Risk Assessing and Regulating Landfill Gas Discharges to New Zealand Residential Developments

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Overview

- LFG from former landfill sites – potential risks and considerations
- Risk assessment, management and regulatory approaches - Auckland, New Zealand
- Example – risk assessment, communication and regulation
  - Museum and railway workshops atop closed landfill, Pt Chevalier
- Assessing LFG risks when consenting new residential developments:
  - Proposed residential development atop closed landfill, Tauranga
  - Site investigations and notified hearings process: proposed retirement home atop closed landfill, Parnell

Historic gas explosions associated with closed landfills – United States

- **1967 - Atlanta, Georgia:** House exploded - 2 fatalities, 2 injured).
- **1969 - Winston-Salem, North Carolina:** LFG migration to adjacent armory; 3 fatalities, 25 injured from lit cigarette
- **1975 – Sheridan, Colorado:** LFG explosion in stormwater pipe - injured children in pipe (lit candle).
- **1983 – Cincinnati, Ohio** and **1984 – Akron, Ohio:** LFG explosion destroyed house across street from landfill.
- **1987 – Pittsburgh, Pennsylvania:** Explosion (LFG suspected) destroyed house near closed landfill.
- **1980's - Port Washington, North Hempstead, NY:** Explosions in 4 homes.
- **1991 - Savannah, Georgia:** 44 families evacuated - $20 million lawsuit.
- **1994 – Charlotte, North Carolina:** Methane explosion at park atop closed landfill; soccer player suffered serious burns.
- **1995 - Port Washington, North Hempstead, NY:** Golf driving range snack bar being constructed on the now-closed landfill explodes after a water heater turns on, igniting the landfill gases.
- **1999 – Atlanta, Georgia:** Young girl suffered arm and leg burns at playground atop an illegal dumping ground.
- **2006 - Fort Meade, Maryland:** 12 families evacuated near 60-year old military closed landfill.

Influencing factors – gas flow, migration, buffer distances

- Incidents involving explosions generally caused by alterations or blockages to gas migration pathways after landfill closure, causing LFG to accumulate in an enclosed space.

- Two types of gas flow from unlined closed landfills:

  - Diffusive / gradual flow, moving steadily towards areas of lower concentration
  - Advective flow – differences in pressure push gas quickly through cracks or other preferential pathways

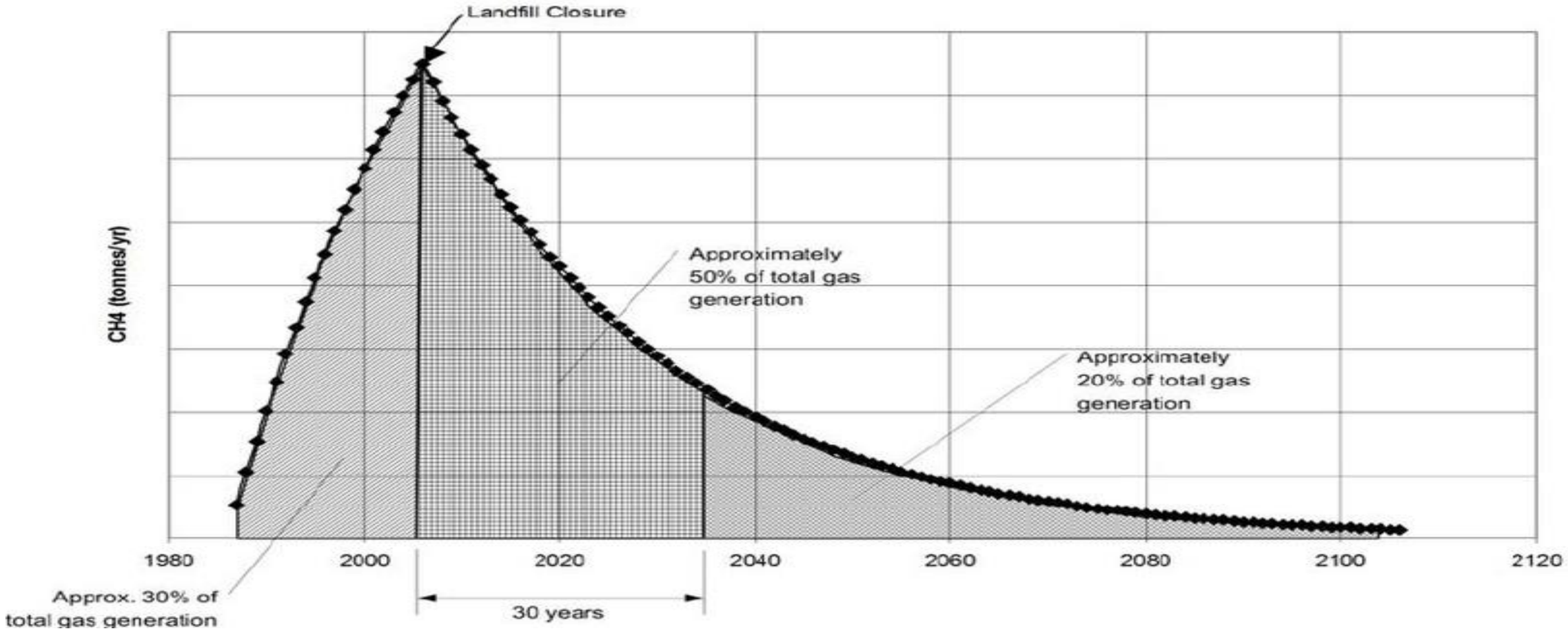
- Older landfills with high organic components and active decomposition of waste: higher vulnerability to advective flow.

- Other factors include landfill cover type; moisture; groundwater levels; temperature; barometric and soil gas pressure.

Buffer distances

- Typically, **250 – 300 metres** from closed landfill boundary is referenced as a ‘safe distance’ in NZ
- Under ‘ideal’ conditions – e.g. highly permeable material trapped between two confining layers - landfill gas can migrate across distances of **over 300m**
- Gas migration greater than **1,500 m** has been observed internationally

Generic example - closed landfill gas production over time
(USEPA Landfill Gas Emissions Model v. 3.02)



Auckland Council - Closed Landfills Asset Management Plan

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Closed landfill Asset Owner Approval (AOA)

Guidance notes and application form

November 2025, Version 2.0

aucklandcouncil.govt.nz

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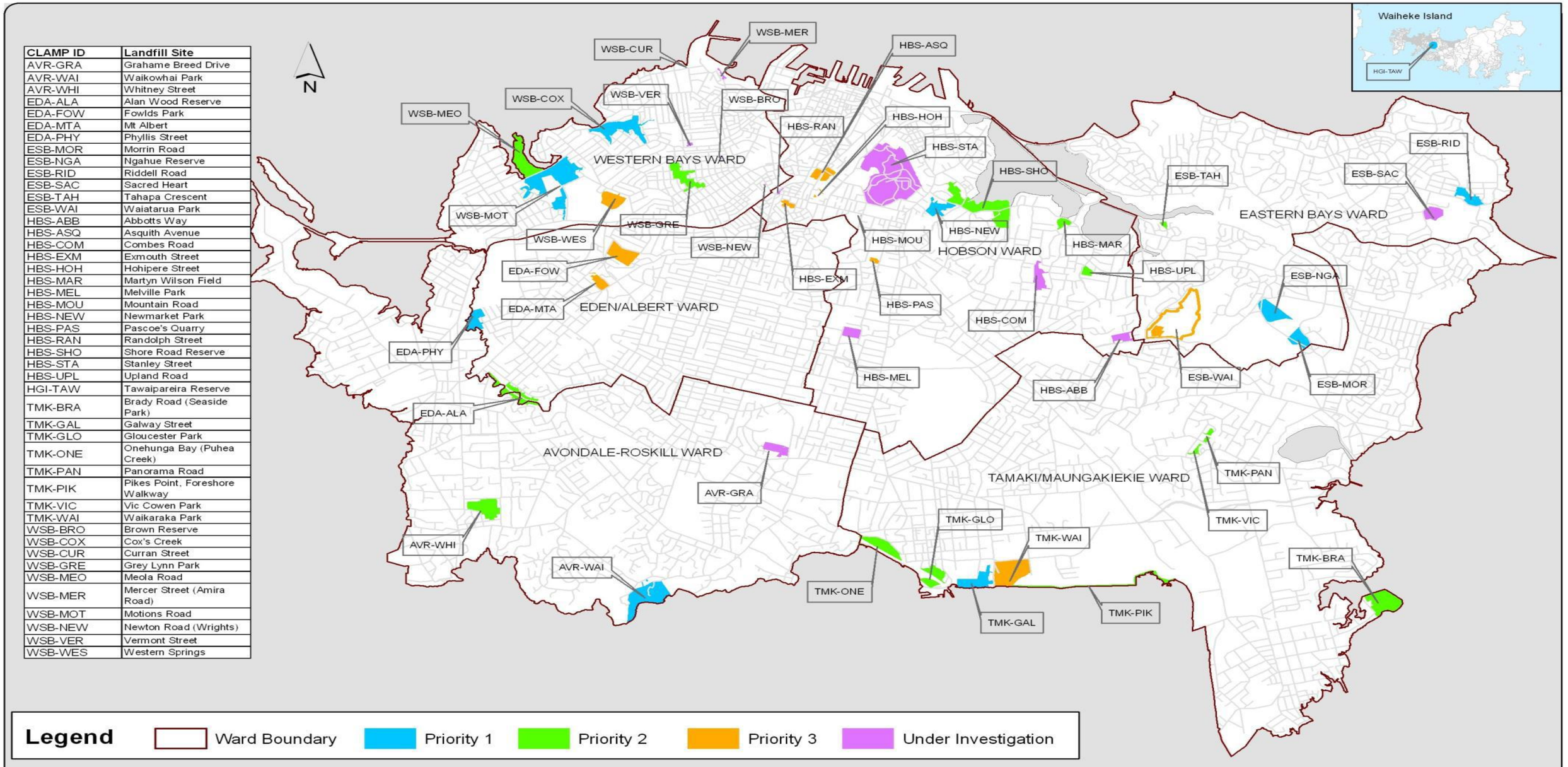
CLAMP ID	Landfill Site
AVR-GRA	Grahame Breed Drive
AVR-WAI	Waikowhai Park
AVR-WHI	Whitney Street
EDA-ALA	Alan Wood Reserve
EDA-FOW	Fowlds Park
EDA-MTA	Mt Albert
EDA-PHY	Phyllis Street
ESB-MOR	Morrin Road
ESB-NGA	Ngahue Reserve
ESB-RID	Riddell Road
ESB-SAC	Sacred Heart
ESB-TAH	Tahapa Crescent
ESB-WAI	Waiatarua Park
HBS-ABB	Abbotts Way
HBS-ASQ	Asquith Avenue
HBS-COM	Combes Road
HBS-EXM	Exmouth Street
HBS-HOH	Hohipere Street
HBS-MAR	Martyn Wilson Field
HBS-MEL	Melville Park
HBS-MOU	Mountain Road
HBS-NEW	Newmarket Park
HBS-PAS	Pascoe's Quarry
HBS-RAN	Randolph Street
HBS-SHO	Shore Road Reserve
HBS-STA	Stanley Street
HBS-UPL	Upland Road
HGI-TAW	Tawaipareira Reserve
TMK-BRA	Brady Road (Seaside Park)
TMK-GAL	Galway Street
TMK-GLO	Gloucester Park
TMK-ONE	Onehunga Bay (Puhea Creek)
TMK-PAN	Panorama Road
TMK-PIK	Pikes Point, Foreshore Walkway
TMK-VIC	Vic Cowen Park
TMK-WAI	Waikaraka Park
WSB-BRO	Brown Reserve
WSB-COX	Cox's Creek
WSB-CUR	Curran Street
WSB-GRE	Grey Lynn Park
WSB-MEO	Meola Road
WSB-MER	Mercer Street (Amira Road)
WSB-MOT	Motions Road
WSB-NEW	Newton Road (Wrights)
WSB-VER	Vermont Street
WSB-WES	Western Springs



REV	AMENDMENTS	BY	APP'd	DATE

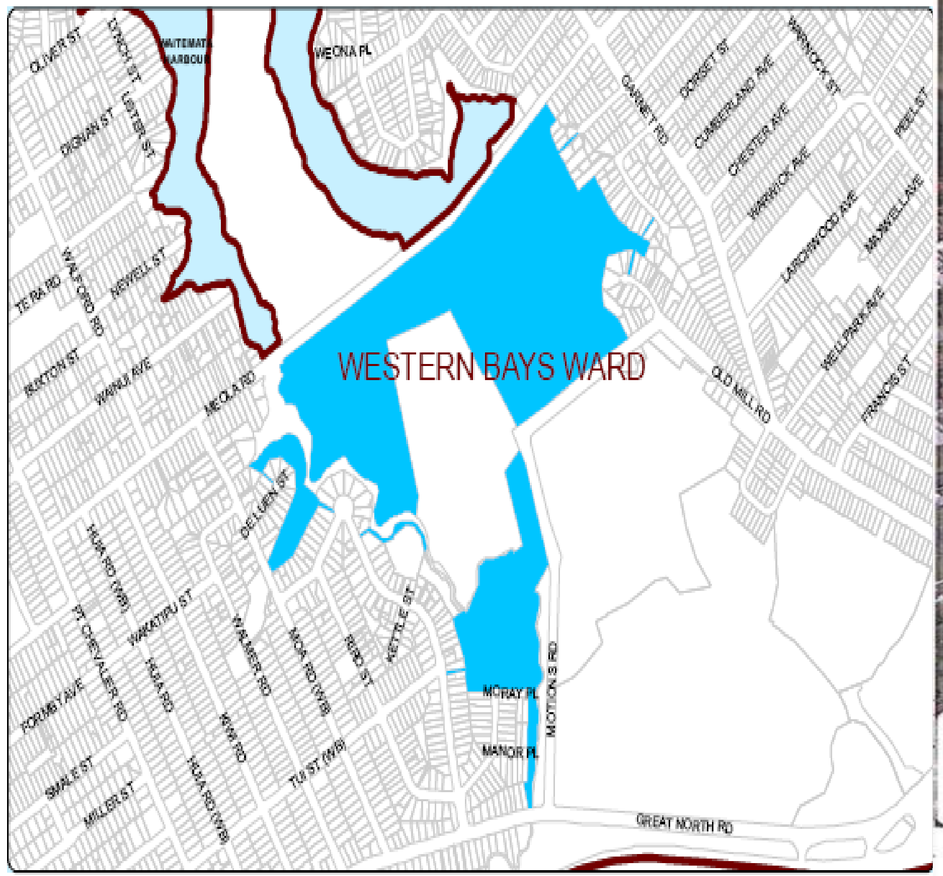
	NAME	DATE
DRAWN	J. CHEN	April 2009
DESIGNED	A. BROCKBANK	April 2009
CHECKED		
APPROVED		
PRINTED		
FILE NAME	G:\61\25973\GIS\Landfill Status Overview_v2.mxd	
SCALE	Scale: 1:60,000 (A3 Size)	

GHD
Level 9, Bledisloe House,
24 Wellesley St., Auckland
P.O. Box 6543, Wellesley Street
Auckland
New Zealand
Ph: (09) 307 7373
Fax: (09) 307 7300

Client:
AUCKLAND City Council

AUCKLAND CITY COUNCIL CLOSED LANDFILL PRIORITY STATUS

Motions Road closed landfill, Western Springs



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Monitoring, management and regulation of landfill gas emissions

Description	Potential Risks	Controls	Consequence	Likelihood	Risk Factor	Risk Level
MOTIONS ROAD	(PRIORITY 1)					
Public Health & Safety						
Gas Migration	Gas explosion & poisoning.	Some buildings on site have gas entry. Ongoing liaison occurs with site tenants to ensure they take prompt management action where gas exceedances are detected. MOTAT buildings have methane detectors which are calibrated and checked twice a year. Old aircraft hangar has gas interception pipe in place. A detailed MMP has been prepared for the site, to clarify tenant and Council responsibilities and to ensure intrusive earthworks are managed. An engineered cap is in place for Seddon Fields, with older variable capping levels present elsewhere on site. 20 gas bores have been installed and these are monitored frequently.	5	5	25	H

4.4.3 Existing Management Measures

Since the initiation of the CLAMP, bores for monitoring and extraction of closed landfill gas have been installed (especially around the MOTAT buildings) and monitors/alarms have been placed in those buildings to detect any dangerous build-ups of gas. Stormwater controls, groundwater bores and leachate interception and monitoring bores have also been used, with efforts made to reduce concentrated leachate discharges to the Meola and Motions Creeks.

Emergency capping has been undertaken on the west and northwest banks to isolate exposed refuse and to improve slope stability. A grout-filled geotextile blanket (growth mat) was trialled along the lower Motions Creek to stabilise the stream bank, which was eroding in places and exposing buried refuse. This relatively new technology allowed beneficial and aesthetic planting of the bank while providing structural protection and containment.

Works have been completed by EUM to provide engineered capping across the Seddon Fields area to minimise water infiltration and reduce leachate production, and for provision of a better quality sports field. Other site management measures include:

- Production and distribution of a detailed Site Management Plan, aimed at providing contextual information about the site's history, constraints on intrusive works and reinforcing site tenant responsibilities.
- Emergency capping to MOTAT2 area
- Drainage swales
- Gas monitoring boreholes (monitoring underway to assess gas production)
- Gas detectors installed in MOTAT buildings with alarms
- A gas interception pipe and aircraft hangar floor repair works have been implemented by MOTAT
- New MOTAT blister hangar construction will take landfill and gas constraints into account

CIRIA C665: Assessing risks posed by hazardous ground gases to buildings

- Document is designed to provide up-to-date, **practical advice on the assessment and mitigation of potentially hazardous ground gases** re: buildings and their occupants
- Advice **covers both residential and commercial** developments
- Relevant to **existing buildings and structures constructed without knowledge / recognition of their location on or adjacent to gas sources**
- Other international guidance documents referenced by consenting authorities in NZ:
  - New South Wales Environment Protection Agency (NSW EPA), November 2012 - Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases.
  - British Standards Institution (BSI) Standards Publication BS 8485:2015 (updated February 2016) - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

Proposed residential properties atop closed landfill: consenting discussions 2023 - present

- Small site (< 1 ha) in Tauranga
- Geotechnical investigations confirming landfill – thin cap
- Limited site investigations – surficial soil contaminant testing and LFG monitoring (four shallow bores)
- Data gaps include characterisation of refuse types, volume, landfill extent.
- Primary risk issue is gas – preliminary LFG risk assessment predicated on limited data set
- Ongoing consenting discussions between applicant and Tauranga City Council / Riley re: site gas risk profile and suitability for residential use.

Decision following the hearing of an application for resource consent under the Resource Management Act 1991

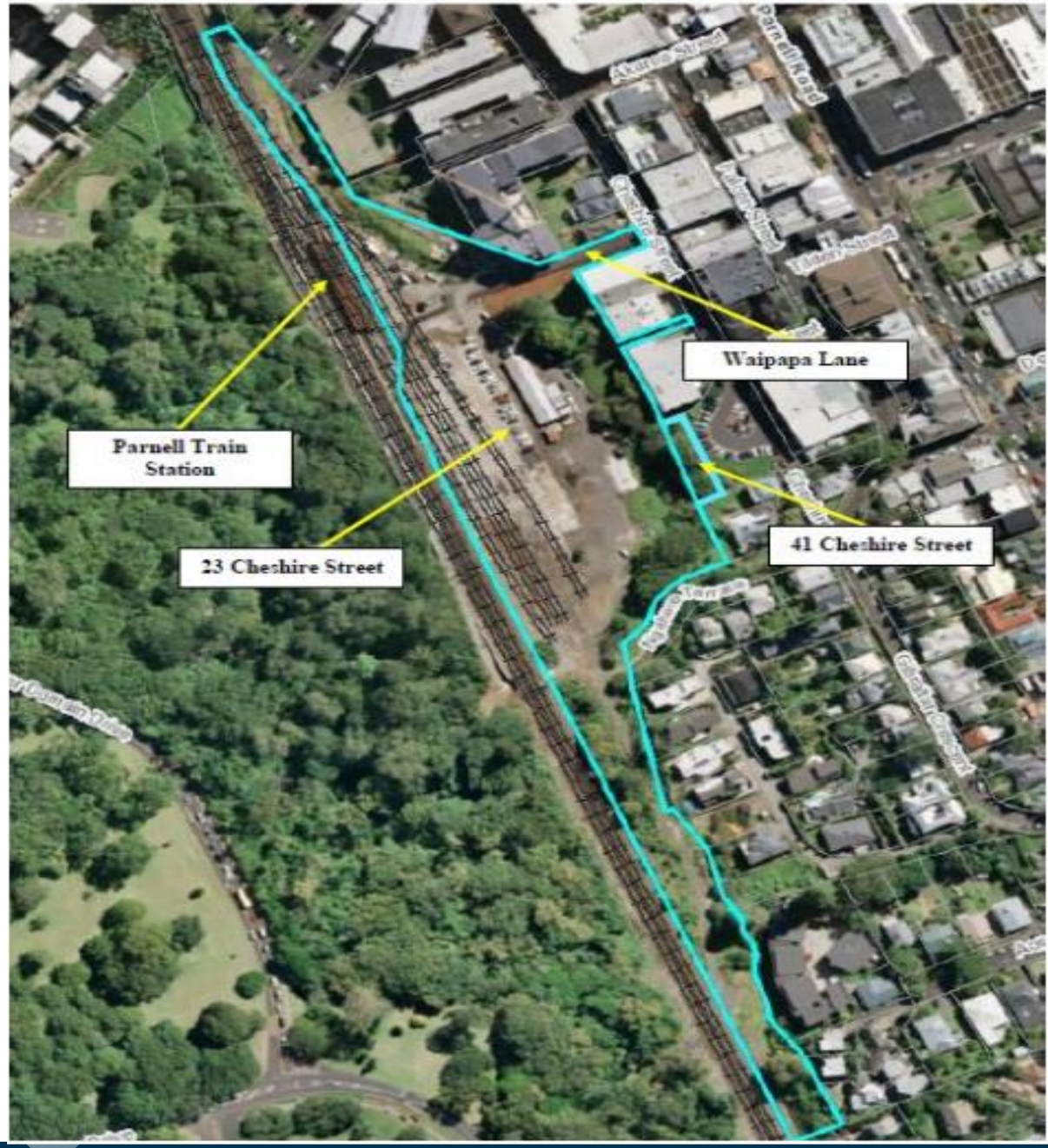
Auckland Council
Te Kaunihera o Tāmaki Makaurau

Proposal

To construct and operate a retirement village on the subject site along with enabling works and necessary infrastructure. The retirement village would include 216 independent living units and 100 aged care units along with a range of ancillary and complementary activities, including a publicly accessible café in the station plaza area. 235 car parking spaces are proposed across a number of basement car park areas.

This resource consent is **GRANTED**. The reasons are set out below:

Application number	BUN60364362
Site address:	23 & 41 Cheshire Street, Ngahere Terrace and Cheshire Street Road Reserve, Parnell
Applicant:	Summerset Villages (Parnell) Limited
Hearing commenced:	Tuesday 6 April 2021, 9.30 a.m.
Hearing panel:	Karyn Sinclair David Mead Alan Pattle
Appearances:	<u>For the Applicant:</u> Summerset Villages (Parnell) Limited represented by: - Francelle Lupis, Legal Counsel - Aaron Smail (Corporate) - Mat Brown (Architecture) - Rachel de Lambert (Landscape, Visual and Urban Design) - Daniel Kamo (Landscape Architecture) - John Burgess (Transport) - Chris Bradley (Noise and Vibration) - Steven James (Civil Engineering and Flooding) - Brett Black (Geotechnical) - Marcus Herrmann (Site Contamination) - Rodney Clough (Historic Heritage) Craig McGarr (Planning)



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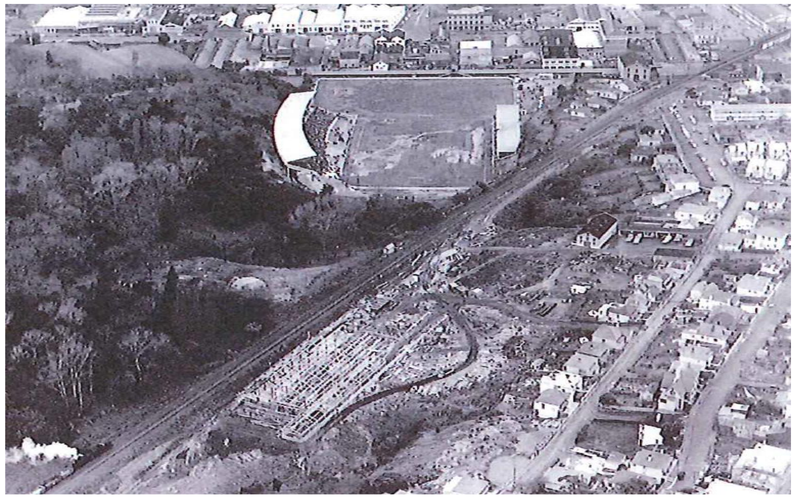
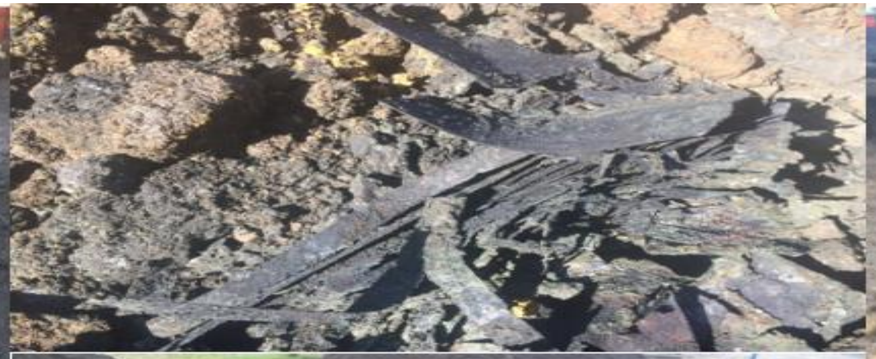
Cheshire Street - Retirement Home Development, Parnell

- Site located adjacent to Parnell commercial and residential area; bounded by railway lines and Auckland Domain to the west. Central area comprises remnant building platforms, asphalt and metal surfacing.
- The site was filled with a combination of rubbish tip fill and controlled earthworks during the 1940s, until construction for railway operations commenced in the mid-1950s.
- It was then used for railway and steel fabrication purposes, with large industrial buildings constructed between 1955 and 1959.
- In 1975, the site was used primarily as a workshop. Mainline Steam leased the property from KiwiRail Ltd from 1994 onwards, with other activities occurring on-site.
- Demolition and removal of the main industrial buildings was undertaken between 2015-2017, with construction of the Parnell Train Station initiated in December 2016.
- Since then, the site has primarily been used as a car park.



Intrusive site contamination investigations, 2016-2020



Landfill Gas Monitoring Well Locations

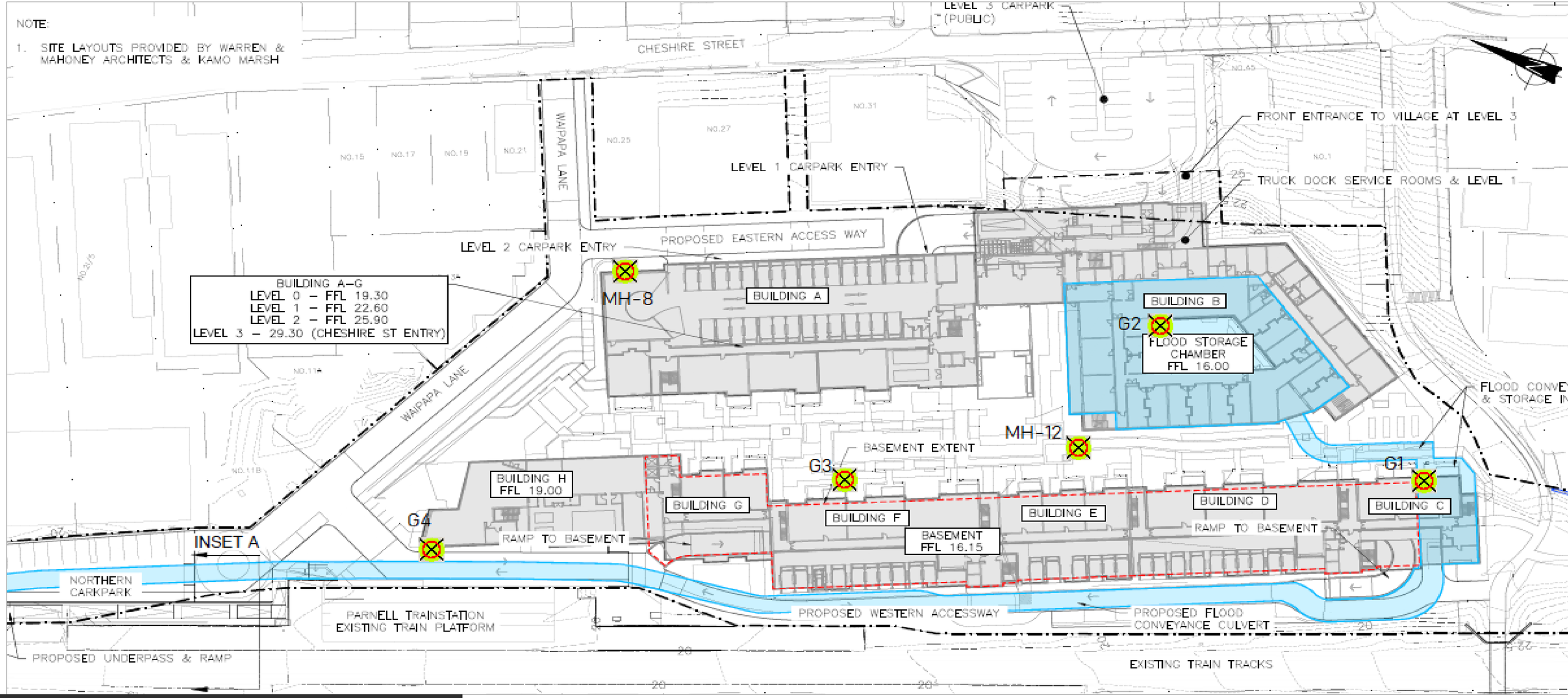


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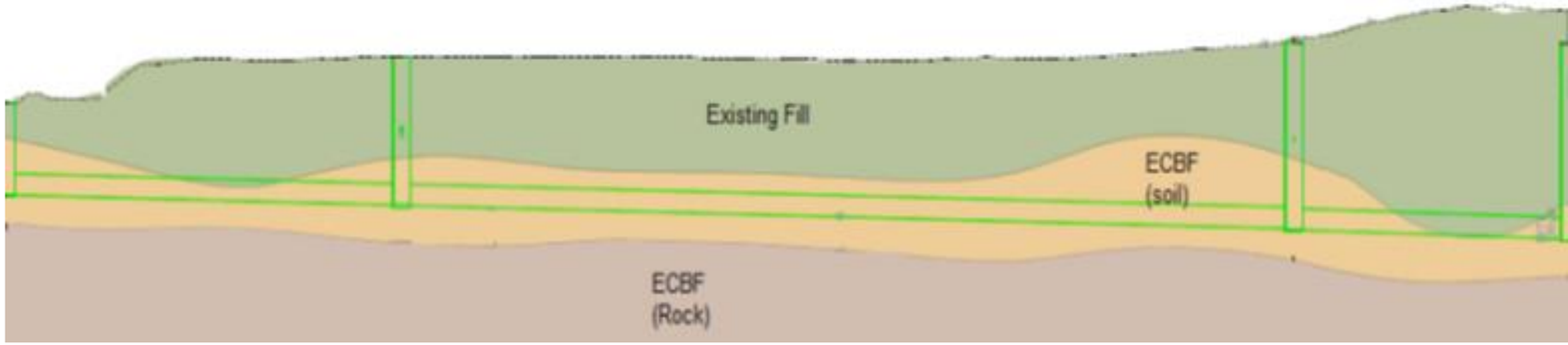
Table 8: Summary of Gas Monitoring Data

LOCATION	GROUND LEVEL RL	DATE	ATM PRES (MB)	FLOW	REL PRESS	MAXIMUM READINGS IN 5 MINUTE PERIOD						Screen Section (m)	WL (mbgl)
						CH_4 %	CO_2 %	O_2 %	CO ppm	H_2S ppm	PID ppm		
												1m-8m	4.12-6.6
MH8 - shallow	22.5	18/02/2020	1015.00	0.00	0.26	0.00	0.90	20.10	0.00	0.00	0.00		6.62
		12/03/2020	1020.00	0.10	-0.07	0.00	0.10	22.60	0.00	0.00	0.00		6.67
		28/04/2020	1025.00	0.00	-0.01	0.00	2.00	18.60	0.00	0.00	0.00		6.71
		12/05/2020	1025.00	0.00	-0.10	0.00	2.00	20.10	0.00	0.00	0.00		6.24
		28/05/2020	1022.00	0.00	0.02	0.00	0.50	19.90	0.00	0.00	0.00		
												9m-19.8m	9.44-10.95
MH8 - deep	22.5	18/02/2020	1015.00	0.00	0.03	0.00	0.50	20.40	0.00	0.00	0.00		10.54
		12/03/2020	1020.00	0.10	0.17	0.00	1.30	22.20	0.00	0.00	0.00		10.66
		28/04/2020	1025.00	0.00	-0.05	0.00	1.30	21.80	0.00	0.00	0.00		10.61
		12/05/2020	1015.00	0.00	-0.05	0.00	0.40	21.40	0.00	0.00	0.00		10.61
		28/05/2020	1022.00	0.00	0.02	0.00	0.30	21.40	0.00	0.00	0.00		
												3.8-6.5	5.2-5.41
MH - 12	18	18/02/2020	1014.00	0.00	-0.46	87.50	0.20	0.20	3.00	0.00	0.00		-
		9/03/2020	1010.00	0.00	0.09	50.00	0.00	18.50	7.00	0.00	0.00		5.37
		12/05/2020	1016.00	0.20	-0.12	64.50	0.50	1.00	0.00	0.00	0.00		5.35
		28/05/2020	1022.00	0.10	0.00	71.20	0.40	0.30	0.00	0.00	0.00		5.09
		7/09/2020	1022.00	0.10	-0.29	58.70	1.00	7.10	-	0.00	-		4.99
												1.5-4.5	2.87-3.19
G1	18	18/02/2020	1017.00	0.00	-0.18	0.20	6.70	17.30	0.00	0.00	0.00		3.15
		9/03/2020	1010.00	0.00	0.12	1.40	8.60	13.50	3.00	0.00	6.10		-
		12/03/2020	1019.00	0.00	-0.10	0.00	10.00	10.10	0.00	0.00	0.00		3.2
		28/04/2020	1024.00	-0.01	-0.05	0.00	10.30	9.10	0.00	0.00	0.00		4.31
		12/05/2020	1015.00	0.10	-0.05	0.00	10.10	10.30	0.00	0.00	0.00		2.87
		28/05/2020	1022.00	0.00	0.02	0.00	8.50	12.10	0.00	0.00	0.00		2.81
		7/09/2020	1022.00	0.10	0.02	0.00	8.20	10.50	-	0.00	-		2.82
												1.5-5	4.24-4.31
G2	18	18/02/2020	1015.00	0.00	-0.15	16.50	16.80	5.00	6.00	0.00	0.00		4.28
		12/03/2020	1019.00	0.10	-	12.30	18.50	0.20	1.00	0.00	0.00		4.31
		28/04/2020	1025.00	0.00	-0.07	10.60	17.50	1.10	0.00	0.00	0.00		4.31
		12/05/2020	1015.00	0.10	-0.07	13.80	17.30	0.20	1.00	0.00	0.00		4.12
		28/05/2020	1022.00	0.10	0.07	30.40	17.80	0.40	1.00	0.00	0.00		4.05
		7/09/2020	1020.00	0.00	0.02	23.10	10.30	7.70	-	0.00	-		4.18
												1.5-7m	5.41
G3	18	18/02/2020	1015.00	0.10	0.15	0.00	0.00	0.00	0.00	0.00	0.00		could not open
		12/03/2020	1017.00	0.10	0.46	1.80	2.00	21.30	0.00	0.00	0.00		Dry
		28/04/2020	1026.00	0.10	0.10	0.10	1.90	19.90	0.00	0.00	0.00		Dry
		12/05/2020	1015.00	0.10	-0.10	0.10	1.20	19.00	0.00	3.00	0.00		Dry
		28/05/2020	1022.00	0.00	-0.07	0.20	0.90	19.70	0.00	0.00	0.00		Dry
		7/09/2020	1023.00	0.00	0.02	0.00	1.60	18.80	-	0.00	-		Dry
												1.5-13.5	8.16-8.25
G4	18	18/02/2020	1016.00	0.00	-0.36	0.00	3.20	20.50	2.00	0.00	0.00		8.16
		9/03/2020	1010.00	0.00	0.12	1.40	8.60	13.50	3.00	0.00	2.80		8.22
		12/03/2020	1020.00	0.00	-0.12	0.00	0.20	22.10	0.00	0.00	0.00		8.23
		28/04/2020	1026.00	0.00	-0.05	0.00	0.20	22.20	0.00	0.00	0.00		8.23
		12/05/2020	1015.00	0.00	-0.05	0.00	0.10	21.60	0.00	0.00	0.00		8.03
		28/05/2020	1022.00	0.00	0.00	0.00	0.10	21.40	0.00	0.00	0.00		8.15
		7/09/2020	1020.00	0.00	0.05	0.00	0.10	20.60	-	0.00	-		8.1



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Preliminary Landfill Gas Risk Assessment

Well ID	CH4 (%v/v)	CO2 (%v/v)	Flow (l/h)	GSV*	Risk	CH4>1%	CO2>5%	Overall Risk	Characteristic Situation
MH-8 shallow	0.20	2.80	0.30	0.008	Very Low Risk	No	No	Very Low Risk	CS1
MH-8 deep	0.50	1.30	0.30	0.004	Very Low Risk	No	No	Very Low Risk	CS1
MH-12	87.50	1.70	0.50	0.438	Low Risk	Yes	No	Low Risk	CS2
G1	1.40	10.30	0.30	0.031	Very Low Risk	Yes	Yes	Low Risk	CS2
G2	38.70	18.50	0.30	0.116	Low Risk	Yes	Yes	Low Risk	CS2
G3	1.80	3.20	0.20	0.006	Very Low Risk	Yes	No	Low Risk	CS2
G4	1.40	8.60	0.20	0.017	Very Low Risk	Yes	Yes	Low Risk	CS2

Summary

- Development on or adjacent to closed landfill sites is occurring nation-wide
- Land is at a premium in major urban centres, including brownfields sites
- Actively gassing closed landfills: challenging set of potential health risks for existing and new residential / public use developments
- **LFG risk assessments essential**, taking into account all site-specific factors that influence gas migration
- Capturing new developments, excavation works, changes in land use for existing sites is key
- Closed landfill **asset owner approval requirements** frequently referenced in Auckland consents
- Available legislative tools (eg: NES-CS) can help - **flag gas risk issues ahead of development**

Final thoughts

This presentation highlights the importance of landfill gas risk assessments and good practice approaches being applied by regulators, asset custodians and consultants to mitigate or manage potential gas migration risks for brownfield site developments.

Undertaking robust risk assessments aligned with best-practice international guidance, and applying these site-specific outcomes towards location and consent design helps utilisation of scarce land resources, while mitigating contingent risk.