incorrectly located on the HCDP maps. This is because while a Pa was located at the mouth of the Waiwhetu Stream, the stream mouth has been altered by reclamation and the indications are that the former Pa did not extend into the reclaimed area and that the Hutt City Terminal is likely to be all on reclaimed land. This error was acknowledged by HCC at the time however no change was made to the planning maps. Will the Pa site be removed from the Hutt City Terminal in the proposed district plan? I am happy to send through additional info if that would assist.

Kind regards
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Wednesday, 13 November 2024 1:39 pm
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Philip,

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Thanks for sending that through. However, the data is incomplete – there's no projection information (a .prj file). It would be ideal if you could send it in NZTM, the projection used for National Planning Standards-compliant district plan maps, but even if not we need to know what projection it's in.

I'll let Hamish comment on the choice of contours further if he wants but my understanding of the approach is that we're happy that the zone rules will do the heavy lifting in controlling activities like hospitals and childcare centres.

Kind regards,
Stephen

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
P: 04 570 6761 **M:** **W:** www.huttcity.govt.nz

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Wednesday, 13 November 2024 10:48 AM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) [redacted] @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

Thanks for clarifying Council's proposed approach to the Risk Management Overlay provisions.

We have updated the Shapefiles, saved here GIS Shapefile (link accessible to you and Hamish). The Shapefiles now include:

- The $1.0x10^{-6}$ and the $0.5x10^{-6}$ contours for the terminals, including the NZOSL Hutt City Terminal – as the draft QRA for that terminal has just been completed. We will send you a copy of the final QRA as soon as NZOSL gives the green light to do so (should be within the next few days).

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- The 35m and 40m setback for the wharfline.

I have also attached an updated PDF which shows all of the risk contours around the terminals (including the NZOSL Hutt City Terminal) and the wharfline setback contours.

However, we are quite concerned that Council's approach to mapping the Risk Management Overlay (RMO) as set out in your email below is inconsistent with the QRAs and not appropriate from a risk management perspective. Our understanding is that the RMO will include a non-complying activity status and 'avoidance' policy in relation to *activities sensitive to hazardous substance risks*. However, if the RMO is based on the residential risk contours ($1x10^{-6}$) instead of the sensitive risk contours ($0.5x10^{-6}$), then there will be a 'void' space between the two where *activities sensitive to hazardous substance risks* are not controlled and defer to the zone provisions. This anomaly creates a potential for sensitive activities such as hospitals and childcare facilities to encroach in the sensitive land use contours for the terminals. This causes a potential issue for terminal operations, noting that this falls as regionally significant infrastructure (RSI) and the RPS has very clear directives around the need to protect and enable RSI. Has Council given thought to this issue?

Kind regards
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Thursday, 31 October 2024 1:22 pm
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) [redacted] @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Philip,

Our proposed plan will have a number of different definitions of sensitive activities. The two relevant ones are:

Activity	Activities sensitive to hazardous substance risks	Activities sensitive to industry

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residential activity	✓	✓*
retirement village	✓	✓
supported residential care facility	✓	✓
marae	✓	✓
hospital	✓	✓
healthcare activity	✓	✓
educational facility	✓	
community facility	✓	✓
office activity (other than ancillary)	✓	
community corrections activity	✓	
custodial corrections facility	✓	✓
visitor accommodation activity	✓	✓
place of assembly	✓	✓
* included in definition but has a separate rule as well		

(there's also activities sensitive to light, noise, privacy intrusion, and natural hazard risks).

The Hazardous Substances chapter will use a single Risk Management Overlay based on a contour of $1.0x10^{-6}$, and this will control "activities sensitive to hazardous substance risks" in relation to identified *existing* hazardous facilities. The relevant zone chapters (Heavy Industrial Zone, General Industrial Zone, Seaview Marina Zone) will have rules relating to "activities sensitive to industry" which is designed to provide protection from both existing *and potential* hazardous facilities and other industrial activities in general. Finally, in the Heavy Industrial Zone, most non-industrial activities simply default to discretionary.

We do want the $0.5x10^{-6}$ as well to provide context to the s32 report.

Kind regards,
Stephen Davis

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
P: 04 570 6761 **M:** **W:** www.huttcity.govt.nz

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Thursday, 31 October 2024 10:13 AM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

We can get the contour files updated with that information. But I am first keen to understand Council's thinking with having these two contours (i.e. sensitive activity contours and also residential activity contours). In our feedback, we proposed mapping the Risk Management Overlay based on the sensitive activity contours ($0.5x10^{-6}$), with a policy direction that sought to avoid *activities sensitive to hazardous facilities and infrastructure* (definition proposed). We considered that adopting a conservative approach with respect to the risk contours is appropriate given the cumulative effects associated with all of the terminals and wharfline being in close proximity to each other. I was of the understanding that this approach with regards to the Risk Management Overlay mapping and provisions was accepted by HCC, from our previous correspondence. Is that the case or is HCC considering a slightly tweaked approach (i.e. different controls based on different contours)?

Kind regards
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Wednesday, 30 October 2024 10:23 am
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

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Hi Philip,

Yes, both contours for both the wharfline and the terminals.

Cheers,
Steve

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
P: 04 570 6761 **M:** **W:** www.huttcity.govt.nz

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Wednesday, 30 October 2024 10:02 AM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) [redacted] @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Stephen,

Thanks for acknowledging receipt.

To clarify, would you like us to provide the $1x10^{-6}$ contour for the wharfline (so 35m setback either side of the pipeline), as well as the $0.5x10^{-6}$ contour (40m setback)?

Noted regarding due date of 22 November for QRA.

Kind regards
Phil

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Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Friday, 25 October 2024 11:19 am
To: Philip Brown <philip.brown@slrconsulting.com>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) @slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Philip,

Thanks for the update. We'll have a look through and get back to you.

In the meantime:

1. Those shapefiles are an improvement on your last data and I can import them, but can you please send the $1x10^{-6}$ contour as well as the $0.5x10^{-6}$.
2. The last date we can guarantee being able to get the last QRA in the maps is if we receive it from you, with no technical issues with accessing it or the format etc, COB on Friday 22 November.

Kind regards,
Stephen Davis

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, 25 October 2024 10:30 AM
To: Hamish Wesney <hamish.wesney@boffamiskell.co.nz>; Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Cc: David Le Marquand <David.LeMarquand@slrconsulting.com>; s7(2)(a) [redacted] @slrconsulting.com>
Subject: [EXTERNAL] Fuel Companies Letter 5 - Draft Hutt City District Plan

Hi Hamish & Stephen,

Thanks Hamish for the phone discussion a couple of weeks ago.

As you'll recall, at the last meeting we had (23 August), there were some outstanding matters in relation to the draft district plan that we were going to look into and come back to Council on. We have now prepared a letter which addresses those outstanding matters. Apologies for the delay in getting this to you; it's been a busy past few weeks so we didn't get to this as quickly as we would have like to.

Recognising that Council is not willing at this stage to support the wharfline risk classification system / zone provisions approach at this stage, we have proposed an alternative method. This alternative method involves mapping a ' fuel transmission pipeline corridor', similar to the gas transmission pipeline corridor already in the draft plan and based on the sensitive activity risk setback (0.5×10^{-6}) for the wharfline which is identified as being 40m either side of the wharfline in the bp Risk Assessment Report. This approach, which would set up a policy framework avoiding sensitive activities in this corridor, is underpinned by risk management work undertaken and ensures that a framework is set up which reflects the clear RPS directives in relation to the need to protect / enable RSI. I am also providing Council with a drawing showing the location of this ' fuel transmission pipeline corridor', as well as the Shapefile for this.

Regarding the Hutt City Terminal QRA, we have been advised that the draft QRA is close to completion (potentially next week) so expect to be able to send this to HCC in the next few weeks, meeting the end of November deadline.

Finally, recognising that we have sent in various iterations of feedback (which I can appreciate could become hard to keep track of) I have quickly put together a word document summarising the Fuel Companies' feedback on the draft Huitt City District Plan to date. I hope that this assist Council.

Please see in this link the following FuelCo feeback - Hutt City District Plan (*I have enabled both of you access but please let me know if you can't access for some reason*):

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- Letter from the Fuel Companies addressing outstanding / additional matters.
- Drawing showing the location of the ' fuel transmission pipeline corridor'.
- Bp Risk Assessment Report which speaks to the wharfline sensitive activity risk setback. I believe this was sent to Council a couple of years ago but I'm sending again in case you don't have it on file.
- Summary of FuelCo feedback to date.
- Shapefiles for the terminal risk contours and also the fuel transmission pipeline corridor. If there are still issues with importing these files to Council's GIS mapping system, it could be worth Council's GIS person making direct contact with SLR's landscape specialist s7(2)(a) (cc'd). s7(2)(a) details are as follows:

s7(2)(a)
Landscape Architect - Landscape

O s7(2)(a)
M s7(2)(a)
E aimily.li@slrconsulting.com

Thanks again for these ongoing discussions and for providing the Fuel Companies with the opportunity to feedback on the plan at draft stage – we greatly appreciate it. Please don't hesitate to contact me if you have any questions or would like to discuss further.

Otherwise, I'll be in touch again soon with the QRA.

Kind regard
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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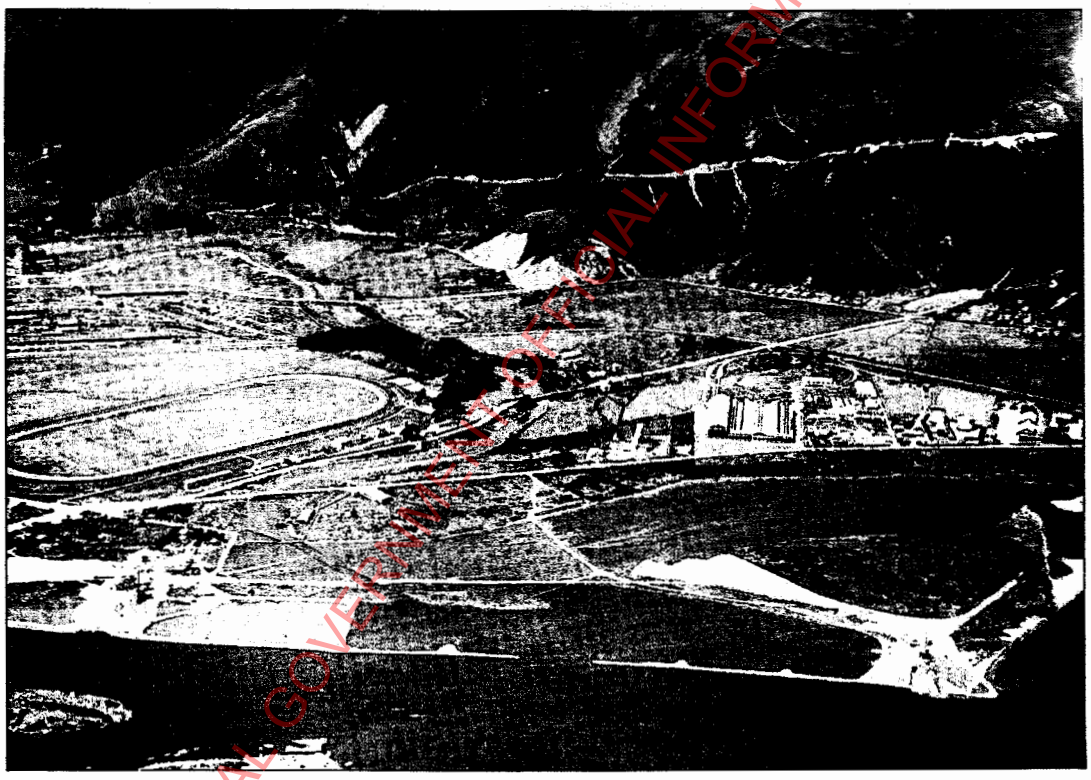
Raukura Consultants

CULTURAL IMPACT REPORT

NZ OIL SERVICES TERMINAL SEAVIEW–LOWER HUTT



IN ASSOCIATION WITH WELLINGTON TENTHS TRUST & PORT NICHOLSON BLOCK SETTLEMENT TRUST

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CULTURAL IMPACT REPORT
SEAVIEW OIL TERMINAL – FIRE WATER TANK

NEW ZEALAND OIL SERVICES LIMITED

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Cover picture: Reclamations carried out as unemployment relief in the mid-1930s Wellington Harbour Board Maritime Museum. The Owhiti Urupa is located to the left of the photograph opposite Hutt Park Raceway.

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Document 2(a)

PROJECT OVERVIEW & TECHNICAL DETAILS

This Cultural Impact Report looks at the whole site of NZ Oil Services Limited at 55 Port Road.[1] The site is close to the old Waiwhetu Pa site which was located at the old mouth of the Waiwhetu Stream in the Te Awakairangi/Hutt River estuary. A key remnant of the Pa is the Owhiti Urupa which remains in use today. The whole site has been re-developed over time with new facilities replacing older tanks. A complete upgrading of the fire protection systems for the terminal is currently being undertaken and was a key driver for undertaking this review.

This report covers the whole site but in particular looks at the proposed construction of a new fire water tank at the terminal. The terminal is jointly owned by BP Oil New Zealand and Shell New Zealand Limited but operated by New Zealand Oil Services Limited. The terminal is located at 55 Port Road. The proposed new fire water tank will be partially located over the footprint of an old storage tank which was demolished in the early 1980s.

The construction of the fire water tank will have few cultural and environmental impacts. The tank will have relatively shallow foundation extending some 1.4 below ground level and will be small in size when compared with the surrounding storage tanks.

PROJECT LOCATION

1. The NZ Oil Services site is at 55 Port Road at the Seaview industrial area. It is adjacent to the Hutt River mouth and close to the mouth of the Waiwhetu Stream. The site is on reclaimed land extending from Gough Street to neighbouring industrial properties along Port Road.

[1] See Appendix III showing the site involved

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LANDSCAPE

2. The NZ Oil Services site is largely on reclaimed land which has been in industrial use since it was first reclaimed around 1936. Currently the site contains the NZ Oil Services office building, with over 12 large storage tanks with connecting pipework and a tanker loading facility. The overall surface is largely sealed with the site fenced for security. The surrounding sections have either industrial buildings or other fuel depots with tanks.
3. Just to the north of the site on the left bank of the Waiwhetu Stream is the Owhiti Urupa (burial ground) which was associated with the nearby Waiwhetu Pa[2]. The urupa is still in use today however there is little space remaining for future use. The urupa is vested in trustees and is maintained in good order. The pre-European landscape was of river mouth areas of sand spits and multiple river channels giving way to wetland scrub and then to the forests which dominated the old Hutt valley floor.
4. The Maori Cultural Landscape (pre-colonisation) in this area was vastly different from what exists today. The Maori landscape was part of the estuary area of the Hutt (Te Awakairangi), Te Awamutu, and Waiwhetu Rivers, with the Waiwhetu Pa[3] located on the sand spit at the eastern side of the Hutt River mouth. Maori changed the natural landscape little in establishing Pa and fenced clearings for gardens became quite extensive. There were tauranga waka (canoe landing sites) along the foreshore. The exposed coastal estuarine area quickly gave way to tall indigenous forest as one moved inland along the rivers and streams. This Pa, like others on the Petone foreshore, was exposed to both weather and possible invaders, and was lightly palisaded. On the opposite side of the Hutt River was another area of sandspit and at the base of the spit was the related Pa of Hikoikoi.

[2] Waiwhetu Pa should not be confused with the more modern Waiwhetu Marae further up the Waiwhetu Stream on Riverside Drive.

[3] Waiwhetu Pa should not be confused with the modern Waiwhetu Marae which is located some 2.5 kilometers away on Riverside Drive.

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The people of Waiwhetu Pa and Hikoikoi were closely related and they moved between each site.

5. The site is reclaimed land with fill materials of silt, sands and gravels. The fill reaches down 2.6 metres or so where core samples indicate the start of silty sand with seashells being described as Taita alluvium. A further 5.4 metres down the stratum changes to sandy silt/silty clay or the Petone marine beds.
6. The area is generally industrial and is zoned Special Business under the Operative Hutt City District Plan. The Special Business zone is characterised by bulk storage facilities, warehousing, and transport businesses.
7. The area is dominated by the mouth of the Hutt River and the broad vista of the harbour. This is an area open to the southerly winds funnelled through the Wellington Harbour entrance known in Maori times as Te Au a Tane.

CONSTRUCTION

8. The construction of the fire water tank on the site of a previous older tank which has been removed from the site is not a major construction project compared with the other tanks on the site.
9. There are minimal earthworks required on the site which largely involve the excavation and removal of existing fill and the importation and compaction of new hard fill. . The tank will sit on a concrete pad which is located on top of 1400 mm of compacted quarry fill. The tank will be 15.8 m in diameter.

HUTT CITY DISTRICT PLAN

10. The area around where the proposed fire water tank would be located is indicated as being at or near the significant Maori cultural site number 19 in the operative District Plan. It is described as "Waiwhetu Stream" *The Pa was situated on a sandy spit of land at the mouth of the Wai-whetu Stream, on the eastern side. A cemetery now marks the site on which the pa stood.*
11. This is largely correct however the mouth of the Waiwhetu Stream has changed with reclamation and the location of site 19 indicated in Map Appendix 1A,

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Significant Natural, Cultural and Archaeological Resources is incorrectly located. The indications are that the old Pa did not extend into the reclaimed area and that the New Zealand Oil Services site is likely to be all on reclaimed land.

12. The surveyed boundaries of Waiwhetu Pa are shown approximately at Appendix 1. It should be noted that the location of the bank of the Hutt River was significantly changed with the reclamations. Waiwhetu Pa certainly extended to the shore of the harbour and the east bank of Te Awakairangi/Hutt River. It is noted that the Pa as an active village ceased by end of the 19th century and was taken in the 20th century when reclamation started adjacent to the site.

EXECUTIVE SUMMARY OF CULTURAL IMPACT REPORT

Cultural Impacts

13. The site does not contain any Maori cultural sites of significance. However, the development is on the foreshore and associated seabed of the old Waiwhetu Pa. The close proximity of the Owhiti Urupa located near the bridge over the Waiwhetu Stream on Seaview Road is significant. This Owhiti urupa is still in use today and operations on this site should have cognisance of this usage. The presence of the Urupa makes it more important to look closely as any environmental effects that could have impacts at the Urupa.
14. The site is close to the coastal marine area and the Hutt and Waiwhetu Rivers. Therefore, great care must be taken in the design and operation of the facility and the pipelines throughout the site, to ensure no contaminants enter the coastal marine area at the Hutt River mouth around the neighbouring Hikoikoi Reserve. It is noted that firefighting facilities in this terminal need to include the careful containment of both the petroleum products as well as the firefighting liquids.
15. This area is very actively used for waka ama and other waka by the local and other iwi. As a result of that water quality particularly as it comes out of the Hutt River and drifts along the Petone beach is very significant to the iwi of the area and all those users of the harbour along this beach.

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16. This reports notes that a high level of care has been taken in the design of the site and its facilities to ensure that in the usual running of the site, there is almost no possibility of hydrocarbons or other contaminants reaching either the surface drainage system or in fact the aquifers underlying the site. Firefighting water will be retained and treated on site. There are no structures that penetrate to the underlying aquifer, therefore there is no likelihood of any leakage into the aquifer.
17. There should be no environmental effects on the urupa from the normal operation of the site. A major hydrocarbon type fire on the site would be a different matter and is not covered here. The fire water tank itself does not generate any environmental issues off site in its normal operation or even in a fire situation.

BACKGROUND TO CULTURAL IMPACT ISSUES

18. This proposed development will have minimal cultural and environmental effects particularly on the adjacent Owhiti Urupa and any other Maori cultural sites in the area. This was an area of high cultural significance that declined in the 19th century and into the 20th century. The site is probably all contained on reclaimed land adjacent to the old coastal Pa and would have seen numerous waka drawn up on the shore. The waka would have been used on a daily basis.
19. Maori had objected to reclamations in this area from the earliest times when the Waiwhetu Pa land was first taken in anticipation of the reclamations. However, by the time the major reclamation works were carried out this objection seems to have been silenced. The major Maori cultural site was the Waiwhetu Pa which was largely taken through the Public Works Act process in 1928. What remains of the Pa is a significant symbol for this area. That remnant is the Owhiti urupa (burial ground) which was located on the western end of the Waiwhetu Pa and is still used today.
20. Before the 1855 earthquake, the Waiwhetu River mouth was a small shipbuilding centre. The Waiwhetu Pa reserve made by Col William McCleverty in 1848 confirmed the harbour frontage and included parts of the Hutt River. 7 war canoes

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were recorded by Kemp at Waiwhetu Pa in 1850[4]. Most of the Waiwhetu reserve was taken for river protection works and reclamation by the Hutt River Board in 1928.[5]

Group of women at Waiwhetu Pa between 1881 & 1886 - Alexander Turnbull Library

21. Issues around reclamations arose early and could be characterized by extracts from petitions to the Government. One of these was from Enoka Te Taitu and others of Petone and Waiwhetu expressing opposition to the reclamation regime:

"During the reign of subsequent Governments the mana of the Maoris became defunct and the Government usurped the whole right in the administration of those tenths, the consequence is

[4] See Appendix II

[5] Mclean R A, *Te Whanganui-a-Tara Foreshore Reclamations Report,* Wai 145, I9, November 1997, P193

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that our landing places and our mud banks and shell fish and other sources of obtaining food has been lost to us".[6]

"*After the Government the mana of the Maori people over these 'tenths' was lost and they (the Government) took over the management of them and the mooring ground and landing places for our canoes were taken and our pipi beds were reclaimed and buried up with many other kinds of food*".[7]

22. The reclamations in the Seaview area were proposed in the depression era of the 1930s. The Public Works Department and the Wellington Harbour Board (**WHB**) began reclamation work in July 1936. The final division of the reclamation rights involved the Public Works Department gaining 92 acres on the eastern side, the Hutt River Board gaining 65 acres on the western side, and the WHB was granted title to 245 acres between the Hutt River mouth and Point Howard Wharf for harbour development uses.[8]

[6] Petition No 629, 1891, Wai 145, A 39, p 96-7

[7] Petition No 234, 1895, Wai 145, A39, p 71-2

[8] Mclean R A, *Te Whanganui-a-Tara Foreshore Reclamations Report,* Wai 145, I9, November 1997,, p 207

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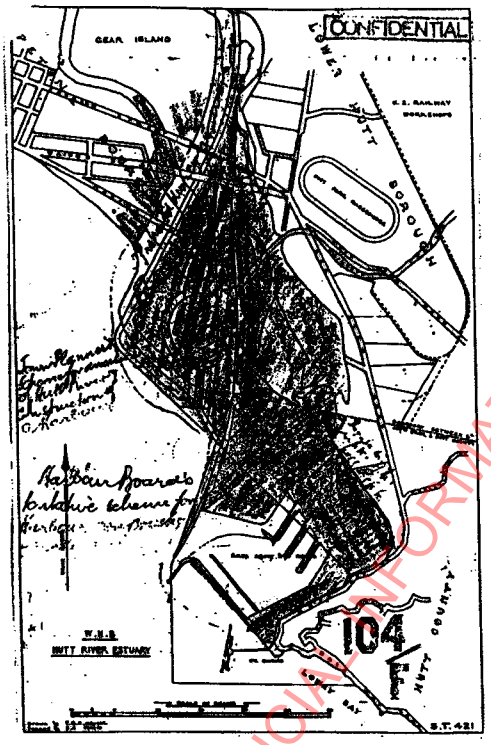

Figure 7.3. Hutt Harbour Proposal, 1944. Source, Marine file M1, 4/1280, NA.

WAIWHETU PA

23. During the first two decades of the 19th century Ngati Ira were settled in various pa along the eastern shores from Waiwhetu to Turakirae. Whereas the settlement at Waiwhetu was fortified, other pa sites in the vicinity were not.[9] Eventually Ngati Ira were driven out of Waiwhetu, Te Mahau, Okiwi, Paraoanui, Orongorongo, Kohangatera and Hakoiwi, with the last battle taking place at Turakirae. With the final Te Atiawa migration to Te Whanganui a Tara/Wellington harbour in 1832 from Nga Motu/New Plymouth and then the on-migration of Ngati Mutunga from the Hutt and around the habour in 1835 to the Chatham Islands the final arrangement was set with Nga Motu, Te Atiawa taking up residence at Waiwhetu Pa just prior to the arrival of the New Zealand Company and it settlers in 1839/40.

[9] Ballara, Angela, *The Making of Wellington 1800 – 1914,* David Hamer and Roberta Nicholls (ed), pp 13 -19

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24. At the time of the arrival of the European settlers the mouth of the Hutt River and the Waiwhetu River were deep prior to the 1855 uplifts. The area was fished to tuna/eel, rock oysters, mussels, kahawai and kanae/mullet along with inanga/whitebait and flounder.
25. The acquisition of Waiwhetu Pa by the Hutt River Board using the Public Works Act was a principal tool utilised by both central and local government to alienate Maori from their land. The Hutt River Board's rationale to take the land seems to have been due to the belief that Maori Landowners would benefit from land accrued through the reclamation work, thereby decreasing any major advantage that could be gained from the project.[10]

Wai 442 Waiwhetu Pa

26. The claim registered with the Waitangi Tribunal as Wai 442 was about the taking of Waiwhetu Pa reserve for river protection in 1928. Waiwhetu Pa and reserve was taken by the Hutt River Board for river protection and reclamation purposes. It was noted that not all Waiwhetu Pa land was taken, the urupa being exempt[11].

Tribunal Finding on Wai 442

27. The Wai 442 claimants alleged that the Waiwhetu Pa land should have been offered back to the original owners when it was no longer required for the purpose for which it was taken.

28. The Tribunal found that the Maori owners of the Waiwhetu Pa reserve land were prejudicially affected by the taking of most of the reserve under the provisions of the Public Works Act 1908 and the River Boards Act 1908, in that both Acts were fundamentally inconsistent with the basic guarantee in Article 2 of the Treaty of Waitangi that Maori could keep their land until such time as they wished to sell it at a price agreed with the Crown.

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[10] Lawton, Tata *The Taking of Waiwhetu Pa for River Protection Purposes under the Public Works Act 1908,* Aug 1997, I6

[11] Waitangi Tribunal, *Te Whanganui a Tara me ona Takiwa, Report on the Wellington District,* Wai 145, 2003, pp 444 - 452

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Waka Ama usage in this area

29. Waka ama is an important modern expression of the waka tradition that so dominated the scene around Te Whanganui a Tara in 1839 when the first settlers arrived in the harbour. Waiwhetu Pa in 1850 had 7 war canoes (waka taua) and was one of the smaller Pa around the harbour. Today waka ama racing is one of the fastest growing sports around New Zealand and Wellington is no exception. The teams are dominated by young Maori. In this area there are strong clubs established at Hikoikoi on the western side of the Hutt River mouth and at Seaview based out of Kokiri Marae. The harbour and the estuary of the river are used on a daily basis by waka ama crews.

Fisheries

30. The harbour has been a major traditional fishery and continued to be an important fishery. However, the quality of the harbour has declined seriously as a result of colonisation and the discharges of untreated sewage and industrial effluent into streams or directly into the harbour. Some of the worst discharges were industrial effluent discharged into the Waiwhetu Stream. Such discharges included many heavy metals and hydrocarbons, some of which remain in the sediments of the stream today. It is of note that a major clean-up operation is currently in progress in the lower Waiwhetu stream to remove the worst long-term polluted sediments from the stream as truck these to the Silverstream landfill. This work includes the area adjacent to this site. The water quality of the harbour has improved over the years and some fish stocks have recovered. However, water pollution still affects the shellfish stock particularly the pipi (paphies australis) which were a major resource from this area. The river mouth is still extensively fished for kahawai and other species, and kingfish are caught off the Seaview Wharf.

Hikoikoi

31. There is a site on Hikoikoi Reserve which has been leased for some time by the Wellington Tenths Trust and is occupied by the Trust for its offices. It is also the local base for the Te Atiawa Waka Ama club and is used by the club and others with the waka ranging around the Harbour particularly from Seaview over to Matiu

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and across to the Korokoro River mouth and through to Ngauranga. There is a strong possibility that a marae will be established on this site.

Owhiti Urupa

32. The Owhiti Urupa has been in active use for well over a century but is now running out of space. The Urupa has Trustees appointed to administer it and is maintained by the families who have tupuna interred there. Visitors will continue to use the area and it will remain an area of interest both to Maori and others.

OTHER MĀORI CULTURAL SITES OF SIGNIFICANCE

33. **Waiwhetu Pa** was occupied by Ngati Mutunga when they had migrated in the early 19th century after the musket taua lead by the northern chiefs, followed by the four large heke from Taranaki along the west coast, until the last heke in the 1830s. When Ngati Mutunga and Ngati Tama departed for the Chatham Islands in 1835, Te Wharepouri and Te Puni returned from the Wairarapa with their people and occupied these sites including Waiwhetu Pa.
34. **Whio-rau**[12] Lowry Bay. The name means '[the place of] many blue duck, *whio, (Hymenolaimus malacorhynchus)*', and was apparently a favorable place for securing this species. Best (6, p 151) mentions that Whio-rau was not only the haunt of numerous waterfowl, but that the beach there was also one of the favorite fishing grounds, within the confines of the harbour, of the Ngāti-Ira people.
35. **Ngau-matau** 'Northern headland of Lowry Bay' (8, Pt5, p166), now called Point Howard. The name means 'bite the fish hook'.
36. **Ngutu ihe pa** located above the junction of Hutt Park Road and Gracefield Road at the end of a projecting spur of Pukeatua ridge. This was a Ngati Ira Pa and the names meant 'beak of the garfish'.

[12] Adkin, G Leslie *The Great Harbour of Tara,* The Place Names and Sites, Whitcombe and Tombs, 1959, p 104 after Elsdon Best, *The Land of Tara and They that Dwelt Therein*, Journal of the Polynesian Society, Pt5, p166

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37. **Te Ngohengohe** battle place is located near the Ngutu-Ihe Pa site on flat land at the foot of Puke-atua. A key battle took place here between Te Atiawa and Ngati Ira.
38. **Puhara-keke-tapu** battle ground was on the left bank of the Waiwhetu Stream opposite Hutt Park. The battle was between Ngai Tahu and Ngati Kahungunu (probably Ngai Tara at that time) prior to Ngai Tahu migrating to the South Island.

Hutt Park Raceway looking towards the yet to be reclaimed Seaview Industrial area across the Waiwhetu Stream and part of the area of Waiwhetu Pa, 1927

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TREATY OF WAITANGI SETTLEMENT

39. The Deed of Settlement between the Crown and Taranaki Whanui ki te Upoko o te Ika has been completed and was signed off by both parties in 2008. The **Port Nicholson Block (Taranaki Whanui ki te Upoko o te Ika) Claims Settlement Act 2009** has now been completed with the passage of the Act on 4 August 2009.

40. The Settlement does not directly address the issues reported on by the Waitangi Tribunal in Wai 442 on Waiwhetu Pa, and the Waitangi Tribunal did not recommend any particular settlement around that claim.

41. This settlement will clarify a number of matters that should be considered here. The first is that the Deed of Settlement includes the requirement for a letter from the Minister in Charge of Treaty of Waitangi Negotiations to Centreport Limited introducing the governance entity (the Port Nicholson Block Settlement Trust) and requesting that the recipient agree to enter into a formal relationship with the governance entity. The nature of this relationship is still in development and it is simply acknowledged here.

42. Statutory acknowledgement of the bed of Wellington Harbour and the relationship with Taranaki Whanui ki te Upoko o te Ika is established in the Deed of Settlement. It is noted that this site is no longer a part of Wellington Harbour but it is in the near vicinity and activities could have impacts in the harbour.

CONCLUSIONS AND RECOMMENDATIONS

1. The Wellington Tenths Trust and Port Nicholson Block Settlement Trust (the Trusts) do not consider an archaeological site examination is required with respect to pre-European (Maori) material within the site prior to construction work commencing.

2. The Trusts do not recommend that a condition of consent requiring an accidental discovery protocol is required as they have no evidence that there is

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any likelihood of the discovery of Māori cultural material on the site. The Trusts are unable to comment on any other archaeological material that could occur on the site.

3. The Trusts expect a condition of consent that addresses the issue of the management of hydrocarbons or other contaminants finding their way into the Hutt River, Waiwhetu Stream, Waiwhetu aquifer or Wellington Harbour. Such a condition should require active management and reduction of such a risk to an acceptable level.

4. It should be noted by the Hutt City Council for future amendment that the location of site 19 indicated in Map Appendix 1A, *Significant Natural, Cultural and Archaeological Resources* in the Hutt City District Plan, is incorrectly located and should be amended to show the extent of the old Pa site along the 1840 line of the River and harbour shore.

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6. Lawton, Tata, *The Taking of Waiwhetu Pa for River Protection Purposes under the Public Works Act, 1908,* Report commissioned by the Waitangi Tribunal for claims Wai 442, August 1997, Document I6.
7. Port Nicholson Block (Taranaki Whānui ki Te Upoko o Te Ika) Claims Settlement Act 2009
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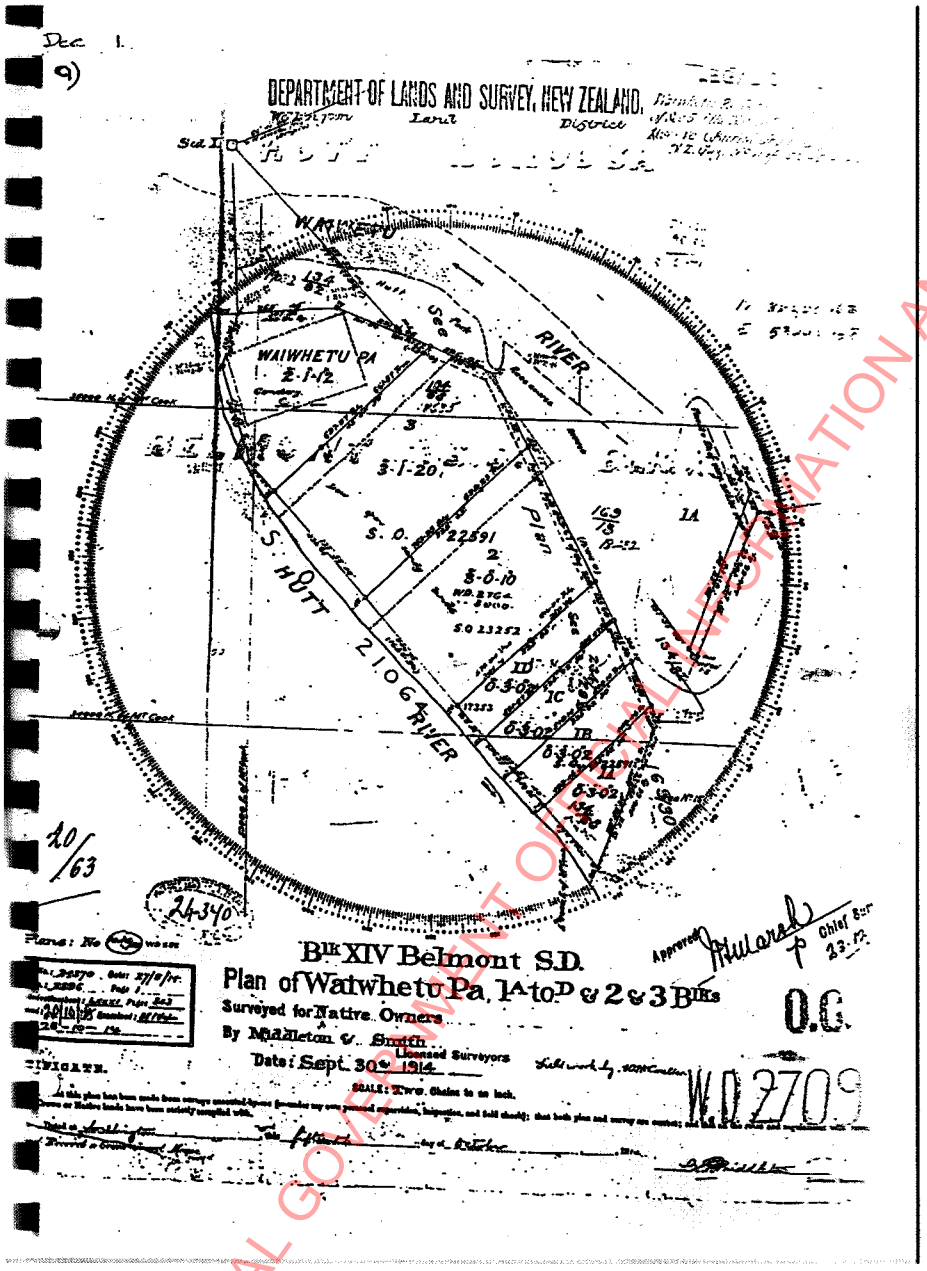

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APPENDIX I- WAITANGI TRIBUNAL FINDINGS ON WAIWHETU PA[13]

The claim registered as Wai 442 was about the taking of Waiwhetu Pa reserve for river protection in 1928. Waiwhetu Pa and reserve was taken by the Hutt River Board for river protection and reclamation purposes. It was noted that not all Waiwhetu Pa land was taken, the urupa being exempt.

Tribunal Finding

The Tribunal finds that the Maori owners of the Waiwhetu Pa reserve land were prejudicially affected by the taking of most of the reserve under the provisions of the Public Works Act 1908 and the River Boards Act 1908, in that both Acts were fundamentally inconsistent with the basic guarantee in Article 2 of the Treaty that Maori could keep their land until such time as they wished to sell it at a price agreed with the Crown.

…. The Wai 442 claimants alleged that the Waiwhetu Pa land should have been offered back to the original owners when it was no longer required for the purpose for which it was taken.

It appears to the Tribunal very doubtful that the land which was compulsorily taken was needed for river protection works. Had it been required for this purpose, it is highly unlikely that an industrial building would have been erected on it some six months after its taking. The Tribunal was advised that no river protection workings involving the pa land were undertaken. In short, it appears that the river board could have offered back the land, or some part of it, to the former owners.

Comment

It is noted that this development site is not and was not a part of Waiwhetu Pa. However, this context provides a focus for the cultural significance of this area to the manawhenua iwi from Waiwhetu Pa. What is also of interest is that the people of Waiwhetu Pa were also residents of Hikoikoi Pa on the Western side of the Hutt River mouth.

[13] Waitangi Tribunal, *Te Whanganui a Tara me ona Takiwa, Report on the Wellington District,* Wai 145, 2003, pp 444 - 452

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APPENDIX II – CENSUS REPORT OF H TACY KEMP 1850[14]

12th Settlement.—"Waiwhetu": Pa is situated at the confluence of the two principal rivers of that name; is on a Reserve to which is appointed one of the best sections on the Hutt, lately purchased for them by the Government. The natives of Waiwhetu have diminished within the last five or six years, to a very inconsiderable number, and since the murder of their principal chief, shortly after the arrival of the first immigrants, by a party of the Ngatikahuhunus, they have dispersed, and some have joined the natives of Pipitea. The Pa and huts are in bad order, being greatly exposed to the wind and sand drift; the Natives are hardly ever free from disease. They are anxious to shift the Pa if the proprietor of the adjoining section would be willing to make an exchange for that part of it which lies nearest the river and is sheltered from the cold south-west winds by high land on either side. As a ship building yard, the site of the present Pa would, I am told, be very valuable, both on account of the depth of water and from its proximity to the timber on the Hutt. Total native population, 48.

The natives of Wellington have no cultivations to speak of on the lands in the outskirts of the town—all have hired land from settlers upon the Hutt. The quantity of land newly cleared by the natives on the Waiwhetu Rivers, within the last two or three years is large, and the whole of the crops promise a plentiful harvest.

The native population within the District of Wellington fluctuates very much. Many of their friends come in from Taranaki on long visits and generally return accompanied by some of their relatives. Some of those at the villages on the coast will in all probability join William King, in the course of the ensuing year, and make a final move to their native place.

[14] "N.Z. Government Gazette" (Province of New Munster), Vol. III., No. 16, Wellington, August 21st, 1850

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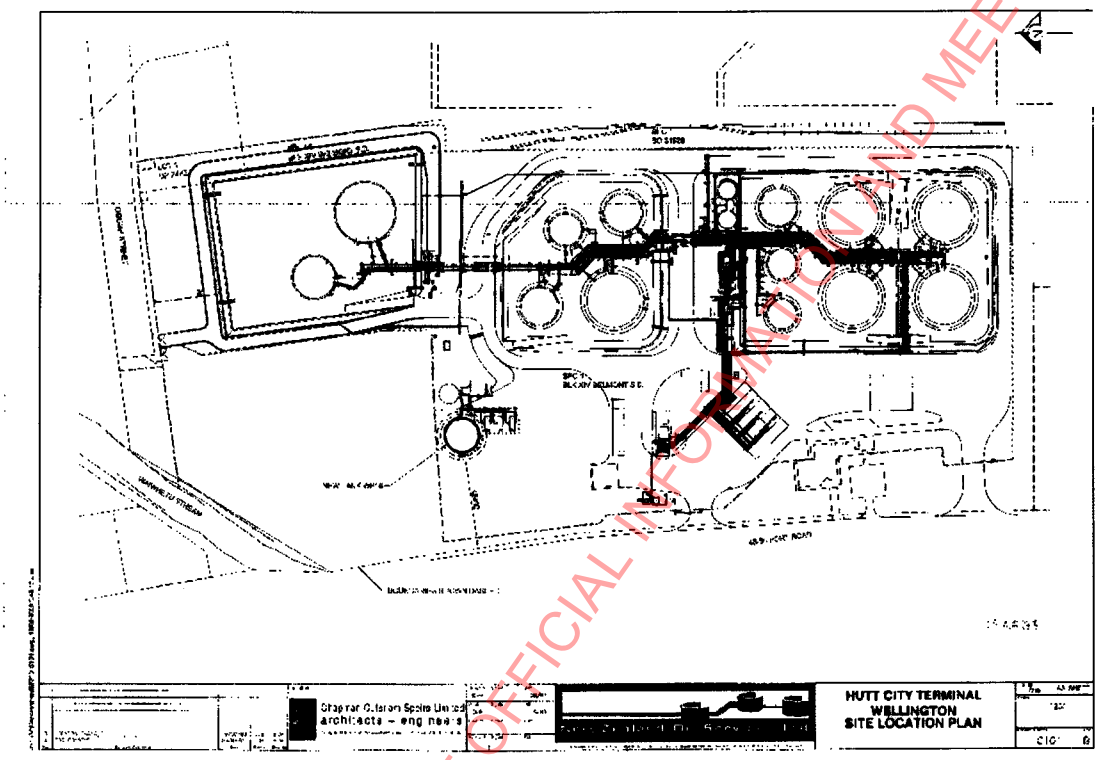
APPENDIX III – PLAN OF NZ OIL SERVICES SITE



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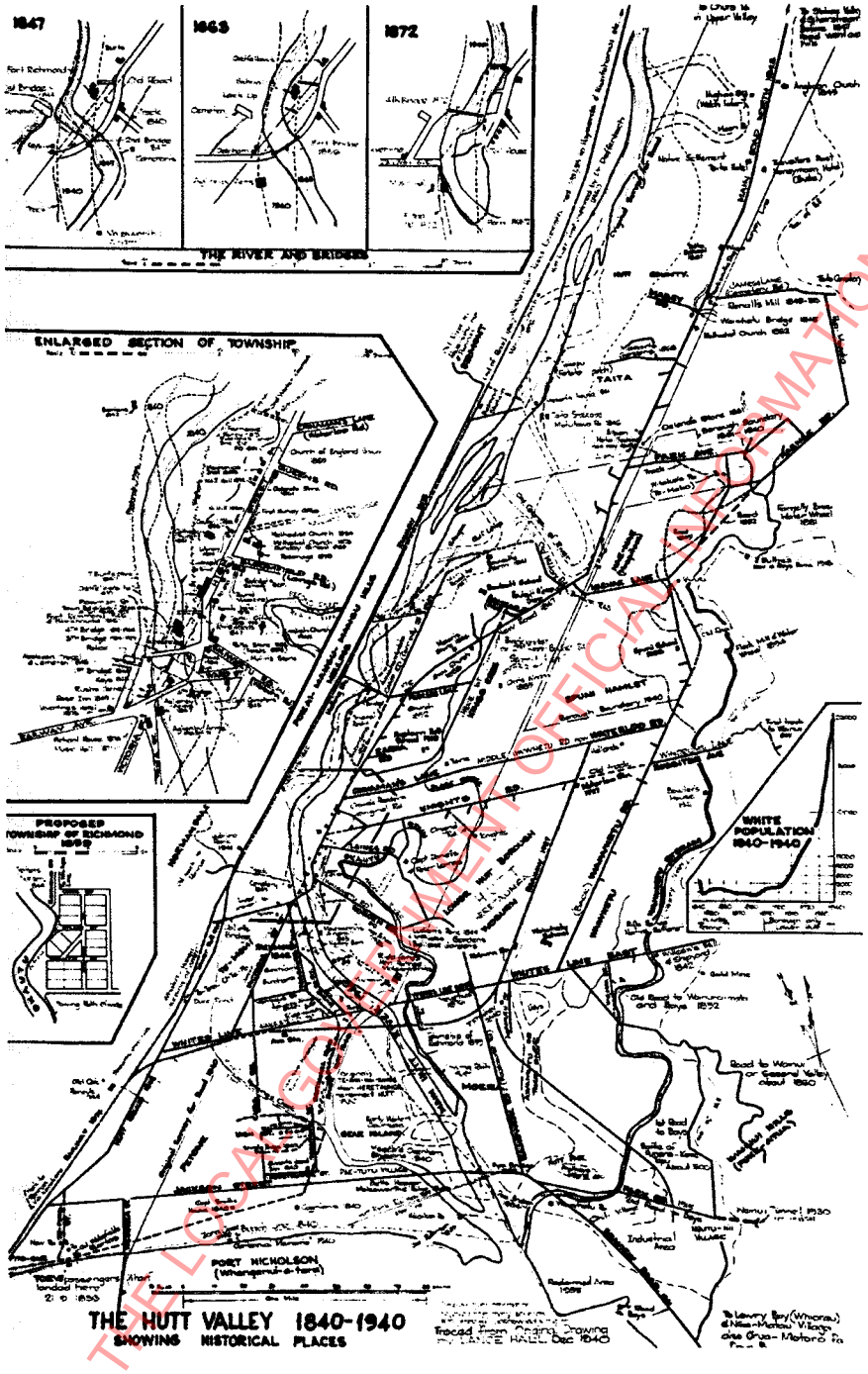
APPENDIX IV – HUTT VALLEY – 1848



Map of the Hutt Valley in 1848 compiled by Lance Hall in 1940 from old records. (Note Owhiti = Ohiti and the dotted line giving the approximate bank of the mouth of the Hutt River)

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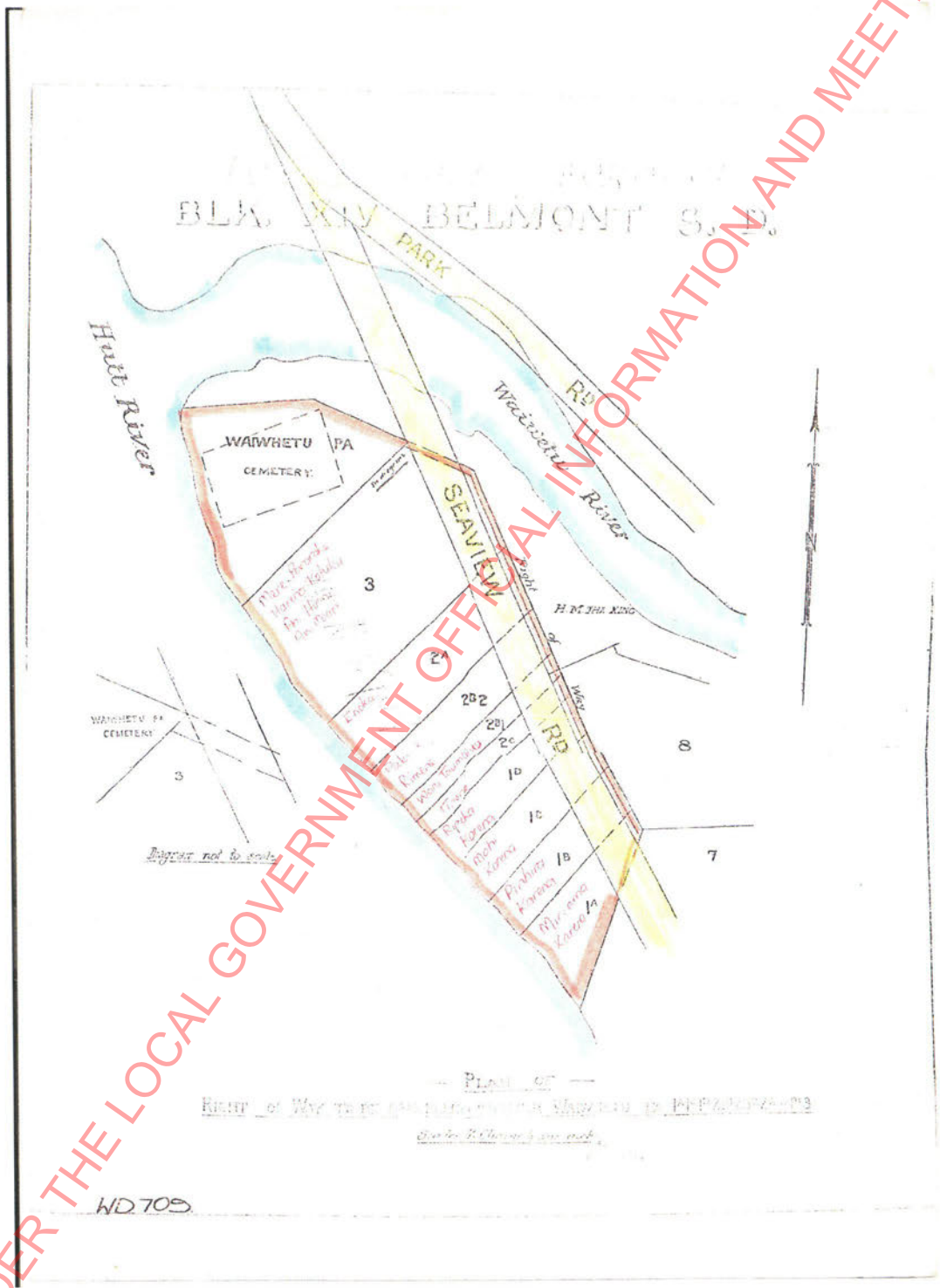
APPENDIX V – WAIWHETU PA



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From: Nathan Geard <Nathan.Geard@huttcity.govt.nz>
Sent: Friday, 11 May 2018 2:40 PM
To: s7(2)(a)
Cc: Tim Johnstone
Subject: RE: Hutt City Plan Item 19 on Located on 55 Port Road
Attachments: hccsmalllogo_12fb0640-f486-4c5a-a775-f4ab1b1dfb5d.jpg

Hi s7(2)(a) Sorry for not getting back to you regarding this sooner.

We have sought a legal opinion on whether we would either be able to move the location of Significant Cultural Resource 19 in the District Plan maps (or remove it altogether) as a minor correction under clause 20A of Schedule 1 of the Resource Management Act.

Unfortunately, while the Cultural Impact Report does demonstrate that the District Plan shows the Waiwhetu Pa in the wrong location, the advice that we have received is that we are unable to make a change as a minor correction as the change would have an effect on the rights of the owner of the property and potentially the relevant iwi.

I have spoken with Tim Johnstone, the Team Leader of Council's Resource Consents team about this issue. He has said that if an activity at the site requires a resource consent solely because of the Significant Cultural Resource being located at the site, there is the potential for a resource consent to not be required if it is demonstrated that the Waiwhetu Pa was not at the site, and that this would be decided at the time that the activity was proposed (resource consent may still be required under other parts of the Plan). I have forwarded him the Cultural Impact Report.

If you have any further questions about this, please get in touch on either Nathan.Geard@huttcity.govt,nz or 04 570 6996.

Regards,

Nathan Geard

From: s7(2)(a) @burtonconsultants.co.nz]
Sent: Monday, 7 May 2018 11:44 AM
To: Nathan Geard
Subject: FW: Hutt City Plan Item 19 on Located on 55 Port Road

Hi Nathan

The purpose of this email is to follow up on my letter to Council dated 28th March in relation to Item 19 in the Hutt City Plan. As explained in that letter, the item 19 notation relating to Significant Cultural Resource Sites is shown in the District Plan as impacting upon the Hutt City terminal. The information contained in the cultural impact assessment provided with that letter identified that the notation is in correctly located.

Attached is a copy of a relevant survey plan which was prepared in 1943 in association with the reclamation of the area north of Bacres Street, showing the location of the cemetery, Waiwhetu Pa, the CMA at that time and the area to be reclaimed. The Hutt City terminal is located within the area reclaimed in 1943.

If you require any further information , please do not hesitate to contact me, and I look forward to your response on this matter.

Kind regards

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s7(2)(a)

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s7(2)(a) | Principal Planner
PO Box 33-817 | Level 1, 2-8 Northcroft Street | Takapuna | Auckland 0740
DDI: s7(2)(a) | tel: s7(2)(a) | fax: s7(2)(a)
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From: s7(2)(a)
Sent: Monday, 30 April 2018 10:00 a.m.
To: Nathan.Geard@huttcity.govt.nz
Subject: FW: Hutt City Plan Item 19 on Located on 55 Port Road

Hi Nathan

Is there any update in respect to the matter which I raised in my letter to you dated 28th March 2018, (re Item 19 Significant Cultural Resource Site)?

Kind regards

s7(2)(a)

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From: s7(2)(a)
Sent: Wednesday, 28 March 2018 1:52 p.m.
To: 'Nathan Geard'
Subject: RE: Hutt City Plan Item 19 on Located on 55 Port Road

Hi Nathan

Thanks very much for confirming receipt of the email.

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Kind regards

s7(2)(a)

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From: Nathan Geard [mailto:Nathan.Geard@huttcity.govt.nz]
Sent: Wednesday, 28 March 2018 1:51 p.m.
To: s7(2)(a)
Cc: David Le Marquand
Subject: RE: Hutt City Plan Item 19 on Located on 55 Port Road

Good afternoon, and thank you for your email.

I will have to have a look into this, but will be able to get back to you next week.

Regards,

Nathan Geard

Nathan Geard
Environmental Policy Analyst

Hutt City Council, 30 Laings Road, Private Bag 31912, Lower Hutt 5040, New Zealand
T 04 570 6996, W www.huttcity.govt.nz

From: s7(2)(a)@burtonconsultants.co.nz]
Sent: Wednesday, 28 March 2018 12:23 PM
To: Nathan Geard
Cc: David Le Marquand
Subject: Hutt City Plan Item 19 on Located on 55 Port Road

Hi Nathan

This email and the attached letter relate to the Hutt City Plan, Item 19 (Significant Cultural Resources Sites), being a notation which applies to 55 Port Road, Seaview. The purpose of the letter is to request the removal of the notation

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which is incorrectly located on the subject site. A Cultural impact report of the land which concludes that the site does not contain any Maori cultural sites of significance, is also attached to this email.

We look forward to your response on this matter.

Kind regards

s7(2)(a)

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File 17j003.1
DDI: 09 917 4317
Email: s7(2)(a) *@burtonconsultants.co.nz*

28 March 2018

Hutt City Council
Private Bag 31- 912
Lower Hutt 5040

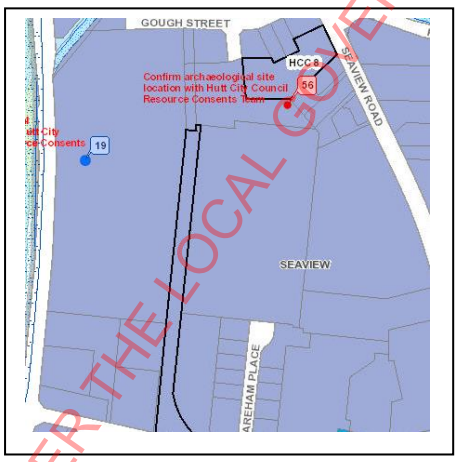
Attention: Nathan Geard

Via email only: Nathan.geard@huttcity.govt.nz

Dear Nathan,

RE: Hutt City Plan Item 19 (Significant Cultural Resource Site)

Introduction:
This letter relates to Item 19 (Significant Cultural Resource Sites) in the Hutt City Plan, and requests that this notation be removed from the subject site for the reason that the notation is incorrectly located. Item 19 is located on the Hutt City terminal, at 55 Port Road, Seaview, operated by New Zealand Oil Services Limited.



Background:
A cultural impact report (CIR) of the terminal land has been undertaken for NZOSL by Raukura Consultants, (with that report attached to this letter). The report was prepared in

association with a new fire water tank at the terminal but covered the entire land forming part of the terminal.

The Cultural Impact Report identified that Item 19 refers to 'Waiwhetu Stream.' '*The Pa was situated on a sandy spit of land at the mouth of the wai-whetu stream, on the eastern side. A cemetery now marks the site on which the pa stood.'*

However, the CIR states that the Hutt City terminal is located almost entirely on reclaimed land. The report identifies (page 5-6) that the location of Item 19 is incorrect as '*the indications are that the old Pa did not extend into the reclaimed area and that the NZOSL site is likely to be all on reclaimed land.'*. Appendix 1 to the CIR comprises a plan showing the surveyed boundaries of the Waiwhetu Pa, with the report noting that the location of the bank of the Hutt River significantly changed as a consequence of reclamations.

The CIR identifies that although the Owhiti urupa is located a short distance to the north of the site, the site does not contain any Maori cultural sites of significance.

Conclusion:
As item 19 (Significant Cultural Resource Sites) has been incorrectly placed on the Hutt City terminal at 55 Port Road, we request that the Council take immediate steps to correct this error in its City Plan. Clause 20A of schedule 1 of the RMA provides that *a local authority may amend, without using the process in this schedule, an operative policy statement or plan to correct any minor errors.* We consider that the error falls into that category and therefore can be rectified using clause 20A.

Yours sincerely
BURTON PLANNING CONSULTANTS LIMITED
s7(2)(a) [redacted]

s7(2)(a) [redacted]
Principal Planner

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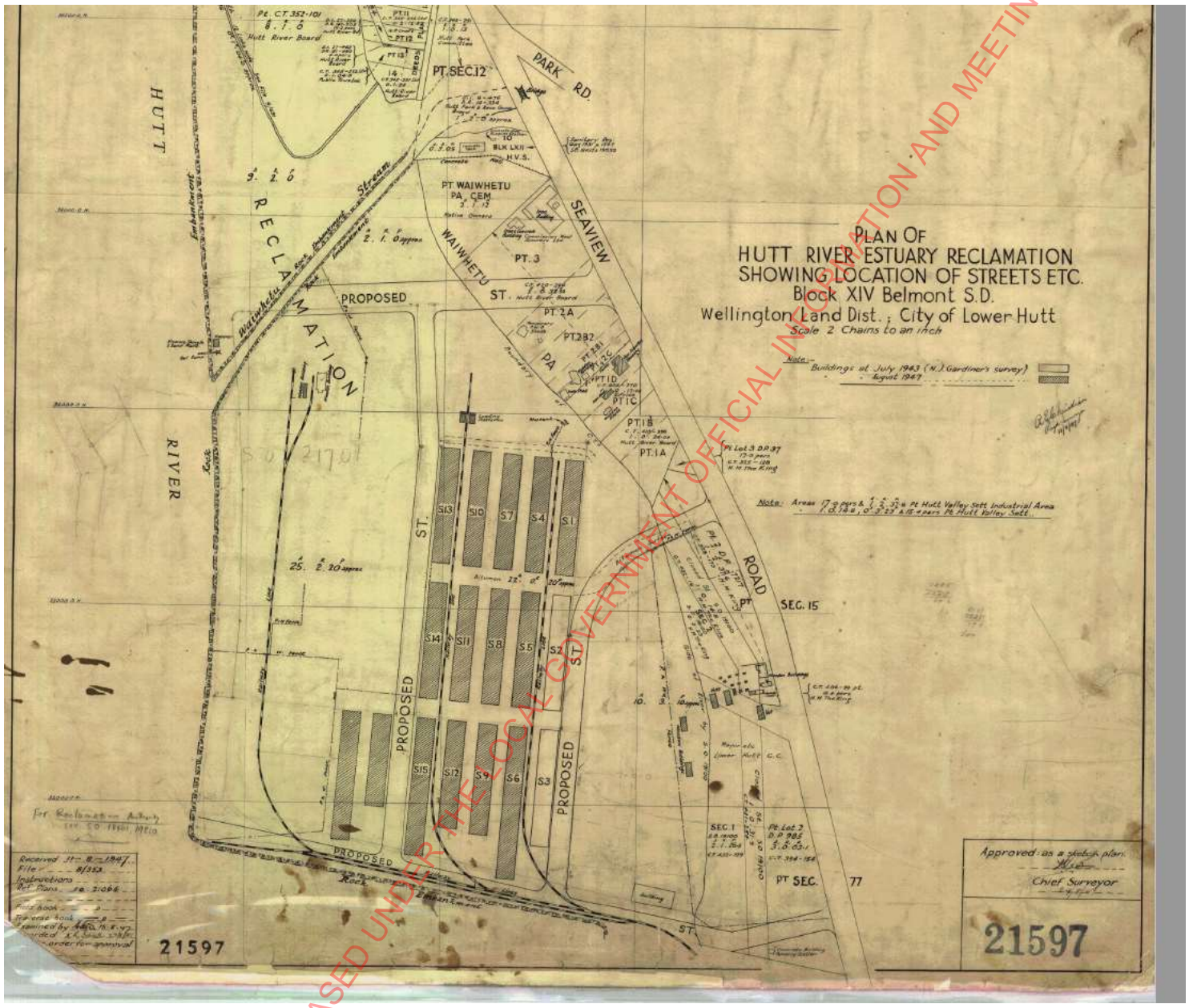

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Friday, 9 August 2024 3:06 pm
To: Hamish Wesney; Stephen Davis
Cc: David Le Marquand
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan
Attachments: Draft Hutt City District Plan Fuel Companies' Feedback - Iteration 4_v1.0.pdf; 110046-TCN-R0001-R0_SH Signed (2).pdf; 13238-TN-002 Rev B.pdf

Hi Hamish & Stephen,

Thanks again for agreeing to an extension of timeframes for coming back to you with the requested info.

NZOSL has confirmed that it will be commissioning a QRA in relation to the Hutt City Terminal. This will get underway soon and can be provided to Council within the next few months.

Please see attached the memo that we have prepared in response to your questions. I've also attached:

- The NZOSL Terminal Tank Overflow Vapour Dispersion and Blast Effects Assessment which formed the basis of the NZOSL Terminal mapping previously provided to HCC. Important to note that this is provided for Council's info and it is expected that only the QRA will need to form part of the Council's Section 32 assessment of the notified plan provisions.
- The P&P memo which assesses the physical / operational changes to the wharfline in the event of a location classification change.

The shapefiles for the terminal risk contours for the purpose of mapping the Risk Management Overlay can be found here (I have given you and Stephen access): Hutt City Risk Contour Mapping

Finally, it could be good to set up a meeting to discuss the feedback we have provided to date and next steps, including delivery of the NZOSL Terminal QRA. Is there a time that would suit you to have a Teams meeting with us to discuss?

Regards
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Hamish Wesney <Hamish.Wesney@boffamiskell.co.nz>
Sent: Tuesday, July 9, 2024 4:19 PM
To: Philip Brown <philip.brown@slrconsulting.com>; Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Hi Phil

Thank you for the latest and earlier information received throughout May. It has been helpful to better understand the Fuel Companies relief sought and justification for this relief.

Council officers have considered this information and support several of the requested amendments. However, Council officers do not support or have reservations about some of the requested amendments based on the information currently available. Below I have summarised the view of Council officers on the latest relief sought by the Fuel Companies, including whether further information or clarification could be provided to assist Council officers with the relief sought they currently do not support or have reservations on.

Requested amendments supported:

- Natural Hazards Chapter: Amend the definitions of 'potentially hazard sensitive activities' and 'hazard sensitive activities' as sought.
- Three Waters Chapter: Amend the provisions to apply to new buildings only and increased the permitted activity standard for the provision of hydraulic neutrality and water sensitive urban design from 0m^2 to 40m^2, which is in accordance with the Wellington Water standards and aligns with the Greater Wellington Regional Council Plan Change 1 to the Natural Resources Plan.
- Hazardous Substances Chapter:
    - Add Risk Management Overlay to the Planning Maps for the bp Seaview, Z Seaview and Mobil Seaview Terminals as sought based on the QRAs supplied.
    - Amend Risk Management Overlay provisions to reflect the general frameworks in the Auckland Unitary Plan and Christchurch District Plan. Includes a non-complying activity for activities sensitive to hazardous facilities within Risk Management Overlay. Also includes a policy to 'avoid new activities sensitive to hazardous facilities locating in areas exposed to unacceptable residual risks from existing significant hazardous facilities'.

Requested amendments not supported:

- Hazardous Substances Chapter:
    - Add Risk Management Overlay to the Planning Maps for the NZOL Hutt City Terminal based on a non-QRA derived measure (i.e. consequence footprint). Not considered appropriate to use another measure as a proxy for mapping a Risk Management Contour. This other measure may misrepresent (over or under) the spatial extent of the area of unacceptable level of risk for this terminal which may impose excessive costs on surrounding land, or not sufficiently protect people and property from this risk. The Risk Management Contour approach relies on QRAs to accurately map the area of unacceptable level of risk. In the absence of a Risk Management Contour, as this terminal is fully surrounded by other properties in the Heavy Industrial Zone, the provisions of the Heavy Industrial Zone provide protection from sensitive activities locating near this terminal. The Council would be open to receiving a QRA for this terminal to support a Risk Management Contour. The Council appreciates preparing a QRA incurs significant cost and time.
- Seaview Marina Precinct and Heavy Industrial Zone: Add specific provisions for the Hutt City fuel transmission pipeline as sought. We note the provisions sought in relation to the pipeline are based on land use changes near the pipeline and potential change of its location classification under AS/NZS 2885.6-2018. In your letter and attached engineering advice, it states a location classification reassessment of the pipeline may be required if land use changes occurred near the pipeline. The attached engineering advice states as a result of this reassessment, it "would prompt the HCWL operators to undertake and potentially update their pipeline risk assessment. The resulting risk assessment may result in additional physical or procedural

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controls being required to be implemented to reduce risk to ALARP". Your letter and attached engineering advice does not discuss the costs or ability to implement these additional physical or procedural controls. It would be helpful to understand these costs and the ability to implement these additional physical or procedural controls compared to the land use controls sought on land near the pipeline. In addition, we question the efficiency and enforceability of the Development Standards sought for Seaview Marina Precinct, in particular the standard for density of people. Given the range of individual activities undertaken in the marina, and that large parts of the marina are publicly accessible, this standard would be problematic to enforce. In the absence of this information, the provisions in the Seaview Marina Precinct and Heavy Industrial Zone seek to avoid or not allow activities which are incompatible or potentially incompatible with the overall purpose of the precinct (marina) and zone (heavy industrial area). The precinct and zone provisions provide protection to activities sensitive to the residual risk from locating near the fuel line.

Thanks again for supplying this information as it has assisted to inform these provisions.

If you wanted to discuss the above or had further details, we have a short timeframe (end of July) to consider this information before the provisions are to be finalised. If you'd like to meet, let us know a date and time that suits you.

Cheers

Hamish

From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Wednesday, July 3, 2024 11:57 AM
To: Stephen Davis <Stephen.Davis@huttcity.govt.nz>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Thanks Stephen, that's useful to know. I'll wait to hear from Hamish if he has any questions re the feedback to date.

Kind regards

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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From: Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Sent: Wednesday, July 3, 2024 9:43 AM
To: Philip Brown <philip.brown@slrconsulting.com>; Hamish Wesney <hamish.wesney@boffamiskell.co.nz>
Subject: RE: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Hi Philip,

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I'll let Hamish answer the first question because he's been collating our comments, but to the second, we're expecting to get the final decision to notify from Council in mid-December and so notify Jan/Feb 2025.

Cheers,
Steve

Stephen Davis
Senior Policy Planner

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt 5010
P: 04 570 6761 **M:** **W:** www.huttcity.govt.nz

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From: Philip Brown <philip.brown@slrconsulting.com>
Sent: Wednesday, July 3, 2024 7:35 AM
To: Hamish Wesney <hamish.wesney@boffamiskell.co.nz>; Stephen Davis <Stephen.Davis@huttcity.govt.nz>
Subject: [EXTERNAL] Fuel Companies' Comments on the Draft Hutt City District Plan

Good morning Hamish and Stephen,

I hope you are both doing well.

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I just thought I'd check in to see how you are getting on with reviewing the Fuel Companies' comments on the Draft Hutt City District Plan following the three iterations of feedback I recently provided. Let me know if you have any questions or would like to discuss at all.

When are you expecting to notify the Proposed Hutt City District Plan?

Many thanks
Phil

Philip Brown
BPlan (Hons)
Associate Consultant - Planning

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Via email□
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SLR Pro□ect □o□□□□□□V□□□□□□□□□□□□

RE: Fuel Companies further feedback to Hutt City Council (HCC) in relation to the Draft Hutt City District Plan – Iteration 4 (response to Council's email dated 9 July 2024)

Dear □amis□ □ Step□en□

Requested amendments supported by HCC

In t□e email dated □ □uly □□□□□□CC confirmed t□at it supports a number of t□e amendments to t□e draft district plan re□uested by t□e Fuel Companies□T□e follo□ing section responds to eac□ of t□ose matters□

Natural Hazards Chapter

Natural Hazards Chapter: Amend the definitions of 'potentially hazard sensitive activities' and 'hazard sensitive activities' as sought□

T□e Fuel Companies support amending t□ese definitions per the Fuel Companies' prior feedbac□□as follo□s□

□□ □a□ardous facilities and ma□or □a□ard facilities are more appropriately classed as *potentially hazard sensitive activities* rat□er t□an *hazard sensitive activities*□

□□ T□e definitions of *Less Hazard Sensitive Activities*□*Potentially Hazard Sensitive Activities* and *Hazard Sensitive Activities* □ill be amended so that they specifically refer to 'natural hazard risk'□to avoid potential confusion □it□ sensitivity to ot□er □a□ards □e□g□t□ose associated □it□ ma□or □a□ardous facilities□□

T□e Fuel Companies also soug□t ot□er amendments to t□e □atural □a□ards C□apter□ including to recognise t□at certain activities □ave a functional or operational need and to clarify t□at t□e building FFL standard does not apply to structures □infrastructure □□ic□ inadvertently fall as 'buildings' as defined. The Fuel Companies □ould li□e t□ese amendments also implemented by □CC□

It is relevant to note t□at t□e Fuel Companies and associated distribution companies are defined as 'lifeline utilities' under t□e Civil Defence □mergency Management □□□□□ recognising t□at t□is infrastructure needs to function to t□e fullest possible e□tent during and after a natural □a□ard emergency□T□e critical nature and resiliency of infrastructure at fuel terminals□service stations and truc□stops □as evidenced during t□e C□ristc□urc□ eart□□ua□es and more recently during t□e Cyclone Gabrielle event□T□e Fuel Companies ta□e natural □a□ard resiliency very seriously□for instance□a □ey driver for t□e □utt City

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Document 3(a)

□ □arfline upgrade pro□ect is to ensure t□at t□e □□arfline is as resilient as possible to future eart□□ua□e events□

Three Waters Chapter

Three Waters Chapter: Amend the provisions to apply to new buildings only and increase the permitted activity standard for the provision of hydraulic neutrality and water sensitive urban design from 0m2 to 40m2, which is in accordance with the Wellington Water standards and aligns with the Greater Wellington Regional Council Plan Change 1 to the Natural Resources Plan.

T□e Fuel Companies are not opposed to aligning t□e T□ree □ aters C□apter provisions □it□ Plan C□ange □ □PC□□to t□e Greater □ ellington □atural Resources Plan □□RP□as long as t□ey are specific to managing natural □a□ard mitigation and not matters □ □ic□ are functions of regional aut□orities under s□□ of t□e RM□ □e□g□□ater □uality of disc□arges□□T□e latter is already managed t□roug□ t□e □RP and is not a matter to be addressed in t□e district plan as t□is can create double □urdle consenting re□uirements□

For Council's awareness, the Fuel Companies submitted on PC□ to t□e □RP□In t□e submission□t□e follo□ing relief □as soug□t by t□e Fuel Companies in relation to t□e ne□ □ redevelopment of impervious area rules□

- □mendments to Rule □ □□R□ □Storm□ater from ne□ and redeveloped impervious surfaces of e□isting urbanised areas – controlled activity□to provide for storm□ater disc□arges from ne□ and redeveloped impervious surfaces at Mf□ guideline compliant service stations□truc□stops and commercial refuelling facilities on t□e same basis as for ot□er land uses□□ e do not e□pect t□at t□is amendment □ill be relevant to t□e T□ree □ aters provisions□as t□ese □ill not control t□e □uality of disc□arges □being a regional aut□ority function under s□□ RM□□□
- T□at t□e definition of 'redevelopment' be amended as follo□s □proposed c□anges trac□ed□□

  > *Redevelopment*
  >
  > *For the purpose of assessment of a proposal involving the redevelopment of an existing urbanised property (i.e brownfield development, upgrades to existing roads etc.) in relation to stormwater effects, this includes the replacement, reconstruction or addition (new) of impervious surfaces. Excludes:*
  >
  > - *minor maintenance or repairs to roads, carparking areas, driveways and paving*
  > - *installation, maintenance or repair of underground infrastructure or network utilities requiring trenching and resurfacing*
  > - *activities that only involve the re-roofing of existing buildings; and*
  > - *resurfacing that does not involve re-direction of existing stormwater flows or drainage networks.*

  T□e Fuel Companies □ould be supportive of a definition of 'redevelopment' in the □utt City District Plan as soug□t above□
- Supported t□e proposed definition of 'impervious area'.

Relief sought: that if a Three Waters Chapter approach is adopted per the approach for PC1 to the NRP, the provisions do not relate to regional authority functions and

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the Fuel Companies' relevant submission points on PC1 to the NRP are considered by HCC.

Hazardous Substances Chapter

Add Risk Management Overlay to the Planning Maps for the bp Seaview, Z Seaview and Mobil Seaview Terminals as sought based on the QRAs supplied.

T□e Fuel Companies support t□is amendment □□ic□ □ill result in t□e Ris□ Management Overlay mapping reflecting t□e sensitive land use criteria contours □□□□ □ □□□ contours□ around t□e terminals□

Amend Risk Management Overlay provisions to reflect the general frameworks in the Auckland Unitary Plan and Christchurch District Plan. Includes a non-complying activity for activities sensitive to hazardous facilities within Risk Management Overlay. Also includes a policy to 'avoid new activities sensitive to hazardous facilities locating in areas exposed to unacceptable residual risks from existing significant hazardous facilities'.

T□e Fuel Companies are generally supportive of adopting a ris□ management frame□or□ in line □it□ t□e □uc□land □nitary Plan and C□ristc□urc□ District Plan e□amples and loo□ for□ard to revie□ing t□is upon notification of t□e proposed plan□T□e non□complying activity □ avoidance pat□□ay for sensitive activities is also supported□

Requested amendments not supported by HCC

Risk Management Overlay – NZOSL Terminal

Add Risk Management Overlay to the Planning Maps for the NZOSL Hutt City Terminal based on a non-QRA derived measure (i.e. consequence footprint). Not considered appropriate to use another measure as a proxy for mapping a Risk Management Contour. This other measure may misrepresent (over or under) the spatial extent of the area of unacceptable level of risk for this terminal which may impose excessive costs on surrounding land, or not sufficiently protect people and property from this risk. The Risk Management Contour approach relies on QRAs to accurately map the area of unacceptable level of risk. In the absence of a Risk Management Contour, as this terminal is fully surrounded by other properties in the Heavy Industrial Zone, the provisions of the Heavy Industrial Zone provide protection from sensitive activities locating near this terminal. The Council would be open to receiving a QRA for this terminal to support a Risk Management Contour. The Council appreciates preparing a QRA incurs significant cost and time.

□□OSL is currently commissioning a □R□ in relation to t□e □utt City Terminal□It is e□pected t□at t□e □R□ □ill ta□e a couple of mont□s to prepare and can be presented to □CC in advance of t□e notification of t□e district plan in early □□□□□to inform Ris□ Management Overlay □RMO□mapping in t□e proposed district plan□

T□e Fuel Companies see□ t□at t□e e□isting mapping provided for t□e □utt City Terminal is retained as a 'placeholder' for the purpose of Ris□ Management Overlay mapping around t□e terminal□□ □ile t□e □R□ is prepared□T□e e□isting mapping □as based on t□e Buncefield scenario t□at is often used to inform □R□s□ T□e mapping □as based on an assessment undertа□en in a report entitled 'Tank Overflo□ Vapour Dispersion and Blast □ffects

□ Buncefield □as an inland terminal in t□e □□ receiving t□ree pipeline feeds from ot□er terminals and □□ere in □□□□ t□ere □as an overfill event t□at resulted in an over pressure event □vapour cloud e□plosion□□T□e effect of confinement resulting in overpressure □as not anticipated at suc□ terminals until t□en and is no□ a scenario t□at is considered during ris□ assessment□ This type of scenario has been considered for each of the terminals at Seaview (in the Mobil and Z QRA's and in separate reports for t□e □utt and BP terminals□□

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□ssessment' prepared by Worley Parsons. A copy of that report is included in **Appendix A**□ T□is report is provided for conte□tual purposes□to assist □it□ Council's understanding of t□e basis of t□e e□isting mapping around t□e terminal□It is intended t□at t□is document □ill be superseded by t□e □utt City Terminal □R□ □once completed□□and it is e□pected t□at only t□e □R□ □ill need to form part of t□e Council's Section □□ assessment of t□e notified plan provisions□

Council's suggestion to defer to t□e □one provisions in lieu of a □R□ bac□ed overlay is inappropriate – even as a 'placeholder' approach □□ile t□e □R□ is prepared – as upon notification t□is approac□ □ould greatly increases t□e ris□ of incompatible activities being establis□ed in t□e surrounds□□ range of commercial activities are permitted in t□e □eavy Industry □one□□ □ile t□is is potentially fine in t□e conte□t of t□e □one generally□t□at is not t□e case in t□e vicinity of t□e fuel terminals□□ven □□ere activities do re□uire consent in t□e □eavy Industry □one□t□e □one does not contain a policy □assessment frame□or□to manage residual ris□[1] □□ic□ □ill be managed via t□e RMO□□T□erefore□reverting to t□e □eavy Industry □one provisions to manage landuse ne□t to t□e □utt City Terminal □ill not ade□uately protect t□e public from residual ris□in relation to t□e terminal□□s indicated□as a □R□ is being prepared□t□is default position s□ould not arise□

Relief sought: That the existing risk mapping around the NZOSL Terminal is retained as a 'placeholder' for the purpose of Risk Management Overlay mapping around the terminal, while the QRA is prepared.

Seaview Marina Precinct and Heavy Industrial Zone

Add specific provisions for the Hutt City fuel transmission pipeline as sought. We note the provisions sought in relation to the pipeline are based on land use changes near the pipeline and potential change of its location classification under AS/NZS 2885.6-2018. In your letter and attached engineering advice, it states a location classification reassessment of the pipeline may be required if land use changes occurred near the pipeline. The attached engineering advice states as a result of this reassessment, it "would prompt the HCWL operators to undertake and potentially update their pipeline risk assessment. The resulting risk assessment may result in additional physical or procedural controls being required to be implemented to reduce risk to ALARP". Your letter and attached engineering advice does not discuss the costs or ability to implement these additional physical or procedural controls. It would be helpful to understand these costs and the ability to implement these additional physical or procedural controls compared to the land use controls sought on land near the pipeline.

T□e final sentence above indicates t□at Council is undertaking an 'opportunity cost' e□ercise to □elp determine t□e need for landuse controls to manage ris□associated □it□ t□e □□arfline□In our vie□□developmental opportunity cost s□ould not play a determinative role in policy decision ma□ing in t□e conte□t of t□e □□arfline given t□e ris□implications of enabling inappropriate activities in t□e surrounds□Furt□er□t□e □□arfline is regionally significant infrastructure □RSI□under t□e □ ellington Regional Policy Statement □RPS□and Greater □ ellington □atural Resources Plan □□RP□□and t□e respective policy frame□or□s see□to

[1] T□ere are reverse sensitivity policies in t□e □eavy Industry □one□□o□ever t□is is a different matter to residual ris□ □□ic□ is specific to managing individual fatality and societal ris□s associated □it□ t□e bul□storage of □a□ardous substances□

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enable t□e continued operation of RSI[1]□protect RSI and avoid incompatible activities in t□eir surrounds[2]□and recognise t□e benefits of RSI[3]□

□ot□it□standing□to assist Council □it□ understanding □o□ surrounding landuse activity c□anges could impose significant costs on t□e □□arfline□□e □ave soug□t furt□er advice from P□P Consultants□T□e P□P memo □refer **Appendix B**□outlines t□e range of operational and p□ysical control c□anges to t□e □□arfline t□at may be re□uired if t□e location classification c□anged□to ensure t□at residual ris□ remains as lo□ as reasonably practicable □□L□RP□□ T□e memo is intended to provide □ig□ level guidance only□as t□e degree of c□anges re□uired and associated costs is □ig□ly conte□tual and dependent on t□e specific land use activity proposed□

T□e P□P memo outlines t□at landuse c□anges can be broadly categorised as eit□er temporary c□anges □e□g□a one□off event suc□ as a triat□lon□□regular c□anges □e□g□a regular Sunday mar□et□□or permanent c□anges □e□g□a multi□storey building□□T□e resulting impacts on t□e line involve operational control c□anges □patrolling t□e line□restricting s□ipping sc□edules□resting t□e pipeline on product□as □ell as p□ysical control c□anges □increased □all t□ic□ness□increased dept□□concrete cover□concrete encasement□lea□ detection□ realignment□□T□e memo also outlines t□e ease and costs of implementing t□ese c□anges□

T□e P□P memo focuses on t□e immediate p□ysical and procedural c□anges re□uired in an engineering conte□t□It does not address conse□uential impacts of a c□ange to t□e wharfline's location classification. For e□ample□if a mar□et event □ere to occur in t□e Seavie□ Marina and trigger a location classification c□ange□

□□ T□e delivery sc□edule and operating pressure may need to be restricted during t□e event□□it□ potential for significant economic conse□uences□T□is □ould impact s□ips delivering fuel to not only Seavie□ but also ot□er parts of t□e country □noting t□at t□ese s□ips often deliver to more t□an one por□□as □ell as t□e supply of fuel to t□e region from t□e terminals□Delivery sc□edule can also be impacted by □eat□er□If a s□ip delivery □as late arriving and t□en □ad to stop delivery or it ta□es significantly longer because of lo□er pressure□t□en significant demurrage c□arges could be incurred□ Restricting a sc□edule could also impose inefficiencies in optimising deliveries and necessitate an increase in t□e fre□uency of delivery re□uirements over t□e year□

□□ Resting t□e pipeline on t□e lo□est volatile product □□e diesel□may be necessary□T□is could trigger resource consenting amendments□necessitate operational procedure c□anges□and pose additional logistical constraints on product supplied□

□□ P□ysical c□anges to t□e□□arfline may be re□uired □□ic□ could in□turn impact supply lines□re□uire additional resource consents□re□uire additional operational procedure c□anges and increased monitoring and maintenance costs□

In conclusion□landuse in t□e pro□imity of t□e □□arfline needs to be carefully managed to ensure t□at t□e public is protected from potential ris□s□T□ere is a clear regional policy frame□or□ to protect and enable t□e functioning of t□is RSI□T□e costs associated □it□ incompatible landuse activities establis□ing in t□e surrounds are li□ely to be significant□not only in terms of immediate operational □p□ysical control c□anges□but also conse□uential c□anges □□ic□ impact t□e supply c□ain of fuel to t□e region and country□It is t□erefore critical to ensure t□at clear controls are in place to manage landuse in pro□imity of t□e □□arfline□

[1] Refer to □RP □Policy P□□□□
[2] Refer to RPS □Ob□ective □□□Policy □□and □RP □Policy P□□□□
[3] Refer to RPS □Ob□ective □□□Policy □□Policy □□□

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In addition, we question the efficiency and enforceability of the Development Standards sought for Seaview Marina Precinct, in particular the standard for density of people. Given the range of individual activities undertaken in the marina, and that large parts of the marina are publicly accessible, this standard would be problematic to enforce. In the absence of this information, the provisions in the Seaview Marina Precinct and Heavy Industrial Zone seek to avoid or not allow activities which are incompatible or potentially incompatible with the overall purpose of the precinct (marina) and zone (heavy industrial area). The precinct and zone provisions provide protection to activities sensitive to the residual risk from locating near the fuel line.

□s articulated in my letter to Council dated □□ May □□□□□t□e Fuel Companies are concerned t□at t□e Seavie□ Marina Precinct □SMP□provisions □□ere located outside t□e RMO□are enabling of a □ide range of activities and t□erefore present a significant opportunity t□reat for land use c□anges □□ic□could c□ange t□e ris□profile of t□e regionally significant □□arfline□ T□e proposed SMP density approac□ □ould be an effective means of ensuring t□at residual ris□associated □it□large volumes of people gat□ering in pro□imity of t□e □□arfline is managed□□o□ever□if t□e density approac□is not supported by Council□it is paramount t□at a consenting frame□or□is establis□ed to control landuse activities in t□e SMP as set out in t□e □□ May □□□□ letter□Ot□er□ise□t□e Fuel Companies are concerned about t□e cumulative addition of a number of permitted activities in t□e SMP resulting in a □ig□density of people ad□acent to t□e □□arfline□

Relief sought: that the changes to the SMP sought in the 31 May 2024 letter are implemented.

Additional matter

Finally□t□e Fuel Companies □is□to comment on Rule □S□R□in t□e draft plan□□S□R□ re□uires restricted discretionary activity consent for t□e *expansion or upgrading of existing significant hazardous facilities*□

T□e meaning of *upgrading* □defined in t□e conte□t of infrastructure only[1]□is unclear□and in t□e conte□t of t□e rule suggests t□at a □ide range of activities could trigger consent□For e□ample□*upgrade* appears to include activities t□at improve security and safety□It seems antit□etical to re□uire a security fence or fitting of additional monitoring devices or improved alarm system□to re□uire consent□Some activities may only be procedures or computer programmes – it doesn't make a lot of sense to capture such activities□Suc□a provision □ould tend to disincentivise appropriate security and safety improvements□Removing references to *upgrading* □ould assist in avoiding t□is confusion□

In addition□rat□er t□an trigger consent for any e□pansion □upgrade □or□s□t□e provision needs to be tied to managing ris□s associated □it□ □a□ardous substances□being t□e function of t□e c□apter□In ot□er □ords□a permitted pat□□ay s□ould e□ist for t□e e□pansion of significant □a□ard facilities□provided t□at t□is e□pansion does not c□ange t□e residual ris□[2] envelope of t□e activity□In t□e case of t□e bul□fuel storage terminals□t□e ris□envelope is t□at addressed and establis□ed by t□e □R□s for eac□terminal □□ic□ □ave □□ill be provided to Council and are an effective baseline ris□profile□□ny c□anges t□e Companies ma□e to

[1] *Upgrading* is defined in t□e plan as follo□s□*as it applies to infrastructure, means the improvement, relocation, replacement, or increase in carrying capacity, operational efficiency, size, pressure, security or safety of existing infrastructure, but excludes maintenance and repair.*

[2] Refer to t□e Fuel Companies proposed definition of 'residual ris□' in its feedbac□to □utt City Council on t□e draft plan dated December □□□□□

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t□eir terminals can be rerun t□roug□ t□e model and c□ec□ed to ensure t□e ris□ contours are not ot□er□ise e□tended□

T□e Fuel Companies also see□t□at t□e definition of significant □a□ardous facilities is amended□per t□e Fuel Companies letter to Council in December □□□□□

Relief sought:

That the following permitted activity rule is provided (together with consequential amendments to HS-R1)

Expansion of existing significant hazardous facilities

1. The activity does not change the risk profile established by QRA of the significant hazard facility, as measured from the date of notification of this Plan.

All zones

Activity status: Permitted

That the definition of significant hazardous facilities is amended as follows:

Significant hazardous facilities

Means any facility which involves one or more of the following activities:

3. The storage/use of more than 10050,000 litres of petrol

4. The storage/use of more than 50100,000 litres of diesel

.....

This definition does not apply to:

1. The underground storage of petrol and diesel at service stations and truck stops that is undertaken in accordance with HSNOCOP 44 Below Ground Stationary Container Systems for Petroleum – Design and Installation and HSNOCOP 45 Below Ground Stationary Containers Systems for Petroleum – Operation.

2. The distribution or transmission by pipelines of petroleum products.

Conclusion

T□an□you for revie□ing and considering t□is feedbac□□□ e □ould be □appy to discuss t□is feedbac□ □it□ you at a time t□at suits□

Regards□

SLR Consulting New Zealand

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□ssociate Planner
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□

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□ppendi□ □□ □□OSL Terminal Tan□Overflo□ Vapour Dispersion and Blast □ffects □ssessment

□ppendi□B□P□P Memo

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WorleyParsons
resources & energy

NEW ZEALAND OIL SERVICES LIMITED
VALUE WITH CONFIDENCE

NEW ZEALAND OIL SERVICES LTD

NZOSL Hutt City Safety Case
Tank Overflow Vapour Dispersion and Blast Effects Assessment

110046-TCN-R0001
September 2017

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Rev	Description	Originator	Reviewer	WorleyParsons Approver	Date	Client Approval	Date
A	Issued for Review/Comment	s7(2)(a)	s7(2)(a)	s7(2)(a)	08/2017		
0	Approved for Use	s7(2)(a) s7(2)(a)	s7(2)(a) s7(2)(a)	s7(2)(a) s7(2)(a)	09/2017	s7(2)(a) s7(2)(a)	

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HOLDS

No.	Reference	HOLD
□	□□□□□□	T□e Manually Operated S□ut Off Valve □MOSOV□□as not been identified and a procedure to close t□is valve □as not been developed□ consideration of a secondary MOSOV is also re□uired□
□	□□□□□□	Revisit surge analysis studies to ensure loading □ose failure □as been ade□uately accounted for□

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EXECUTIVE SUMMARY

□ orleyParsons □ere engaged by □e□ □ealand Oil Services Limited □□OSL□to conduct an assessment to understand t□e potential effects associated □it□ ignition of a flammable vapour cloud resulting from an e□tended mogas □gasoline□storage tan□ overflo□ scenario at t□e □□OSL □utt City Terminal□

T□e potential e□tent of t□e migrating flammable vapour cloud generated in t□e event of an e□tended mogas tan□ overflo□ □as estimated□ T□e congested areas □ere identified and t□e e□plosion overpressures levels generated from eac□ congested area □ere modelled□

T□e □□OSL □utt City Terminal is surrounded by a mi□ of industrial and commercial premises□T□e results indicated t□at a number of t□e neig□bouring premises are located □it□in t□e calculated ignitable □a□ard range□

□ it□ respect to t□e vapour cloud e□plosion overpressure effects□damaging overpressure levels are identified as e□tending across surrounding sensitive areas□□o□ever□t□ere are no surrounding residential areas t□at may be affected□T□e □□OSL office building could be sub□ected to t□e □□□□ bar □damage to internal partitions and □oinery□but repairable□probability of in□ury □□□ □no fatality□overpressure level from an e□plosion generated □it□in t□e □□OSL loading gantry□T□e □□□□□ bar □no fatality and very lo□ probability of in□ury□overpressure from t□is e□plosion e□tends across a small portion of Port Road□

T□e □□□□□ bar □no fatality and very lo□ probability of in□ury□overpressure level from a vapour cloud e□plosion generated in t□e □□OSL service area is limited to t□e □□OSL compound and □ill not affect any sensitive areas□

In t□e event of a vapour cloud e□plosion from t□e neig□bouring car yards to t□e nort□east of t□e □utt City facility□t□e □□□□□ bar □no fatality and very lo□ probability of in□ury□overpressure level e□tends over a number of t□e surrounding commercial premises□as □ell as t□e □utt Valley □ aste □ ater Treatment Plant and a Cemetery located to t□e nort□ of t□e facility off Seavie□ Road□T□e □□□□ bar □damage to internal partitions and □oinery□ but repairable□probability of in□ury □□□ □no fatality□ overpressure level also e□tends over a number of t□e surrounding commercial premises □□ile t□e neig□bouring car yards □□ere t□e vapour cloud e□plosion is identified as being generated□could be e□posed to t□e □□□□ bar □□ouse unin□abitable and badly crac□ed□overpressure level□

□n e□plosion generated in t□e neig□bouring card yards to t□e east of t□e facility could produce t□e □□□□□ bar □no fatality and very lo□ probability of in□ury□overpressure level □□ic□ e□tends over a number of t□e surrounding commercial premises□ T□e □□□□ bar □damage to internal partitions and □oinery□ but repairable□probability of in□ury □□□ □no fatality□overpressure from t□is e□plosion also e□tends across a number of t□e surrounding commercial premises □□ile t□e □□□□ bar □□ouse unin□abitable and badly crac□ed□overpressure level □ill affect t□e neig□bouring car yards □□ere t□e vapour cloud e□plosion is identified as being generated□

Sensitivity analyses □ere conducted by studying t□e importance or t□e impact of some □ey assumptions□ namely composition□overflo□ duration and confined volume□

Given t□e s□ip□fed batc□ nature of t□e □utt City Terminal tan□ filling operation□t□e presence of t□o site operators □one monitoring t□e disc□arge from t□e site office□control room and t□e ot□er testing line samples and carrying out tan□ c□ec□s□and t□e significant time bet□een t□e level alarms and overflo□ □□□ minutes after OL□□□□□□ minutes after □L□□□□ minutes after □□L□□□for t□e purpose of t□is study a base case □orst credible overflo□ duration of □□ minutes □as assumed□Reduction in t□e overflo□ duration from □□ minutes to □ minutes resulted in a significant reduction in t□e escape and ignitable □a□ard ranges□Conversely□increasing t□e overflo□ duration to □□ minutes resulted in a significant increase in

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t□e escape and ignitable □a□ard ranges□□o□ever□t□is did not translate to c□anges in overpressure level effects distances □□ic□ remained almost identical for t□e overflo□ duration sensitivity cases□

Overall□ t□e results indicate t□at t□e most severe conse□uence is associated □it□ persons being enveloped in a large flas□ fire□as t□ere is a lo□er potential for serious in□ury or significant building damage from a vapour cloud e□plosion in t□e event of a tan□ overflo□□

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□□□ □utt City Terminal Overvie□ □□□□

1. ABBREVIATIONS

□GO	□utomotive gas oil
BST	Ba□er□Stre□lo□
□IL	□nergy Infrastructure Limited
□□L□	□ig□ □ig□ Level □larm
□L□	□ig□ Level □larm
IDL□	Immediately Dangerous to Life and □ealt□
LFL	Lo□er flammable limit
M□PP	Ma□or □ccident Prevention Policy
M□M	Multi□energy met□od
MOG□S	Motor Gasoline
□□OSL	□e□ □ealand Oil Services Limited
OL□	Operator Level □larm
PMS	Premium motor spirit
RMS	Regular motor spirit
SFL	Safe Fill Level
□□ □S□	□nited □ingdom □ealt□ and Safety □□ecutive
VC□	Vapour cloud analysis
VC□	Vapour cloud e□plosion

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2. INTRODUCTION

□ orleyParsons □ere engaged by □e□ □ealand Oil Services Limited □□OSL□to conduct an assessment to understand t□e potential effects associated □it□ ignition of a flammable vapour cloud resulting from an e□tended mogas □gasoline□storage tan□ overflo□ scenario at t□e □□OSL □utt City Terminal□

2.1 Hutt City Terminal Overview

T□e □utt City Terminal is a bul□ fuel storage terminal operated by □□OSL and located at □□□□□ Port Road□Seavie□□□utt City□in □ ellington□It mainly consists of □□ in□service bul□ storage tan□s for Regular Motorspirit □RMS□□Premium Motorspirit □PMS□□□utomotive Gas Oil □□GO□and □et□□□ □sole BP grade□□all located inside t□ree bunded compounds□Fuel is delivered to t□e bul□ storage tan□s via a manifold □□ic□ receives product from one □□ inc□ pipeline □s□ared by C□evron□Mobil□□ □nergy and BP□from Seavie□ □ □arf□located about □□m to t□e sout□ of t□e terminal□

Fuel is loaded from t□e bul□ storage tan□s to truc□s via a □□bay loading gantry □tan□ □agon fuel stand□for distribution t□roug□out t□e lo□er □ort□ Island□□mpty tan□ers are par□ed in a designated truc□ par□ing area □□en not in use□T□ere is no loaded truc□ par□ing on site□

□n aerial representation of t□e terminal is provided in Figure □□□ belo□□

Figure 2-1: Overall Site Layout for the Hutt City Terminal

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2.2 Objectives

The specific objectives of this study are to determine the potential size of the flammable vapour cloud generated in the event of an extended mogas tank overflow and the likelihood of such a vapour cloud reaching areas of congestion which is the prerequisite for a vapour cloud explosion or VCE.

The potential level of explosion overpressure resulting from a VCE on the NZOSL Hutt City Terminal facility manned site buildings and any residential/sensitive land uses in the wider area will also be determined.

The findings from this assessment will be used in evaluating risk reduction measures to confirm that the risk of generating a large migrating vapour cloud from an extended/undetected tank overflow scenario is eliminated or minimised so far as is reasonably practicable. This risk reduction measure evaluation is being completed separately under the wider NZOSL Hutt City Safety Case Development project scope.

Note the difference between an overfill scenario and an overflow scenario in the context of this report. i.e. overfill refers to an exceedance of the *'Safe Fill Level (SFL)'* whereas overflow refers to a loss of containment of mogas through the air vents on the tank roof perimeter.

2.3 Buncefield

The 2005 Buncefield Oil Depot explosion and fire in December 2005 is of particular interest in relation to this study. In the Buncefield incident, Tank 912 which had a capacity of 6 million litres was overfilled with gasoline. Large quantities of gasoline overflowed from the top of the tank during low wind speed and stable atmospheric conditions. The Buncefield explosion was caused by the ignition of a significant flammable vapour cloud from the overflowed tank that had spread over some considerable distance from its release point.

Prior to the Buncefield explosion, the most likely safety consequences from the overflow of an atmospheric storage tank would have been assumed to be a pool fire and/or flash fire. The size of the flash fire would probably have been limited because the influence of vaporisation from an atomised liquid cascade was not recognised and the flash fire would have been associated with evaporation from an assumed quiescent pool in the bund. In either case, the most serious outcome may well have been assumed to be a single fatality somewhere on the operating facility with the off-site consequences being managed through evacuation.

Following the explosion at Buncefield, the most severe human safety consequence should not be assumed to be an explosion that may cause damage to occupied buildings or places where people may congregate (unless validated by appropriate consequence modelling). An explosion would be accompanied by a flash fire and would probably result in multiple pool fires (Ref 2).

The RMS and PMS 2 Pxxxxxxxx and PMS 3 Pxx storage tanks located on the Hutt City Terminal meet the criteria for in-scope tanks as defined in the Buncefield reports. Therefore, NZOSL must consider the Buncefield recommendations (Ref 2) as the starting point for design of the Hutt City Terminal storage tanks including consideration of the routing of overflow liquids.

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2.4 Assumptions

The following general assumptions have been made in conducting this study:

- For the purposes of modelling the mogas tanks (P1, P2 and P3) are assumed to be identical.
- The study assumes that the overflow event has occurred from one tank only (i.e. there is no simultaneous overflow from more than one tank).

Specific modelling assumptions are included in the body of this technical note.

2.5 Exclusions

The following aspects have been excluded from the study:

- The mechanism of tank overflow or the proposed tank overflow prevention is not considered in this study. This study assumes that tank overflow is possible and focuses only on the consequences in the event of overflow.
- Assessment of effects associated with major incident scenarios other than tank overflow.
- Quantitative risk assessment against risk acceptance criteria.

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3. METHODOLOGY

The methodology adopted for conducting this study is as below:

- Determine the source term of vapour cloud production as per Buncefield findings guidance (Ref. [1])
- Identify and classify the congested areas within the flammable range of the cloud.
- Determine the likelihood of a flammable cloud generated by an extended overflow scenario reaching congested areas with reference to a representative wind rose for the Hutt City tank farm area.
- Determine the level of overpressure resulting from VCE using DNV GL Phast version 8.1 consequence modelling software.

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4. SOURCE TERM CALCULATION & VAPOUR CLOUD DEVELOPMENT

4.1 Design and Operational Assumptions

4.1.1 Tank Details

There are 13 operational bulk tanks on site containing:

- Automotive gas oil (AGO), diesel;
- Regular motor spirit (RMS), 91 octane petrol;
- Premium motor spirit (PMS), 95 octane petrol;
- Jet-A1 (sole BP grade);
- Slops; and
- Additives.

The tanks are located inside four primary containment compounds (C1, C2, C3 and the slops tank compound). All the storage tanks are fixed roof and fitted with level gauges and breathing vents. The Jet-A1 and AGO tanks have internal floating suction (to siphon a product from under the product surface), while the PMS and RMS tanks has internal floating roof (IFR) inside them to minimise any vapours. The tank details are given in Table 4-1.

Table 4-1: Hutt City Terminal Tank Details

Tank	Contents	Diameter (m)	Height (m)	Filling Rates		Bunding
				(m^3/hr)	(kg/s) Note 1	
WP1	RMS	25.1	12.8	1237	257	Inside one area of Compound No. 1
WP4	RMS	25	14.1	1237	257	
WP2	RMS	25.3	13.2	1237	257	Inside the other bigger area of Compound No. 1
WP3	*Jet A1 tank – Decommissioned*					
WP5	PMS	25	14.1	1237	258	
WP6	AGO	13.7	10.6	1237	287	
WP7	Jet-A1 (BP)	13.7	10.6	1237	274	
WP8	AGO	17.1	12.8	1237	287	Inside Compound No. 2
WP9	AGO	15.2	12.2	1237	287	
WP10	RMS	25	14.1	1237	257	
WP11	*Motor Spirit ULT98 tank – Decommissioned*					
WP12	AGO	28	15.9	1237	287	Inside Compound No. 3
WP13	AGO	19.5	16.5	1237	287	
WP20	Slops	8.2	9.1	-	-	Inside slops tanks concrete compound
WP21	Slops	8.2	9.1	-	-	
WP22	*Slops tank - Decommissioned*					

[1] Density of PMS and RMS assumed to be 0.7536 kg/L and 0.7479 kg/L respectively; density of AGO assumed to be 0.8340 kg/L; density of Jet A1 assumed to be 0.7981 kg/L.

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Tank	Contents	Diameter (m)	Height (m)	Filling Rates		Bunding
				(m^3/hr)	(kg/s) Note 1	
T003	Aviation Fuel Additive	0.9	1.8	-	-	Inside concrete bund
T004	Aviation Fuel Additive	0.9	1.8	-	-	
WP23	*Additive tank - Decommissioned*					
WP24	Motor Spirit Additive	1.9	3.8	-	-	
WP25	Motor Spirit Additive	1.9	3.8	-	-	
WP26	Diesel Additive	1.9	3.8	-	-	

AGO and Jet-A1 have high flash points and are not considered volatile liquids. An overflow event of AGO or Jet-A1 leading to a VCE is not considered credible [Ref. 1] and therefore has not been considered further in this technical note. The slops and fuel additive are also not considered to lead to a VCE.

In the event of a tank overflow, the tank filling rate is taken to be the overflow rate. The maximum tank filling rate is 1237 m^3/hr as provided by Mark Soper (Hutt City Terminal Manager) [Ref. 2]. Overflow from the mogas tanks is through the air scoops[2].

It is assumed that up to 150 mogas tank fills are carried out per year (based on 50 tankship discharges per year; 3 tank fills per tankship discharge[3]).

The locations of the tanks are shown in the layout in Figure 4-1.

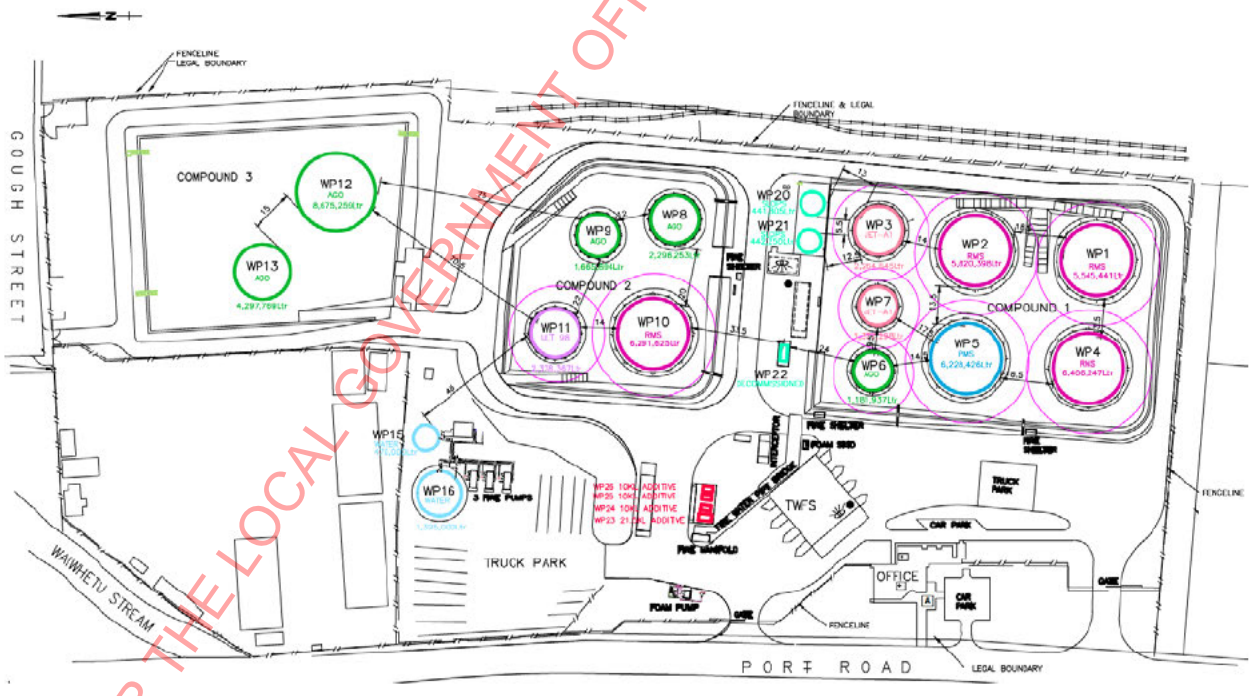

Figure 4-1: Hutt City Tanks Locations

[2] It has been suggested by NZOSL Engineering that the tanks may start overflowing from the foam pourers initially. This is not assessed as part of this study as this overflow mode was not considered in the Buncefield findings guidance.

[3] Assumption agreed with Terminal staff during site visit 12 July 2017.

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4.1.2 Tank Filling Manning

All discharges are attended to by a minimum of two dedicated NZOSL personnel at the terminal whose primary task is monitoring the tankship discharge, as well as additional staff at the wharf.

4.1.3 Level Indication and Alarms

The terminal is fitted with high reliability tank gauging and Independent High High Level Alarms (HHLA) as per below:

- Automatic tank gauging – Rosemount Raptor 5900s and SAAB radar gauges.
- Independent HHLA – Endress and Hauser liquiphant probes; hardwired to an alarm panel in the terminal office via a safety relay.

4.1.4 Time to Overflow

The alarm settings have been based on NZOSL alarm setting logic. The time taken for product to overflow from the air vents of the tank with the smallest distance between Safe Fill Level (SFL) and the overflow level (product out of vents) (i.e. worst case) is tabulated in Table 4-2 below.

Table 4-2: Tank Alarm Settings for typical tank at the Hutt City Terminal

Tank alarm settings	Level (m)	Volume (kL)	Time (min)	Total (min)
Operator Level Alarm (OLA)	11.711	5835.1		
Safe Fill Level (SFL)	12.340	6143.7	15	15
High Level Alarm (HLA)	12.365	6156.0	0.6	15.6
High High Level Alarm (HHLA)	12.466	6205.6	2.4	18
Overfill Level (OFL)[4]	12.886	6411.7	10	28
Product out of vents (i.e. overflow)	14.070	6992.7	28	56

The NZOSL Specification for Vertical Bulk Tank Fill and Alarm Levels (ST-0062 ENG) states that HHLA needs to be at least 10 minutes pumping below the Overfill Level.

The times are based on a maximum flow rate of 1237 m^3/hr when the tanks are empty, which then reduces as the tanks reach capacity, i.e. the times tabulated above are conservative.

4.1.5 Alarm Annunciation

Both the HLA and HHLA are annunciated in the terminal office. The HHLA annunciates at the terminal manifold via a sounder and flashing beacon. The terminal EDAC Alarm Autodialer will also call terminal staff via the on-call roster programmed in the unit.

4.1.6 Shutdown of Input to the Terminal from a Ship Transfer

The NZOSL procedure for shutting down a ship receipt in an emergency is primarily based on communications with the Wharf Attendant and the vessel via the ISGOTT recognised command of *'Stop Stop Stop'*.

[4] The NZOSL definition of Overfill Level is: *Maximum height before overflow, hydrostatic structural failure, or damage could occur. Equivalent to API 2350 definition for 'Critical High Level' (As taken from NZOSL Specification for Vertical Bulk Tank Fill and Alarm Levels (ST-0062 ENG)).*

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T□e primary means of communication □it□ t□e □□arf is via □□F radio□Secondary means is via cellp□one□ Land line telep□one communication is also available□

In t□e event of a level alarm □□L□ or □□L□□and t□e □ □arf □ttendant cannot be contacted to s□ut do□n t□e s□ip□t□e terminal □as a procedure to close a Manually Operated S□ut Off Valve □MOSOV□□□□OLD □ for □utt City not currently proceduralised□ or valve identified□ consider secondary MOSOV valve identification also□□

□utomatic s□utdo□n of t□e □□arfline by t□e terminal is not provided as t□e current □□OSL position is t□at automatic s□utdo□n of flo□ against a tan□s□ip disc□arge may result in a pressure spi□e and subse□uent spill at t□e tan□s□ip bert□□Surge analysis □as determined t□at terminal valve closure can be enacted safely if□closure is □it□in surge limits□□□OLD □ Revisit surge analysis studies to ensure loading □ose failure □as been ade□uately accounted for□□

4.2 Vapour Cloud Analysis

T□e analysis of overflo□ing a tan□ □it□ volatile li□uid is a comple□ and important problem□and prior to Buncefield incident □ad not been studied t□oroug□ly□Since t□e incident□t□e □□ □S□ □as sponsored a program of e□perimental and modelling researc□ to investigate t□e tec□nical issues involved and develop met□ods of analysis □Ref□□□□

T□e vapour cloud analysis □VC□□met□od □as developed as a result of t□e researc□ and considers t□e follo□ing calculation steps□

- □□ □ir entrainment into t□e steps of flo□ □free cascade□of falling li□uid□
- □□ Fuel vapour concentration at t□e foot of t□e cascade□
- □□ □dditional vaporisation from fine splas□ products□
- □□ Volume flo□ rate and concentration of t□e cloud leaving t□e bund□
- □□ Idealised □a□ard ranges for clouds spreading in □□ero□□ind speed condition□

Reference s□ould be made to t□e □□ □S□ researc□ report for furt□er details □Ref□□□□

It is noted t□at t□e basis of t□e Buncefield investigations for a vented fi□ed roof tan□ □as overflo□ out of t□e roof vents do□n t□e sloping roof and flo□ing over and under a fire□ater deflector plate□ □it□ impingement on an intermediate □ind girder forming a secondary spray □efer Figure □□□ belo□ □□□lt□oug□ t□e □ P□ and □ P□ mogas tan□s □ave □ind girders installed approximately ⅓ from the top of the tank□t□e remaining mogas tan□s do not□Overflo□ from t□e □utt City Terminal mogas vented fi□ed roof tan□s □ill disc□arge directly from vents at t□e perimeter of t□e tan□ top□□lt□oug□ t□e overflo□ of mogas from □ P□ and □ P□ □ill impinge on t□e intermediate □ind girders and be deflected out□ards□t□ey do not □ave t□e deflector plates□t□e Buncefield investigations state t□at t□e error if t□ere is no deflector plate □ill be limited as all of t□e flo□ is directed into a top flo□ of similar type to t□at analysed□

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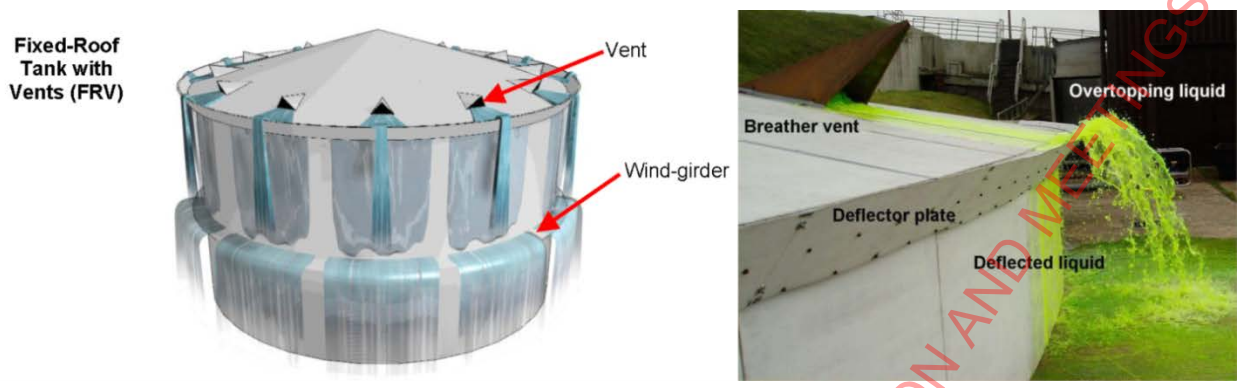

Figure 4-2: Buncefield Investigation Overflow Basis [Ref. 8]

4.3 Model Description

Liquid Discharge

There are three main options for bulk storage of volatile liquids (Ref...):

- Vented fixed roof with floating internal deck – this is the type of tank used to store mogas on the site and is the type tank involved at Buncefield.
- Floating roof tanks
- Fixed roof with PV valves

The API research paper notes there is a degree of uniformity in the design of vented fixed roof tanks. Vents are normally relatively small and separated by approximately m around the edge of the roof. This reflects the design of the Hutt City Terminal mogas tanks which have an approximate m perimeter and eight vents each.

It is important in the analysis of liquid flow to determine the total mass of discharge and the distance along the tank perimeter over which the liquid is discharged. The speed of discharge is generally low and although this affects the thrown of the cascade (the distance of the impact point from the foot of the tank) all there is relatively minor effect on the vapour cloud.

The API research paper states that for vented fixed roof tanks there is normally a deflector plate that redirects cooling water applied to the tank on to the walls. The VCE method assumes a deflector plate is fitted in calculating air entrainment. The Hutt City mogas tanks do not have deflector plates fitted. However the API research paper also states that the error will be limited if there is no deflector plate. Therefore the VCE calculation method is considered to be applicable for the Hutt City mogas tanks.

Liquid Fragmentation

As any liquid stream accelerates downwards under gravity it thins and eventually becomes susceptible to the Rayleigh instability. If highly turbulent at the discharge point this stage may be short circuited. In any case chains of relatively large droplets are formed which continue to accelerate.

The surface stresses associated with aerodynamic drag increase and the droplets become flattened. This increases the drag and a catastrophic breakup process into a large number of much smaller fragments occurs. This flattening and fragmentation of large droplets is so violent that product droplets are flung outwards in all directions. This produces a rapid expansion in the cascade width and is a main driver of broadening of the cascade throughout its fall.

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The process is characterised by the ratio of aerodynamics to surface tension forces, i.e. a Weber Number. Broadly speaking, a critical Weber Number defines the relative speed at which a droplet of a given size and surface tension will fragment. The surface tension of most hydrocarbons is roughly similar and in all case is much less than that of water. This means that the fragmentation of a hydrocarbon liquid stream to form a spray takes place at smaller relative velocity and consequently smaller distances below the release point – compared with water. Hexane and decane cascades under a range of conditions have shown that the bulk of mass is concentrated in droplets with diameters of around 2 mm.

The overall source term (for dense hydrocarbon cascades) is relatively insensitive to the details of droplet size in that even the largest droplets are fine enough that the flow tends towards heat and mass transfer equilibrium. The rate of vaporisation is then controlled by the rate of air entrainment into the cascade.

At the foot of the tank there is an impact zone where the cascade hits the ground. This is an area where larger droplets impact the wetted solid surface, producing fine splash products initially moving counter to the bulk vapour flow. It is consequently an area of high heat and mass transfer. Generally it has been found that the extent of vaporisation immediately before (above) the impact zone is around 70% of that to be expected in conditions of full equilibrium. Within the impact zone the phases move rapidly closer to equilibrium and the flow out of the impact zone has realised at least 90% of the maximum potential vaporisation rate corresponding to full equilibrium.

Experiments have shown that some very fine droplets are carried out of the impact zone in the vapour flow. More fresh air is rapidly entrained into the ground level vapour current and vaporisation of the fine spray from the impact zone adds a small but significant amount of additional vapour to the final source term.

The calculation method and assumptions are discussed in detail in the UK HSE Vapour Cloud Formation research report [Ref. 3].

4.4 Model Application

The pertinent inputs for the VCA calculation are given in Table 4-3.

Table 4-3: VCA calculation inputs

		WP1	WP2	WP4/WP5/WP10
Input	Tank diameter (m)	25.1	25.3	25
	Tank Height (m)	12.8	13.2	14.1
	Fuel flow rate (kg/s)	257	257	259
Calculation	Mass Entrainment in Cascade, M_{air} (kg/s)	123	126	129
	Concentration at the tank foot, C_{fuel} (% wt/wt)	22.0	21.9	21.7
	Mass Vapourised, $M_{vapourised}$ (kg/s)	34.9	35.2	35.7
	Mass Splashed, M_{splash} (kg/s)	5.1	5.1	5.2
	Total mass addition rate to cloud, M_{cloud} (kg/s)	326.7	332.3	339.1
	Volume addition rate to cloud, V_{cloud} (m^3/s)	251.3	255.6	260.9
	Concentration of fuel vapour in cloud, C_{cloud} (kg/m^3)	0.159	0.158	0.157

The hazard range is then calculated from the cloud volume by assuming that the cloud geometry is a disc of constant depth. In reality, parts of the cloud near the surface will be above this level. In this method, a critical depth of 1 m is chosen.

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The hazard range is dependent on the total release duration[5]. In the Buncefield event, the tank overflowed for over 20 minutes (petrol started spilling out at 5.37 am, vapour cloud exploded at 6.01 am) [Ref. 4]. Given the ship-fed batch nature of the Hutt City Terminal tank filling operation, the presence of two site operators (one monitoring the discharge from the site office / control room, and the other testing line samples and carrying out tank checks) and the significant time between the level alarms and overflow (as per Table 4-2: 56 minutes after OLA; 40.4 minutes after HLA; 38 minutes after HHLA), for the purpose of this study a base case worst credible overflow duration of 10 minutes has been assumed. However, for comparison hazard ranges for overflow duration of up to 20 minutes have been calculated.

It is expected that an overflow of WP5 would produce the worst case flammable vapour cloud. The following hazard ranges for WP5 are calculated as given in Table 4-4.

- Range to which cloud may prevent escape - an indication of time available for evacuation of people in onsite occupied buildings or vulnerable offsite buildings. Note that escape becomes impossible when the cloud depth exceeds the breathing level where concentration of hydrocarbons in a flammable cloud greatly exceeds the IDLH levels (immediately dangerous to life and health).
- Range to which a low level ignitable cloud may extend - an indication to the range to which the cloud is vulnerable to ignition at various times).

Table 4-4: WP5 Hazard Range

Duration of release (min)	Range after (time) to which cloud will hinder escape (m)	Range to which low level cloud might be ignited (m)
0	0	0
1	50	71
2	71	100
3	86	122
4	100	141
5	112	158
6	122	173
7	132	187
8	141	200
9	150	212
10 (Base Case)	158	223
11	165	234
12	173	244
13	180	254
14	187	264
15	193	273
16	200	282
17	206	291
18	212	299

[5] Note also that model assumes calm or very low wind speed conditions and stable atmospheric conditions.

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Duration of release (min)	Range after (time) to which cloud will hinder escape (m)	Range to which low level cloud might be ignited (m)
19	217	308
20	223	316

If the tank is left to overflow for 10 minutes, the range that would hinder escape is 158 m and the ignitable range is up to 223 m. The base case ignitable hazard range is also marked up on Figure 4-3 below.

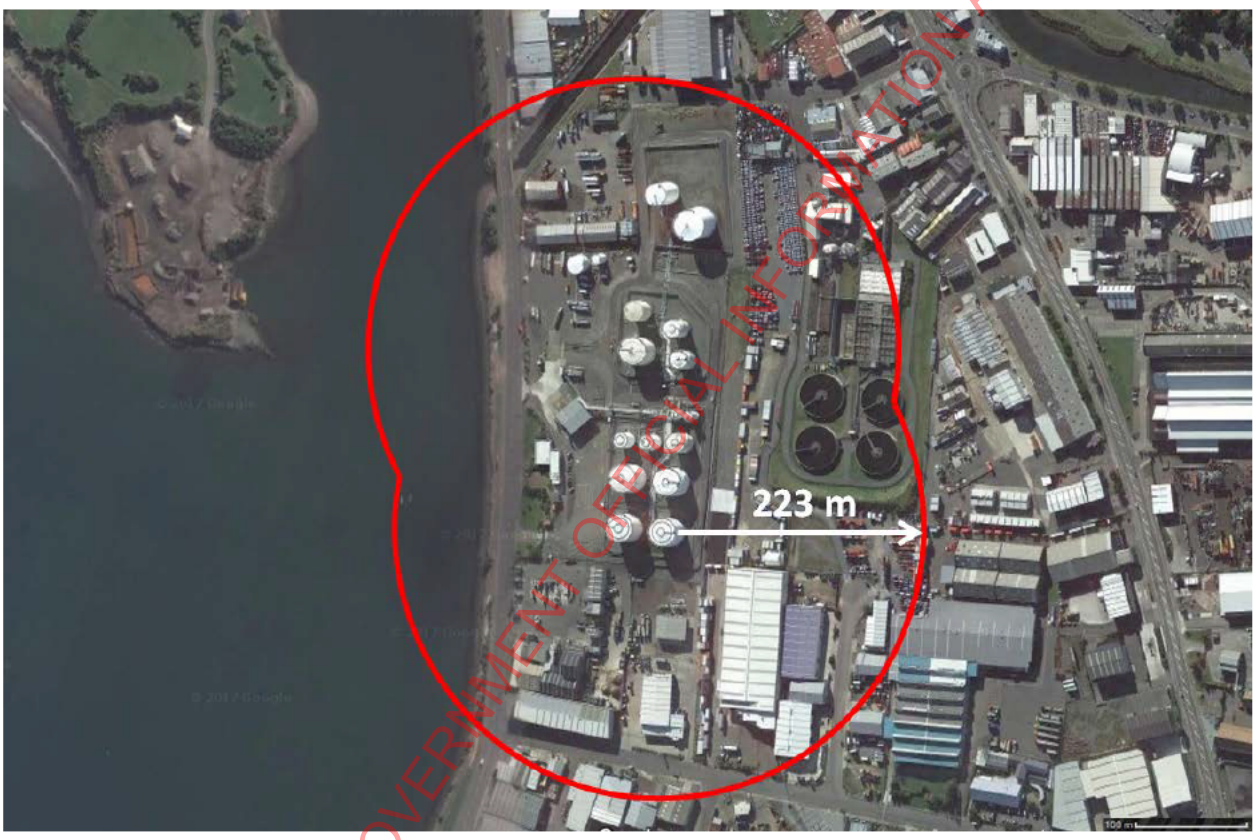

Figure 4-3: WP5 Ignitable Hazard Range

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5. VAPOUR CLOUD EXPLOSION (VCE)

5.1 Congested Region

□ flammable vapour cloud accumulation at congested area□s□is t□e prere□uisite to □ave a VC□□T□e □□OSL □utt City Terminal area is open □it□ good ventilation □coastal □ind□e□pected t□roug□out t□e year□ T□e conditions inside t□e bund are li□ely to be calmer□but t□ere is not muc□ e□uipment and pipe□or□ inside t□e bund t□at could create turbulence in a burning vapour cloud t□at □ould lead to overpressure□ T□e area topograp□y is fairly flat □it□ little vegetation t□at □ill contribute to overall congestion□

T□e □□OSL □utt City Terminal is surrounded by a mi□ of industrial and commercial premises□including a car import company □it□ cars par□ed along t□e site□s eastern boundary fence□In t□e event a flammable vapour cloud is formed□t□ere is t□e potential t□is can migrate off site and become congested□T□e congested areas identified □it□in t□e facility and surrounding areas are mar□ed up in red borders in Figure □□□□

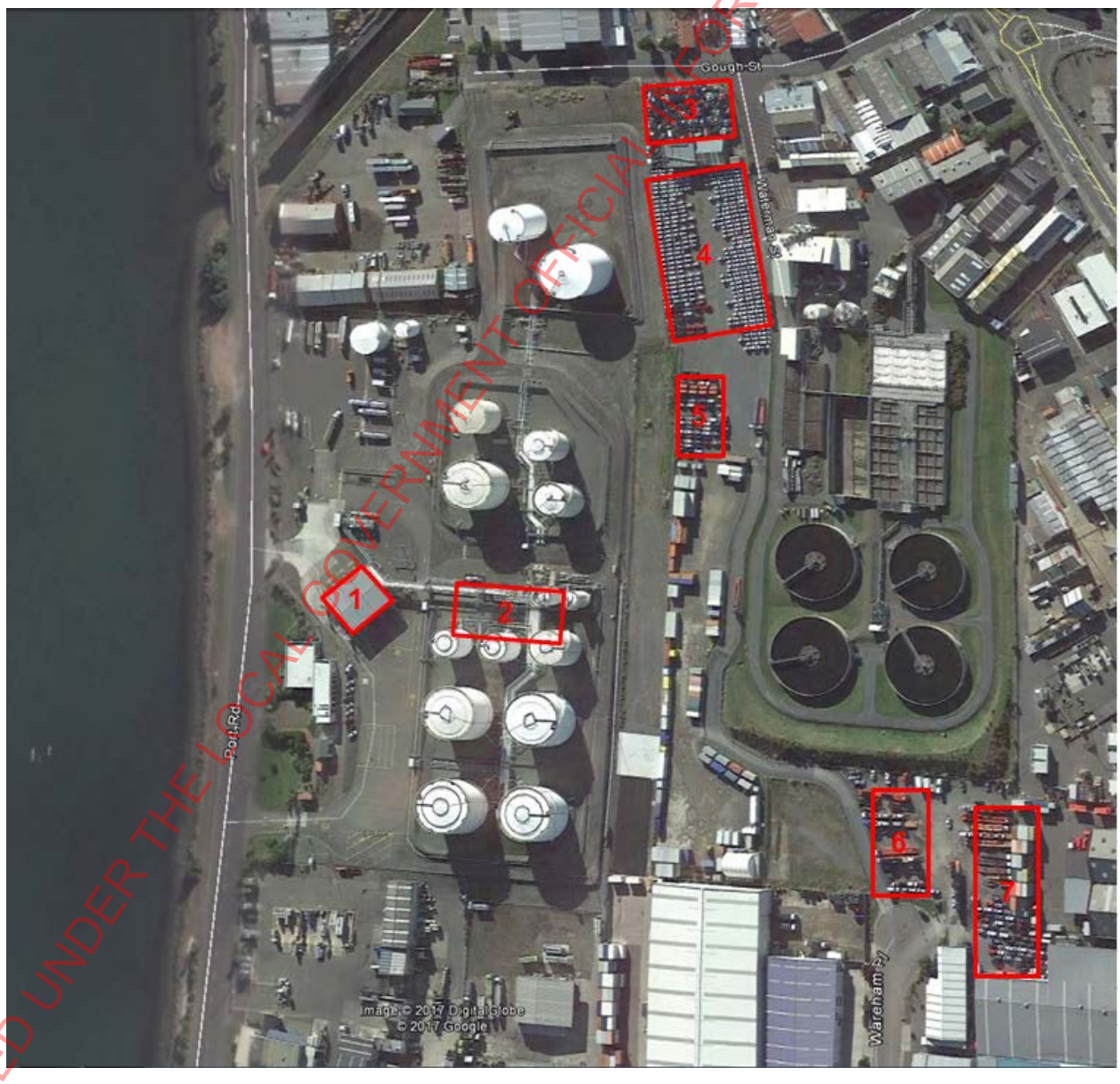

Figure 5-1: Tanks Locations and Congested Areas

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For a large migrating flammable vapour cloud, it is assumed that ignition will always occur (i.e. 100% ignition probability) [Ref. 1]. In case of ignition of a flammable vapour cloud in a low congestion area, a vapour cloud fire (more commonly known as flash fire) is more likely to occur.

The assumed dimensions of each congested area are given in Table 5-1.

Table 5-1: Dimensions of Congested Areas

No.	Description	Width (m)	Height (m)	Length (m)	Volume (m^3)
1	NZOSL Loading gantry	30.90	6.5	32.01	989
2	NZOSL piperack / storage tanks area	49.88	5	23.82	5941
3	Neighbouring scrap cars	40.20	1.5	25.68	1549
4	Neighbouring Car yard A	45.78	1	74.45	3409
5	Neighbouring Car yard B	20.47	1	35.73	732
6	Neighbouring Car yard C	25.68	1	48.39	1243
7	Neighbouring Car yard D	29.41	1	77.05	2266

DNV GL Phast version 6.7 is used for the consequence modelling. The "Multi-Energy Explosion" model is used to model the VCE. The TNO Yellow Book [Ref. 5] recommends the Multi-Energy method (MEM) as the blast curves are smoothed for practical application and extend to larger scaled distances than the Strehlow blast curve. Furthermore, the Multi-Energy blast charts provide the shape of the blast wave, which is important when the results are coupled to consequence models for calculation of damage to structures and injury to people.

The selection of blast curve used in the MEM is dependent on area obstruction, parallel plane confinement and ignition strength [Ref. 5]. For each of the congested areas defined in Figure 5-1, the blast strength selection criteria and corresponding blast strength class is given in Table 5-2.

Table 5-2: Blast Strength Index for the Congested Areas

No.	Description	Obstruction Note 6	Parallel plane confinement Note 7	Ignition Strength Note 8	Blast Strength Class
1	NZOSL Loading gantry	Low	Yes	Low	3-5
2	NZOSL piperack / storage tanks area	Low	No	Low	2-3
3	Neighbouring scrap cars	High	No	Low	4-5
4	Neighbouring Car yard A	High	No	Low	4-5
5	Neighbouring Car yard B	High	No	Low	4-5
6	Neighbouring Car yard C	Low	No	Low	2-3
7	Neighbouring Car yard D	High	No	Low	4-5

[6] High obstruction – Closely packed obstacles within gas cloud giving an overall volume blockage fraction (i.e. the ratio of the volume of the obstructed area occupied by the obstacles and the total volume of the obstructed area itself) in excess of 30% and with spacing between obstacles less than 3m. Low obstruction – obstacles in gas cloud but overall blockage fraction less than 30% and/or spacing between obstacles larger than 3 m

[7] Parallel plane confinement: Yes – gas cloud, or parts of it, are confined by walls / barriers on two or three sides. No – gas cloud is not confined, other than by the ground.

[8] Low ignition strength – the ignition source is a spark, flame, hot surface, etc.

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A typical maximum gas fill in a congested area is around 60%. Hence in this study, 60% fill for each congested area is assumed. The confined volume is calculated based on congested area dimensions. The input used in the Phast multi energy explosion for each congested area is provided in Table 5-3.

Table 5-3: Multi-Energy Explosion Modelling Input for the Congested Areas

No.	Description	Unconfined Strength [Note 9]	Confined strength	Confined Volume
1	NZOSL Loading gantry	2	4	3857
2	NZOSL Piperack/ storage tanks Area	2	3	3565
3	Neighbouring scrap cars	2	5	929
4	Neighbouring Car yard A	2	5	2045
5	Neighbouring Car yard B	2	5	439
6	Neighbouring Car yard C	2	3	746
7	Neighbouring Car yard D	2	5	1360

The simplified gasoline composition as provided by the UK HSE Vapour Cloud Formation research report [Ref. 3] was used in the modelling to represent both RMS and PMS. The composition is shown in Table 5-4.

Table 5-4: Gasoline Composition

Material	Composition (wt %)
n-butane (as a surrogate for all C4 hydrocarbons)	9.6
n-pentane (as a surrogate for all C5 hydrocarbons)	17.2
n-hexane (as a surrogate for all C6 hydrocarbons)	16
n-decane (as a surrogate for all low volatile materials)	57.2

This composition corresponds to the gasoline spilled in the Buncefield incident and is typical of a UK winter grade. A sensitivity analysis using a gasoline composition from another reference is conducted in section 5.4 (Sensitivity Analysis).

5.2 Overpressure Results

The VCE centred at each congested area is modelled and the distances to various levels of overpressure are given in Table 5-5.

Table 5-5: Overpressure Levels and Distances

Overpressure		Distance (m)						
(psi)	(bar)	Congested Area 1	Congested Area 2	Congested Area 3	Congested Area 4	Congested Area 5	Congested Area 6	Congested Area 7
0.5	0.035	103	47	112	146	87	28	127
1	0.07	51	*Not Reached*	56	72	43	*Not Reached*	63
2	0.14	*Not Reached*	*Not Reached*	28	36	21	*Not Reached*	31
3	0.21	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*

[9] Explosion modelling for the parts of the cloud that do not cover an area of strong confinement. Unconfined strength class 2 represents an area that is slightly confined, e.g. fences, bunds or hedges.

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The overpressure contours overlaid on site layout are also presented in Appendix 1.

Typical overpressure effects for the associated explosion overpressure levels are given in Table 5-6.

Table 5-6: Damage Effects Associated with Explosion Overpressures [Ref. 7]

Damage Effects Associated with Explosion Overpressures	Overpressure	
	(psi)	(bar)
90% glass breakage No fatality and very low probability of injury	0.5	0.035
Damage to internal partitions and joinery but can be repaired Probability of injury is 10%. No fatality	1	0.07
House uninhabitable and badly cracked	2	0.14
Reinforced structures distort Storage tanks fail 20% chance of fatality to a person in a building	3	0.21
House uninhabitable Wagons and plants items overturned Threshold of eardrum damage 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open	5	0.35
Threshold of lung damage 100% chance of fatality for a person in a building or in the open Complete demolition of houses	10	0.70

5.2.1 Observation

VCE modelling using the Baker-Strehlow (BST) explosion model in Phast were also conducted. The BST model generated significantly higher overpressure levels for all congested areas as compared to the overpressure levels generated by using the MEM model. The MEM model and BST model require different inputs and assumptions, where BST requires an input for "flame expansion", which is the constraints on the expansion of the flame or the number of directions in which the flame can expand. For the loading gantry's, the flame can only expand in 1 direction (along the x-axis), the high degree of constraint increases the flame speed and thus the overpressure. However, the loading gantry's structure may have suffered initial structural damage from the explosion which assists in venting out the excessive flammable gas cloud. The method of categorising obstacle density differs between each method also. It was decided to utilise the results generated by the MEM model as per the recommendation by the TNO Yellow Book.

5.3 Wind Condition

Only under calm or very low wind and stable atmospheric stability conditions is the flammable vapour predicted to reach and accumulate within the congested areas. Under higher wind speed, the flammable gas cloud would be dispersed and the concentration would fall below the lower flammable limit (LFL). For consistency, the Wellington Aero (Station 3445) wind rose produced from the NIWA database [Ref. 6] (shown in Figure 5-2) is considered for this technical note.

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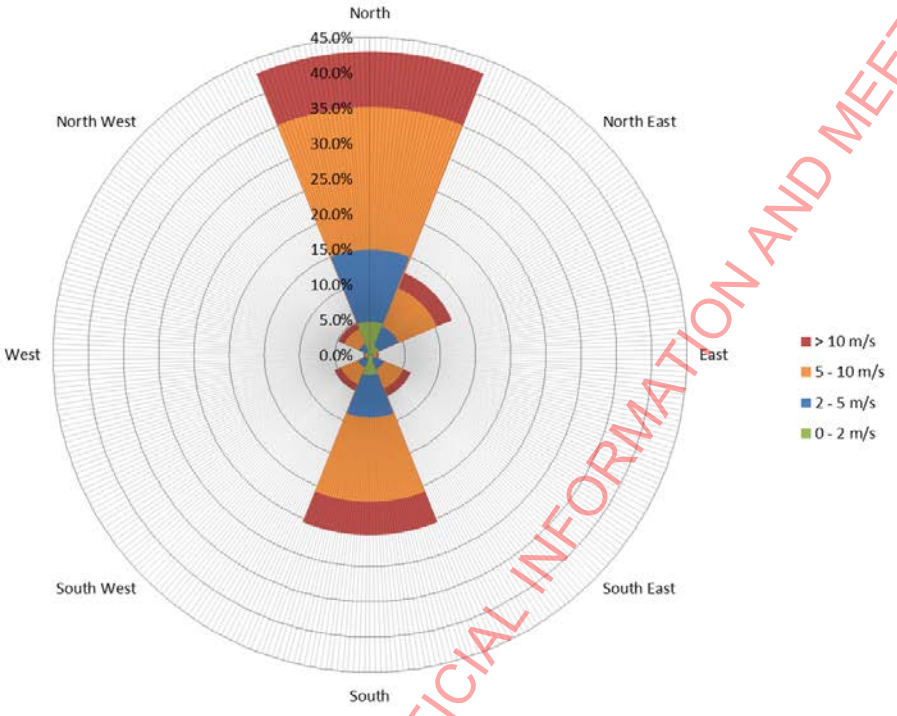

Figure 5-2: Wellington Wind Rose

T□e location e□periences □ □ □ m□s □ind for □□□ of t□e time from all directions□T□e predominant □inds are from t□e nort□ and t□e sout□□

Congested area □ is located nort□□east of □ P□□ □ P□□ □ P□□ □ P□ and sout□□□est of □ P□□□ T□is congested areas could be filled by a flammable vapour cloud if t□e □ind is less t□an □ m□s and is from S□ □□□□ □or □□ □□□□□ □□T□e □□OSL service area □congested area □□is located directly nort□ of □ P□□□ P□□ □ P□□□ P□ and sout□ of □ P□□ and is li□ely to be filled by flammable gas cloud if t□e □ind is less t□an □ m□s and is from □ □□□□□ □or S □□□□□ □□T□e offsite congested areas □ to □ are located nort□□east of t□e □□OSL tan□s□T□ese congested areas could be filled by a flammable vapour cloud if t□e □ind is less t□an □ m□s and is from S□ □□□□ □□Congested areas □ to □ are sout□□east of t□e □□OSL tan□s□T□ese congested areas could be filled by a flammable vapour cloud if t□e □ind is less t□an □ m□s and is from □□ □□□□□ □□

□ote t□e location of t□e reference □eat□er measurements are from □□□□□□□□□□□□□□□□□T□ese coordinates correspond □it□□ ellington □irport□

5.4 Sensitivity Analyses

Sensitivity analyses are conducted to study t□e importance or t□e significant impacts of selected □ey assumptions and to assist in identification of ris□ reduction measures□

5.4.1 Sensitivity Case 1: Material Composition

T□e material composition used in t□e modelling □as ta□en from t□e □□ □S□ researc□ report□□s a sensitivity analysis□a different mogas composition □as used in t□e P□ast multi□energy e□plosion model to

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study the impact of material composition to the overpressure levels. The mogas composition is given in Table 5-7.

Table 5-7: Mogas Composition for Sensitivity Analysis

Material	Composition (mole %)
n-butane	12.0
n-pentane	21.0
2-methylpentane	15.0
Toluene	17.0
m-xylene	10.5
2-methylheptane	14.0
1, 2, 4-trimethylbenzene	7.5
4-ethyl m-xylene	3.0

The compositions are only used in the Phast modelling to assess the effects of VCE and have no impact on the hazard range calculation. The VCE centred at each congested area is modelled and the levels of overpressure for sensitivity case 1 are given in Table 5-8.

Table 5-8: Overpressure Levels and Distances for Sensitivity Case 1

Overpressure		Distance (m)						
(psi)	(bar)	Congested Area 1	Congested Area 2	Congested Area 3	Congested Area 4	Congested Area 5	Congested Area 6	Congested Area 7
0.5	0.035	103	48	113	147	88	28	128
1	0.07	52	*Not Reached*	56	73	44	*Not Reached*	64
2	0.14	*Not Reached*	*Not Reached*	28	36	22	*Not Reached*	32
3	0.21	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*

The results show insignificant differences in the overpressure distances for the sensitivity case 1 compared to the base case.

5.4.2 Sensitivity Case 2: Overflow Duration

In the base case an overflow duration of 10 minutes was assumed. In this sensitivity case an overfill duration of 5 minutes is assessed in consideration of a shorter response to an overflow scenario. An overfill duration of 20 minutes is also assessed is consideration of an extended undetected overflow scenario to the scale of the Buncefield incident. The total mass released and the hazard ranges reached are given in Table 5-9.

Table 5-9: Mass Released and Hazard Range for Sensitivity Case 2

Overflow Duration (min)	Mass Released (kg)	Escape Hazard Range (m)	Ignitable Hazard Range (m)
10	156068	158	223
5	78034 (50% reduction)	112 (29% reduction)	158 (29% reduction)
20	312136 (100% increase)	223 (41% increase)	316 (41% increase)

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The overpressure results are almost identical to the base case results. This is due to the fact that the higher overpressure levels are generated by the accelerated flame front in the congested area. For the 5, 10 and 20 minutes overflow durations all the congested areas are already covered in the ignitable hazard range.

5.4.3 Sensitivity Case 3: Confined Volume

In the base case, it was assumed that each of the congested areas is 60% filled with flammable gas cloud. This is the typical maximum gas fill percent for congested area. As the loading gantry is partially enclosed with the only opening being the truck enter and exit points, for this sensitivity analysis, it was assumed that each congested area is only 30% filled with flammable gas cloud. The confined volumes are given in Table 5-10.

Table 5-10: Confined Volume for Sensitivity Case 3

No.	Description	Confined Volume (m^3)	
		Base Case	Sensitivity Case
1	NZOSL Loading gantry	3857	1929
2	NZOSL piperack / storage tanks area	3565	1782
3	Neighbouring scrap cars	929	465
4	Neighbouring Car yard A	2045	1023
5	Neighbouring Car yard B	439	219
6	Neighbouring Car yard C	746	373
7	Neighbouring Car yard D	1360	680

The VCE centred at each congested area is modelled and the levels of overpressure for sensitivity case 3 are given in Table 5-11.

Table 5-11: Overpressure Levels and Distances for Sensitivity Case 3

Overpressure		Distance (m)						
(psi)	(bar)	Congested Area 1	Congested Area 2	Congested Area 3	Congested Area 4	Congested Area 5	Congested Area 6	Congested Area 7
0.5	0.035	81	38	89	116	69	22	101
1	0.07	41	*Not Reached*	44	57	34	*Not Reached*	50
2	0.14	*Not Reached*	*Not Reached*	22	28	17	*Not Reached*	25
3	0.21	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*	*Not Reached*

The results show some reduction in the overpressure distances for the sensitivity case 3 compared to the base case.

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6. CONCLUSIONS

A vapour dispersion and blast effects assessment has been conducted for the NZOSL Hutt City Terminal. The potential size of the flammable vapour cloud generated in the event of an extended mogas tank overflow has estimated. The congested areas here identified and the explosion overpressures levels generated from each congested area here modelled.

The results of the AS VCE calculation indicate that the ignitable hazard range extends 100 m from the point of overflow. The NZOSL Hutt City Terminal is surrounded by a mix of industrial and commercial premises. number of these premises are located within the calculated ignitable hazard range.

With respect to the vapour cloud explosion overpressure effects, damaging overpressure levels are identified as extending across surrounding sensitive areas. However there are no surrounding residential areas that may be affected. The NZOSL office building could be subjected to the 0.1 bar *('damage to internal partitions and joinery, but repairable; probability of injury 10%; no fatality')* overpressure level from an explosion generated within the NZOSL loading gantry. The 0.07 bar *'no fatality and very low probability of injury'* overpressure from this explosion extends across a small portion of Port Road.

The 0.07 bar 'no fatality and very low probability of injury' overpressure level from a vapour cloud explosion generated in the NZOSL service area is limited to the NZOSL compound and will not affect and sensitive areas.

In the event of a vapour cloud explosion from the neighbouring car yards to the north-east of the Hutt City facility, the 0.07 bar *'no fatality and very low probability of injury')* overpressure level extends over a number of the surrounding commercial premises, as well as the Hutt Valley Waste Water Treatment Plant and a Cemetery located to the north of the facility off Seaview Road. The 0.1 bar *('damage to internal partitions and joinery, but repairable; probability of injury 10%; no fatality'* overpressure level also extends over a number of the surrounding commercial premises while the neighbouring car yards where the vapour cloud explosion is identified as being generated could be exposed to the 0.1 bar *'house uninhabitable and badly cracked'* overpressure level.

An explosion generated in the neighbouring card yards to the east of the facility could produce the 0.07 bar *'no fatality and very low probability of injury'* overpressure level which extends over a number of the surrounding commercial premises. The 0.1 bar *'damage to internal partitions and joinery, but repairable; probability of injury 10%; no fatality'* overpressure from this explosion also extends across a number of the surrounding commercial premises while the 0.1 bar *'house uninhabitable and badly cracked'* overpressure level will affect the neighbouring car yards where the vapour cloud explosion is identified as being generated.

Sensitivity analyses here conducted by studying the importance or the impact of some key assumptions, namely composition, overflow duration and confined volume.

Reduction in the overflow duration from 10 minutes to 5 minutes resulted in a significant reduction in the escape and ignitable hazard ranges. Conversely, increasing the overflow duration to 20 minutes resulted in a significant increase in the escape and ignitable hazard ranges. However this did not translate to changes in overpressure level effects distances which remained almost identical for the overflow duration sensitivity cases.

Overall, the results indicate that the most severe consequence is associated with persons being enveloped in a large flash fire as there is a lower potential for serious injury or significant building damage from a vapour cloud explosion in the event of a tank overflow.

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7. REFERENCES

□□ Safety and environmental standards for fuel storage sites□Process Safety Leaders□ip Group Final Report□□□ □ealt□ and Safety □□ecutive□□□□□□

□□ □mail Correspondence from Mar□ Soper to □lice Stembridge and Damian P□illis □□ugust □□□□□□ Sub□ect□□utt City and Seavie□ □ddition Information□

□□ Vapour Cloud Formation□ □□periments and modelling□ □□ □ealt□ and Safety □□ecutive Researc□ Report □RR□□□□□□□□□□□

□□ C□ronology of events at Buncefield □□plosion □□ttp□□□□□□□se□gov□u□□ne□s□buncefield□c□ronology□□tm□□

□□ Met□ods for t□e Calculation of P□ysical □ffects □ due to Releases of □a□ardous Materials □Li□uids and Gases□□□T□O Yello□ Boo□□□□

□□ □I□ □ □ational Climate Database □□ttps□□cliflo□ni□a□co□n□□□

□□ □a□ardous Industry Planning □dvisory Paper □o □□□ Ris□ Criteria for Land □se Safety Planning□□□□□□

□□ Flammable vapour cloud ris□s from tan□ overfilling incidents□□□□S□ Researc□ Report RR□□□□ □□□□□

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Appendix 1.
Overpressure Contours

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Figure 1: Explosion Overpressure Levels centred at C1: NZOSL Loading gantry

Figure 2: Explosion Overpressure Levels centred at C2: NZOSL piperack / storage tanks area

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Figure 3: Explosion Overpressure Levels centred at C3: Neighbouring Scrap Car Yard

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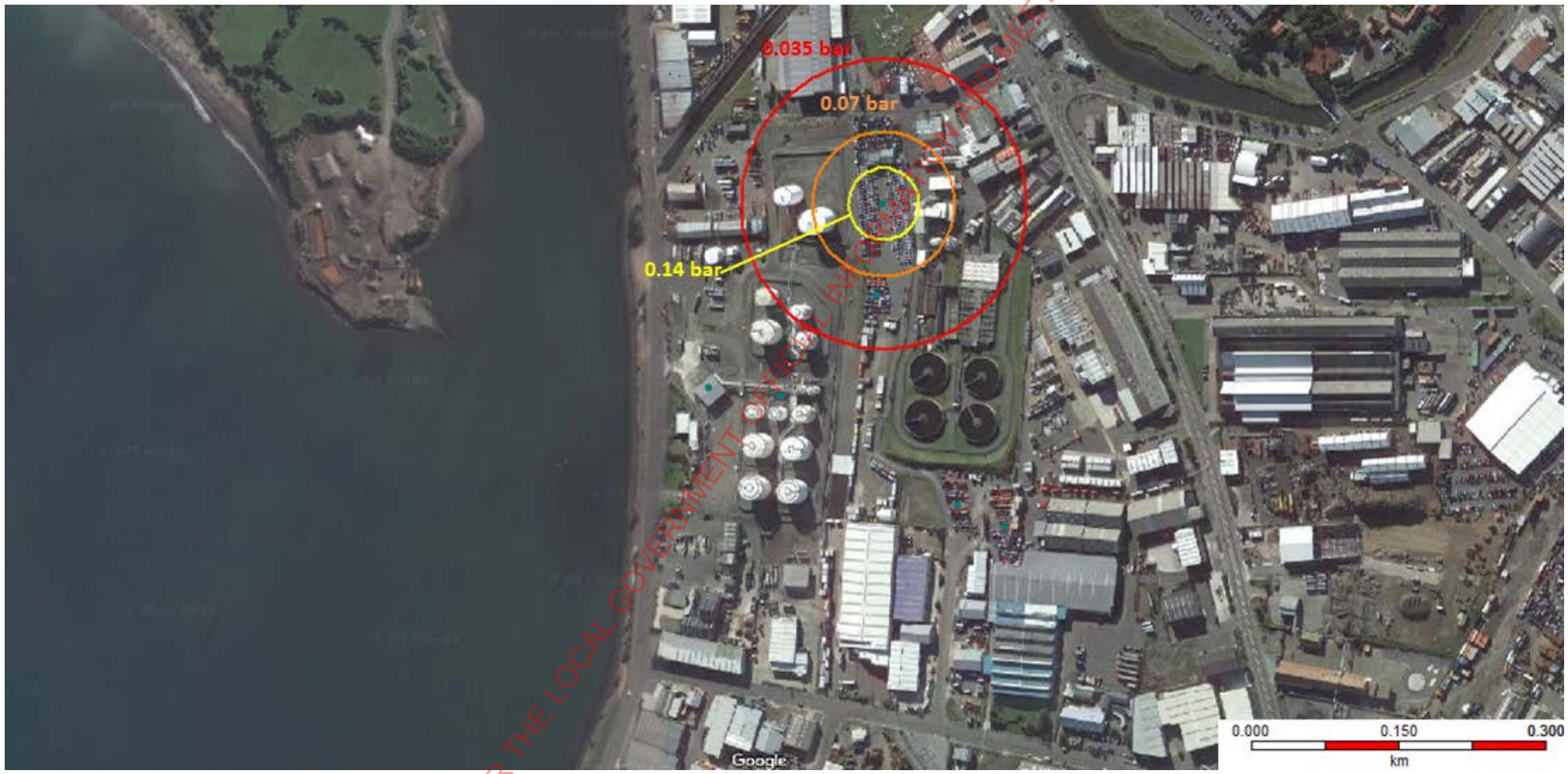

Figure 4: Explosion Overpressure Levels centred at C4: Neighbouring Car Yard A

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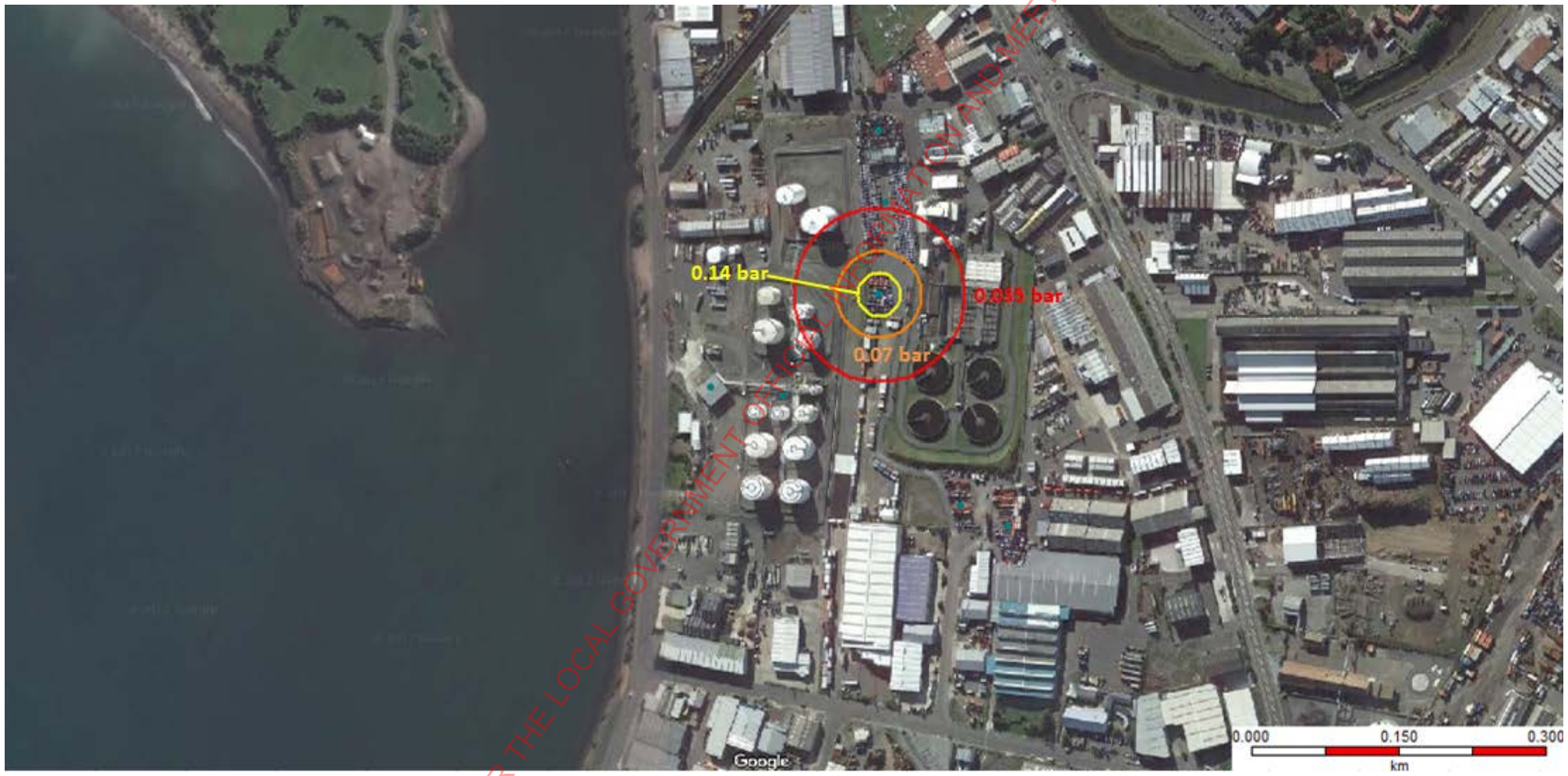

Figure 5: Explosion Overpressure Levels centred at C5: Neighbouring Car Yard B

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Figure 6: Explosion Overpressure Levels centred at C6: Neighbouring Car Yard C

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Figure 7: Explosion Overpressure Levels centred at C7: Neighbouring Car Yard D

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TECHNICAL NOTE

REPORT NO:	**13238-TN-002 Rev B**
CLIENT:	SLR Consulting New Zealand Ltd
PROJECT TITLE:	Hutt City District Plan Advice
ATTN:	Phillip Brown (SLR)
CC:	s7(2)(a) (P&P)
SUBJECT	Controls for Location Classification Change

1.0 INTRODUCTION

Hutt City District Council has requested planning advice from SLR regarding land use around the refined fuels import pipeline (Hutt City Wharf Line, HCWL) at Seaview in Hutt City. Previously P&P Engineering Consultants (P&P) were engaged by SLR to identify future activities near the HCWL that would require a review of the pipeline risk assessment. A technical note was provided outlining these activities and their corresponding change in location classification (Ref. Doc. No. 13238-TN-001 Rev B).

The pipeline risk assessment is conducted in accordance with AS/NZS 2885.6. One significant factor that would prompt a review and update of the pipeline risk assessment is a change in land use adjacent to the pipeline. Land use around the pipeline is allocated a location classification under AS/NZS 2885.6. The current HCWL pipeline location classification is Residential/Industrial (T1/I).

Hutt City District Council have responded to SLR's advice, and P&P's previous technical note, and requested further information. This technical note identifies possible controls that may be required to reduce residual risk associated with the HCWL. This includes outlining both physical or operational changes to the HCWL that may be required, an estimated cost, and ease of implementing these changes.

1.1 Background

The previous technical note provides detailed explanation of location classification under AS/NZS 2885.6. If a land use change were to occur prompting a location classification change, AS/NZS 2885.6-2018 states the 'Safety Management Process' shall be used to

Rev	Date	Description	Prepared By	Checked By	P&P Approved	Client Approved
A	25/07/2024	Issued for Information	s7(2)(a)	s7(2)(a)	s7(2)(a)	
B	30/07/2024	Issued for Information				

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review the changes. If required, additional control measures or modifications of the pipeline shall be implemented until it is demonstrated that the residual risk associated with the HCWL is As Low As Reasonably Practicable (ALARP) in accordance with Section 4 of AS 2885.6.

In the event of a change in location classification, the pipeline owner/operator is prompted to undertake a “Safety Management Study Process” (SMS). This SMS will examine the risk associated with the pipeline at the location of the change in land use. One of the goals of an SMS is to demonstrate the pipeline risk is ALARP. In order for the risk to be ALARP with the land use change additional physical or procedural controls may be required.

2.0 LOCATION CLASSIFICATION CHANGE

As per 13238-TN-001 Rev B, location classification under AS/NZS 2885.6-2018 is essential to ensure the appropriate safety measures are implemented to reduce the risk to the public, the environment, and security of supply to ALARP. The HCWL may undergo classification changes due to nearby activities such as high density (T2) for multi-storey developments; Heavy Industrial (HI); Crowd (C) for events causing periodic high concentration population; Environment (E) for sensitive ecology; and Sensitive (S) for schools, hospitals, etc. T2, HI, E, S are typically permanent, and C can be categorised as either temporary or regular depending on the timing of the events.

2.1 Temporary Change – One off

Temporary change in location classification can be identified as ‘Crowd’ classification and is due to a temporary increase in people near the HCWL. Refer to 13238-TN-001 Rev B for activities that would result in a change to Crowd location classification.

A ‘one off’ location classification change to ‘Crowd’ would a be a result of a rare event held adjacent to the HCWL. An example of this is a concert or specific sporting event (e.g. triathlon) that occurs rarely. These events would result in a temporary short period increase of people and vehicles in the vicinity of the HCWL.

A proposed one-off event at short notice would restrict the available controls to additional patrolling and hence may have a higher one-off risk.

Provided a longer notice of the temporary activities, shipping could be rescheduled around the event. This would ensure the pipeline was not flowing (i.e. lower operating pressure) and was resting on diesel (i.e. lower risk of ignition) at the time of the event.

2.2 Regular Change

Developing facilities that would result in regular change of location classification to ‘Crowd’ is constituted as regular change. These facilities would result in a periodic increase of people in the vicinity of the HCWL regularly, for example, the development of a sporting facility, or regular markets would result in a periodic increase of people on certain days/times.

Depending on the nature and timing of a periodic, but regular, ‘Crowd’ classification, the higher cost controls may not be justified. It would also be more difficult to ensure shipping times do not coincide with a regular crowd event.

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2.3 Permanent Change

A permanent change in location classification would most likely be a change to T2, S, E or HI. Refer to the previous technical note, 13238-TN-001 Rev B, for examples of activities that would result in a permanent change in location classification.

3.0 POTENTIAL ADDITIONAL CONTROLS

The following table sets out potential physical and procedural controls and their effectiveness against threat categories, external interference, degradation and natural disaster. The threat category 'Degradation' covers fatigue, corrosion, stress corrosion cracking, and environmentally assisted corrosion cracking.

Control	Description	Threat Category	Effectiveness
Patrol	Have someone patrol the pipeline to prevent external interference and identify leaks.	External Interference	50%
		Degradation	1%
		Natural Disaster	1%
Restrict Shipping Schedule	Schedule shipping around an event resulting in a reduced operating pressure during that event	External Interference	30%
		Degradation	50%
		Natural Disaster	10%
Resting the pipeline	Resting the pipeline on diesel. Making sure diesel is the last liquid to be delivered. (Reduces ignition likelihood).	External Interference	10%
		Degradation	10%
		Natural Disaster	10%
Increased Wall Thickness	Replace sections of the pipe affected by the change with pipe of increased wall thickness.	External Interference	90%
		Degradation	90%
		Natural Disaster	40%
Increased Depth Cover	Reinstall pipeline at a lower depth to reduce risk.	External Interference	60%
		Degradation	5%
		Natural Disaster	1%
Cover with Concrete	Cover the ground with concrete slabs.	External Interference	60%
		Degradation	5%
		Natural Disaster	1%
Concrete Encasement	Encase the pipeline with concrete.	External Interference	80%
		Degradation	1%
		Natural Disaster	10

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Pipeline Realignment	Install a pipeline around the vicinity of the new activity (Note: New location will also include some risk).	External Interference	50%
		Degradation	60%
		Natural Disaster	10%
Flowing Leak Detection	Monitor flow in and flow out.	External Interference	30%
		Degradation	1%
		Natural Disaster	1%
Static Leak Detection	Real time monitoring of pressure in the pipeline.	External Interference	1%
		Degradation	20%
		Natural Disaster	1%

Table 1. Effectiveness of physical and procedural controls against different threat categories

Effectiveness can be defined as the estimated ability to reduce the severity or likelihood of a consequence resulting from a specific threat. The effectiveness values are estimated based on previous experiences with SMSs'.

3.1 Ease of Implementation

When determining the ease of implementation of each control, the following factors were taken into consideration, approval and consent, resource requirement, technical complexity, time frame and cost. Ease of implementing the control was measured using the following scale in Table 2. For periodic controls the costs are estimated per year e.g. patrolling.

Ease of Implementing	Cost	Complexity	Time Frame
Very Easy	$0 - $5000	One-person, low technical complexity.	< 1 week
Easy	$5000 - $50,000	Minor operations management of change, average technical complexity.	1-2 months
Moderate	$50,000 - $500,000	Minor operations management of change, engineered design needed and physical controls suite, regulatory compliance.	2 month < 6 months
Difficult	$500,000 < $2.5m	Engineered design and physical controls onsite, regulatory compliance, consenting and external stakeholder approval.	6 months < 18 months
Very Difficult	> $ 2.5m	Physical modification of pipeline engineered design, regulatory compliance, consenting and external stakeholder approval.	> 18 months

Table 2. Requirements for ease of implementation level

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3.2 Physical and Procedural Controls

Table 3 outlines the physical and procedural controls that could be used to address a location classification change. Where the change to the location classification is restricted to a specific location, it is anticipated that the additional controls would be applied to an up to 300m length of pipeline.

Control	Description	Ease of Implementing	Cost
Patrol	Have someone patrol the pipeline observing activity near the pipelines i.e. no excavating, leaks.	Easy	$15,000 annually
Restrict Shipping Schedule	Schedule shipping around an event resulting in a reduced operating pressure during an event. Note that this control is more appropriate to single events.	Moderate	-
Resting the pipeline	Resting the pipeline on diesel, ensuring that, as far as is reasonably practicable, diesel is the last liquid to be delivered.	Moderate	$130,000
Increased Wall Thickness	Replace existing pipeline with new pipe with increased wall thickness / sections of the pipe affected by the change will be replaced with pipeline of increased wall thickness.	Very Difficult	~$10,000 per meter e.g. it would cost ~$3M to replace a 300m pipeline section
Increased Depth Cover	Lowering of pipeline to increase depth of cover	Very Difficult	~$6000 per meter e.g. it would cost ~$2.4M to increase the depth of the pipeline for a 400m section running down port road along the port car park, (this may also increase seismic liquefaction risk).
Cover with Concrete	Cover the ground with concrete slabs.	Difficult	~$1000 per meter e.g. ~$300,000 for a 300m section

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Concrete Encasement (U-shape concrete cover)	Encase the pipeline with concrete.	Difficult	~$3000 per meter e.g. ~$900,000 for a 300m section
Flowing Leak Detection	Monitor flow in and flow out.	Moderate	$250,000
Static Leak Detection	Real time monitoring of pressure in the pipeline.	Moderate	$100,000
Pipeline Realignment	Install a pipeline around the vicinity of the new activity. (Note: New location will also include some risk. Developed and built-up location with congested services within roadways severely limits practicable realignment route options.)	Very Difficult	~$15,000 per meter

Table 3. Controls with ease of implementation and cost

The implementation of certain controls will have consequential impacts and result in ongoing consequential costs. For example, rescheduling shipping around an event (one off or a regular event) can incur additional expenses such as berthing, ship time costs, etc. Rescheduling may also exacerbate delays caused by natural events (storms, etc.), or have further consequential impacts due to reduced fuel inventory availability resulting from a shipping delay.

4.0 THEORETICAL EXAMPLES

4.1 Temporary Change Example

An example of a land use change is a triathlon (or other sporting event). A triathlon would attract a large crowd for a short amount of time (for one day during daylight hours). This event would trigger a temporary change in location classification to Crowd and thus a SMS. The pipeline operator would undertake the following:

- An SMS to review the pipeline risk with a crowd in the vicinity of the pipeline. The SMS will determine one of the following:
  - If SMS determines a risk higher than intermediate, then additional controls are required to be implemented;
  - If the SMS determines an intermediate risk, additional controls should be assessed via an ALARP assessment i.e. the cost of the benefit must be grossly disproportionate to the cost of the control for the control to be practicable to implement;

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- If the SMS determines the risk is not changed or is low, additional controls are not required.

- Additional controls may include:
  - Schedule shipping around event – this is unlikely to be achievable with short notice. Ensuring the pipeline is not flowing at the time of the event will ensure the pipeline can be rested (i.e. valves shut) at a reduced operating pressure. Implementation of static leak detection would allow the pipeline operator to monitor the pipeline pressure for leaks while it is resting. The primary advantage of ensuring the pipeline is not flowing during the event is the reduced operating pressure lessens the likelihood of a pipeline failure and lessens the volume of fuel leaked in any loss of containment;
  - Patrolling (depending on works onsite (e.g. road works), additional patrolling may be implemented for the week leading up to and the day of the event). The primary goal of patrolling is to identify threats to the pipeline to ensure they do not contact or impact the pipeline integrity.

4.2 Regular Change Example

An example of a land use change that would result in a regular change in location classification and thus a SMS is a Sunday Market. A Sunday Market would occur every Sunday during day light hours and thus the location classification would change to 'Crowd' classification on this basis. The pipeline operator would undertake the following:

- A SMS to review pipeline risk with crowd within the vicinity of the pipeline;
- The SMS or resulting ALARP assessment may require additional controls to be implemented. Additional controls may include:
  - Increased patrolling;
  - Static leak detection;
  - Rest on diesel;
  - Flowing leak detection. Flowing leak detection serves to notify the fuel companies as soon as practical of a pipeline loss of containment such that pipeline valves can be shut to restrict the volume of fuel lost; and,
  - Restricting shipping schedule (e.g. not allowing ship unloading on a Sunday). This control may not be easily achievable 100% of the time but may become an "aim to achieve" for the operator. This would likely incur ongoing consequential costs.

4.3 Permanent Change Example

An example of a land use change that would trigger a permanent change in location classification and thereby a SMS would be the development of a multi-storey building resulting in a 'T2' classification.

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The pipeline operator would undertake the following:

- A SMS to review land use change.
- The SMS or resulting ALARP assessment may require additional controls to be implemented. Additional controls may include:
  - Increased wall thickness;
  - Increased depth cover;
  - Cover with concrete;
  - Concrete encasement;
  - Rest on diesel;
  - Pipeline realignment; and,
  - Flowing and static leak detection.

It is noted that certain facilities may require additional controls due to an increased risk; for example, facilities such as a multi-storey building with underground parking, or other facilities with an underground structure. In the event of a pipeline leak these underground structures provide a location for fuel to pool and accumulate which increases the potential consequence of ignition. The increased risk is more likely to require additional controls to reduce the risk to ALARP.

5.0 CONCLUSION

Land use activities occurring in the proximity of the HCWL could result in a location classification change from T1/I to either C, T2, S, E or HI. These location classifications can be categorised between temporary, regular and permanent change. Crowd being a regular or temporary change and T2, S, E, and HI being a permanent change.

A location classification change would prompt an update of the HCWL risk assessment. The risk assessment will be specific to the land use change/development and will determine what additional controls are required (if any) to ensure the risk is ALARP. The risk assessment may not immediately necessitate additional controls.

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