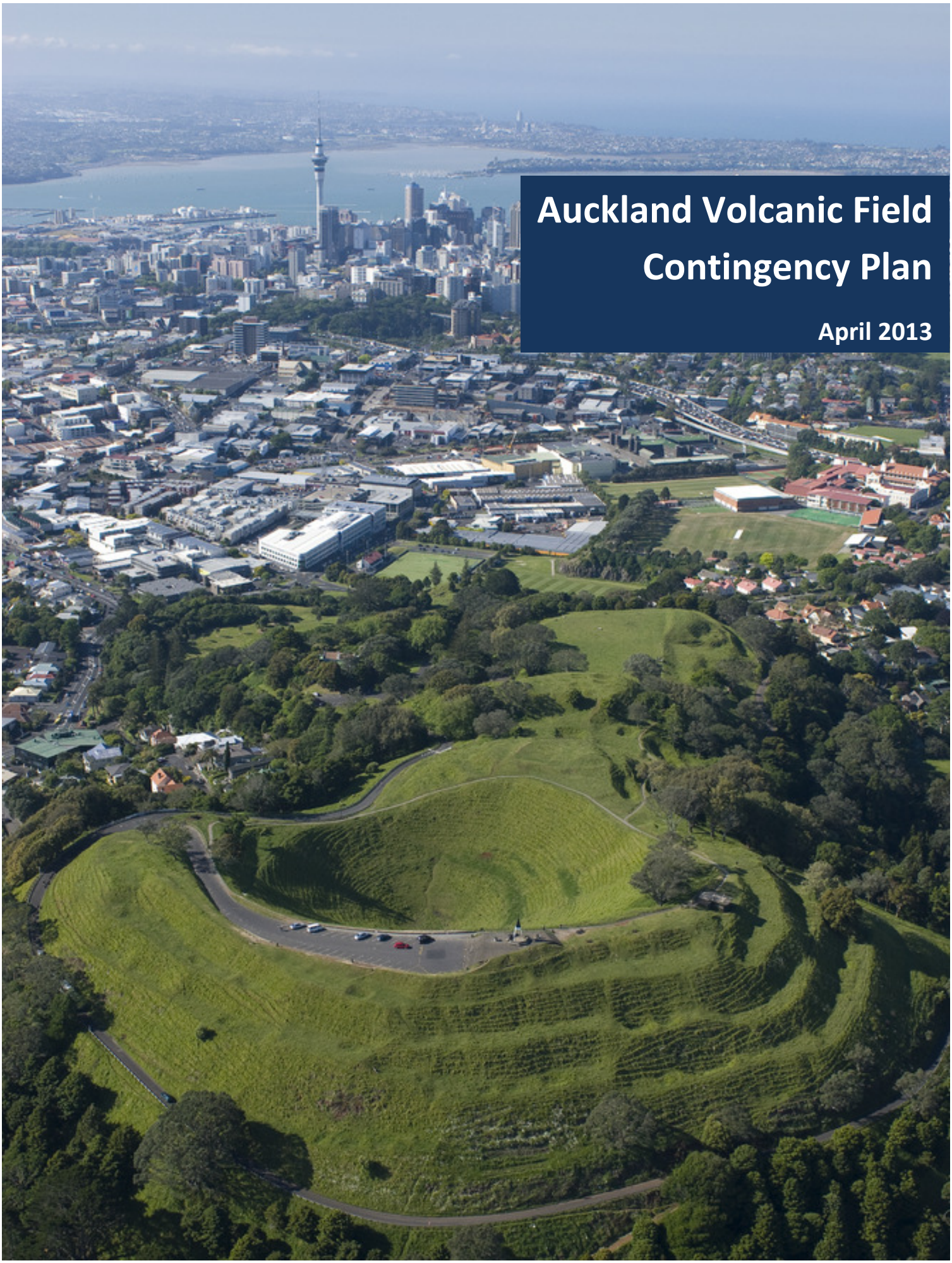

Auckland Volcanic Field Contingency Plan

April 2013

Civil Defence and Emergency Management
Te Rakau Whakamarumaru

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Table of Contents

Section 1: Introduction

Volcanic eruption within the Auckland Volcanic Field (AVF) is a very real hazard for the Auckland region. While an AVF volcanic eruption may directly affect a relatively small proportion of the region's population, the longer term impacts are likely to affect a much wider geographic area with significant implications for a broad range of industries and services, nation-wide.

This Contingency Plan: Auckland Volcanic Field (the Contingency Plan) sets out the planning arrangements for management of an eruption within the AVF.

Purpose of the Contingency Plan

The purpose of the Contingency Plan is to direct and coordinate response to an eruption in the AVF.

This Contingency Plan **does not** address contingency planning for a volcanic eruption outside the AVF.

Objectives of the Contingency Plan

The principal goal of this plan is to establish comprehensive and co-ordinated management of response and recovery operations. To achieve this goal, the following objectives are identified:

- Establish a preliminary hazard assessment technique
- Guide provision of appropriate and timely public information and warnings
- Guide decision making around evacuations
- Establish processes for the provision of scientific advice on hazards, risk and consequences.

Supporting Plans

The Contingency Plan complements existing civil defence and emergency management operational planning documents, and only contains information specific to the management and co-ordination of response to a volcanic eruption.

The Contingency Plan also identifies roles, responsibilities of key response agencies but does not replace the need for these organisations to prepare their own contingency plans (for the continuance of their core business functions).

Plan Maintenance

This plan will be reviewed annually for the first 5 years in order to incorporate the latest volcanic research and reflect changes in the Civil Defence Emergency Management sector.

Section 2: Operational Environment

This section provides a summary of the volcanic hazards and risks specific to Auckland's volcanic field. An understanding of the special character of the Auckland Volcanic Field (AVF) allows an appropriate planning and response framework to be established.

Geographic Context

Central Auckland is located on a narrow isthmus between the Waitamata and Manukau Harbours. This is a major geographical feature that constrains the location of lifeline utilities including power, transport, gas and communication networks. This also limits land-based evacuation routes. The AVF covers the entire width of the Auckland isthmus (see figure 1), consequently there is a high risk of a volcanic eruption causing multiple and catastrophic utility failure. Many utilities running through the Auckland isthmus service large areas (e.g. power to Northland) and consequences may be widespread.

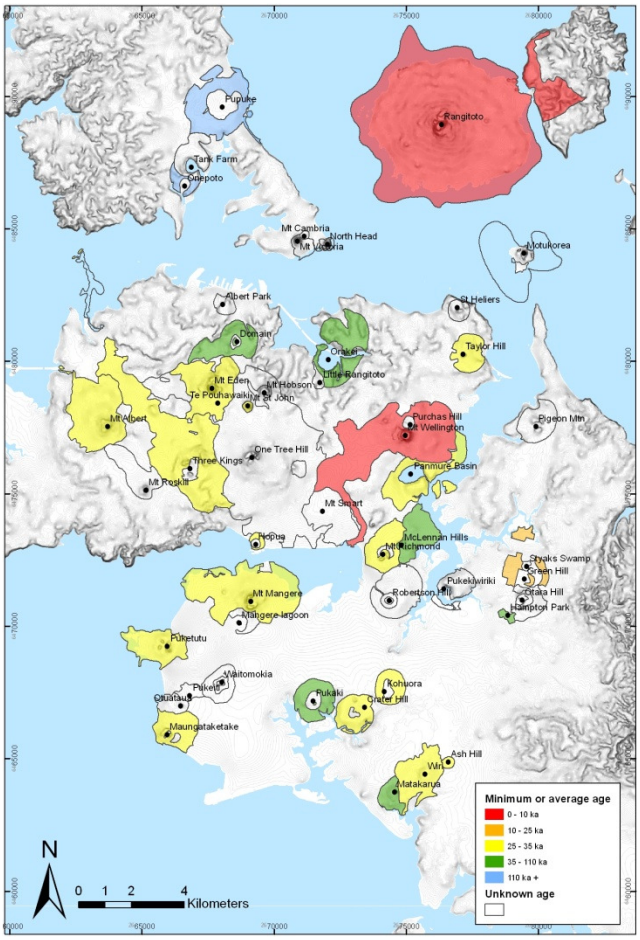

Figure 1: The Auckland Volcanic Field best-guess age estimates[1]

[1] Modified from Lindsay, J. M, Leonard, G. L. 2009. Age of the Auckland Volcanic Field. IESE Report 1-2009.02. Refer to Appendix 7 for indication of uncertainties surrounding these age estimates)

The Auckland Volcanic Field extends beneath both the Waitemata and Manukau Harbours. Interactions of magma with shallow harbour water, or terrestrial ground or surface water can result in explosive and highly destructive volcanic activity.

Auckland's topography is largely comprised of short steep catchments. The distance and direction that volcanic products such as base surges and lava flows will travel is largely controlled by topography. Consequently these hazards will probably affect targeted areas however, it is difficult to predict which areas will be affected until the location of the vent is determined.

Auckland Volcanic Field Characteristics

An eruption within the AVF could occur anytime: The return period between past events has ranged from tens to thousands of years. The most recent eruption occurred some 550 years ago. A future eruption may therefore occur at any time in the future.

The site of future eruption cannot be predicted: The geologic record indicates that the AVF is a monogenetic volcanic field (typically only one eruption episode occurs from each vent, although some eruption episodes have involved more than one vent). The monogenetic nature of Auckland's volcanoes means that a future eruption will most probably involve a new volcano being formed, rather than renewed activity from an existing volcano.

There will be a relatively short pre-eruption period (possibly only a couple of days): The AVF volcanoes are characterised by low viscosity basaltic magma, which rises quickly to the crust (at speeds of between 0.1 and 2.2 km/hr[2]). This means that the warning period for any pending eruption (from the early stages of detection to the commencement of volcanic activity) is likely to be short, in the order of 1 day to a few weeks[2].

The initial phase of activity is likely to be the most catastrophic: Most of the past eruptions have started with an explosive phreatomagmatic eruption producing base surges and resulting in the formation of a tuff ring. The abundance of sea water and groundwater in and around Auckland means a future eruption is also likely to start this way.

There may be more than one eruption vent: It is possible that there will be more than one eruption vent, or that magma may erupt along an elongated fissure (though it is expected that any vents in a multi-vent episode will be in relatively close proximity)

The volcanic event will continue for a long time: Unlike many other natural hazards in New Zealand, a volcanic event will occur over a long time frame, over a period of months up to a year or more;

Many hazards will result from a volcanic eruption: Volcanic activity will give rise to a number of hazards, which will have minor to severe impacts both in terms of damage and geographic extent.

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[2] Blake, S, Smith, I.E.M, Wilson, C. J.N, Leonard, G.L. 2006: Lead times and precursors of eruptions in the Auckland Volcanic Field, New Zealand: Indications from historical analogues and theoretical modelling. GNS Science Consultancy Report 2006/34.

Volcanic Hazards

Detailed information on AVF hazards and their consequences is given in Appendix 3. The risk associated with these hazards has been assessed and is summarised in table 1.

When planning for response, particular attention should be given to those hazards that pose a potentially high or severe risk, for which some mitigation options are available (see table 1). For example, crater formation poses a severe risk, but there are no known options for mitigation (other than evacuation with sufficient prior warning). Whereas lava flow and airfall tephra pose high and moderate risks, against which some mitigative options are available for risk reduction. See Appendix 3 for information on mitigation options.

Table 1: Volcanic Risk Matrix

Hazard	**Area Affected** *(radial distance from vent, km)*	**Immediate Risk to Life**	**Ongoing Risk to Life**	**Anticipated Consequences** *(Social, Built, Economic, Environmental)*	**Mitigation** *(see Appendix 3 for mitigation options)*	**Recovery Period following Cessation of Activity**
Crater, Cone or Ring Formation	0 to 3	Extreme	Low	Extreme	None	Several months to years
Base Surge	0 to 5	Extreme	Low	Extreme	None	1 week to several months
Fire Fountaining*	0 to 0.5	High	Low	Extreme	**Minor**	1 week to several months
Shock Waves	0 to 5	High	Low	High	None	1 week to several months
Lava Flow*	0 to 5	High	Low	High	**Moderate**	Several weeks to several months
Gas	0 to 5	High	Moderate	Moderate	**Minor to Moderate**	Not applicable
Lava bombs*	0 to 0.5	Moderate	Low	Moderate	**Minor**	1 week to several months
Earthquake (MM 6)	0 to 10[3]	Low	Nil	Small	**Minor****	Not applicable
Airfall Tephra	0 to 100 downwind	Low	Moderate	High	**Moderate**	1 week to several months
Lightning	up to 100	Low	Low	Low	None	Up to 1 - 2 days
Tsunami	1	Low	Nil	Low	**Moderate**	Up to 1 – 2 days

* Events which are likely to be repeated over a period of time (weeks to months) following the initial event

** Building code structural standards allow for significant mitigation but need to be applied pre-event.

[3] Sherburn, S, Scott, B. J, Olsen, J, Miller, C. 2007: Monitoring seismic precursors to an eruption from the Auckland Volcanic Field, New Zealand. v50 pg. 1–11.

Weather

Weather conditions can complicate and exacerbate volcanic hazards and should be considered during volcanic response and planning.

Wind

- The direction and strength of wind will influence the distribution of volcanic ash and lapilli from the eruption column. Auckland's predominant wind direction is westerly but this is highly variable. Regular wind forecasts will be required in order to determine the hazard zone. The hazard zone should be reviewed and updated regularly based on these forecasts.
- Ash that has settled can also be remobilized by wind.
- Wind direction can vary at different altitudes causing unexpected aviation risk.
- Strong winds can spread fires that result either directly or indirectly from volcanic activity.

Rain

- Wet ash is up to two times as dense as dry ash, increasing the risk of roof collapse.
- Rain will wash volcanic ash off roofs and roadways into stormwater systems blocking drains and causing flooding.
- Ash can cause corrosion and may be electrically conductive. Rain may cause flashovers on electricity insulators resulting in power outages.

Potential Consequences

The risks and impacts of a volcanic eruption in the AVF are diverse and complex, with different physical processes likely to give rise to many different physical, social and economic impacts. Importantly, the location and duration of the volcanic eruption will largely dictate the extent of these impacts. These are likely to be both 'moderate term' (for the months or years of volcanic activity) but also significantly longer term (e.g. for the volcanic vent area where reoccupation of the area may not be possible for many years, if ever).

Local Consequences

Refer to Appendix 3 for more detailed information.

While not exhaustive, the following is intended to provide general guidance on the possible local impacts resulting from a volcanic eruption. The Auckland Volcanic Scientific Advisory Group (AVSAG) will provide a more detailed assessment of consequences that is specific to the event and location.

Built

- **Buildings and Infrastructure:** Total destruction and burial of buildings and infrastructure directly over the vent and in the path of base surges and lava flows. Damage to infrastructure from ash (e.g. roof collapse, electricity failure, damage to water and wastewater pump stations, storm water system blockages). Secondary effects, particularly resulting from electricity failure. Windows blown out from shockwaves.

- **Transport:** Disruption to the Region's transport and lifeline networks, including direct physical impacts on infrastructure, severance of transport corridors or service lines, closures to ports, airports and maintenance/operational impacts (e.g. ash fall disruptions) depending on the location of any volcanic vent. Large volumes of ash on roads requiring removal and disposal;
- **Hazardous Substances Storage:** Potential impact on hazardous chemical and fuel storage areas;

Economic

- **GDP:** Economic modeling suggests that an AVF eruption will result in a reduction in Auckland's GDP in the first year;
- **Business Operations:** Disruption to regional and local business and to economic operations (e.g. loss of staff, loss of access to supplies, loss of business operation centres);
- **Trade:** Potential disruption to the port, airport or main land based transport corridors, major gateways for goods and access to the region;
- **Commercial:** Disruption to commercial activity (particularly retailing due to loss in market confidence and loss of markets);
- **Tourism:** Loss of tourism initially, probably followed by an influx of tourist to see the volcano;
- **Insurance:** Issues with post-event insurance availability and premium loadings;
- **Resources:** Long term (or possibly permanent) loss of land use and economic return from volcanic vent area.

Social

- **Displacement:** Displacement of residents and businesses from evacuation zone.
- **Community Services:** Disruption to operation of community services (e.g. schools);
- **Psychological:** Psychological impacts on community, high levels of stress;
- **Networks:** Displacement of community and social networks (moderate to long term);
- **Employment:** Loss of employment and economic security;
- **Health:** direct (casualties, respiratory effects, eye irritations), and indirect (car crashes, giardia outbreaks, contamination, clean-up risks, roof collapse etc).
- **Safety:** Health and safety impacts on the region's resident population (e.g. resulting from ash fall, volcanic gasses, fire fountaining or indirect casualties);

National Consequences

- **GDP:** Economic modeling has suggested that an AVF eruption would result in a reduction in GDP in the first year;
- **Air Travel:** Disruption to Auckland International Airport as a major portal to the country (trade and tourism);
- **Business:** Disruption to nationally important business and commercial activity (particularly if the CBD affected);
- **NZD:** Pressure on the New Zealand dollar;
- **Port:** Disruption to the Port as a major national gateway for goods to the country;
- **Transport and Infrastructure:** Disruption of transport and infrastructure services to and from the north (e.g. the Harbour Bridge, Marsden Point Pipeline and the Main Power Trunk);
- **Resources:** The need for national support and resources to be deployed.

- **Financial Markets:** Possible implications for New Zealand's international reputation and financial markets if Auckland, or New Zealand generally, is or is perceived as suffering significant and prolonged disruption affecting the ability to function;
- **Welfare:** Significant accommodation and other welfare needs for a prolonged evacuation of a large impacted population.
- **Wider Impacts:** All other regions would suffer from a lack of accessibility to Auckland infrastructure, supply chains, business closure and possible relocation of large numbers of internally displaced people
- **International Aid:** It is possible that New Zealand would need to accept and coordinate overseas aid.

Coordinated civil defence emergency management support at the national level or, should a national state of emergency be declared, the direction and control of national resources, may be required to assist local response, as set out in the National CDEM Plan (and supporting Guide).

Section 3: Monitoring and Warnings

Monitoring

Under the National Plan GNS Science is required to undertake routine volcano surveillance and assess the significance of information gathered in terms of the status of the AVF.

The Auckland Volcanic Seismic Monitoring Network

The Auckland Volcano-Seismic Monitoring Network (AVSN) comprises eleven sites (at April 2013) distributed around the AVF, (Waiatarua, Moumoukai, Motutapu, Herne Bay, East Tamaki, Awhitu Peninsula, Eden Park, Army Bay, Riverhead, Waiheke Island and Karaka Rd) (Figure 5). The AVSN is part of GNS Science's GeoNet network.

The AVSN is designed to monitor seismic activity associated with the onset of volcanic activity, but also detects non-volcanic earthquakes. By recognising a change in the prevailing seismic pattern that may signify magma movement within the volcanic field, warning of impending volcanic eruption can be given.

Seismic activity is monitored continuously. Data are digitally recorded and then transmitted via satellite to GNS Science at Wairakei and Wellington for computer analysis.

GNS Science will deploy additional portable monitoring equipment when signs of possible volcano unrest are detected.

Warnings

The National Civil Defence Emergency Management Plan Order 2005 (S62) sets out the responsibilities and procedures for civil defence emergency warnings.

- **GNS Science** is responsible for issuing **Volcanic Alert Bulletins** indicating the appropriate **Volcanic Alert Level**.
- **MCDEM** is responsible for issuing **national CDEM** warnings.
- The **ACDEMG** will be responsible for issuing appropriate **public alerts** (refer to Appendix 2) within the region.
- **MetService** is responsible for issuing **aviation SIGMET** and **volcanic ash advisories**, reporting and forecasting the distribution and spread of the ash cloud from an erupting volcano for the purpose of aviation safety.

Volcanic Alert Levels

The status of the volcanic field at any time is defined by an assigned *Volcanic Alert Level* (VAL) as described in Table 2. **GNS** Science is responsible for assessing the level of activity of Auckland's volcanoes and issuing Volcanic Alert Bulletins.

Volcanic activity in the AVF is likely to develop over a relatively short time. Table 2 also indicates an estimated 'period' or duration for each Level. The periods indicated in Table 2 do not reflect either the minimum or

maximum duration of each level, but provide an indication of a realistic lower bound time period between alert levels. These periods are an indication of the mobilisation or resourcing time that can be anticipated.

The durations suggest that early changes in seismicity (VAL 0 to 1) provide the most valuable warning of impending eruption because such changes occur over a time period in which mitigative responses can be reasonably implemented. In other words, this is the period where emergency managers have an opportunity to prepare for response to a volcanic eruption.

Once volcanic activity progresses beyond VAL 1, hazardous effects could be experienced within hours, and full-scale eruption within as little as a day.

Table 2: Volcanic Alert Levels (Reawakening Volcanoes) *Modified from 'The Guide to the National Civil Defence Emergency Management Plan 2006'*

Volcanic Alert Level*	Indicative Phenomena	Volcano Status	Duration**
0	Typical background surface activity; seismicity, deformation and heat flow at low levels.	Usual dormant or quiescent state.	Not applicable
1	Apparent seismic, geodetic, thermal or other unrest indicators.	Initial signs of possible volcano unrest. No eruption threat.	A few days and up to a few weeks
2	Increase in number or intensity of unrest indicators (seismicity, deformation, heat flow, etc.).	Confirmation of volcano unrest. Eruption threat.	Up to 1 to 3 days
3	Minor steam eruptions. High-increasing trends of unrest indicators, significant effects on volcano, possibly beyond.	Minor eruptions commenced. Real possibility of hazardous eruptions.	A few hours to 1 day
4	Eruption of new magma. Sustained high levels of unrest indicators, significant effects beyond volcano.	Hazardous local eruption in progress. Large scale eruption now possible.	Up to a few hours
5	Destruction with major damage beyond active volcano. Significant risk over wider areas.	Large hazardous volcanic eruption in progress.	A few weeks

* The VAL will not necessarily increase gradually from 0 to 5 and may increase by more than 1 level at a time.

** Durations have been assigned to Volcanic Alert Levels (VALs) as a tool for planning purposes only and apply only to the Auckland Volcanic Field. The VAL may rise to 1 and then return to 0 and is not intended to be a predictive tool.

Physical Warnings

The next AVF eruption will occur when magma presently forming 80-100km beneath Auckland rises to the surface. As the magma rises through the crust, it will most likely generate small tremors which can be detected using seismometers and later, earthquakes which can be felt. A volcanic eruption is expected to occur after a period of earthquakes lasting a few days to a few weeks, although some modelling suggests that, in extreme cases, the warning time may be as little as several hours. Results of seismic monitoring to date indicate a very low level of background seismicity in Auckland, which improves the likelihood of detection of an impending eruption and eventual location of its vent.

Physical signs of an impending eruption may include:

- Tremors up to MM6[4]

[4] MM6 Slightly Damaging – Felt by all. People and animals are alarmed, and may run outside. Walking steadily is difficult. Furniture and appliances may move on smooth surfaces, and objects fall from walls and shelves. Glassware and crockery break. Slight non-structural damage to buildings may occur.

- Localised ground uplift and surface cracking at the eruption site (eruption imminent)
- Steam eruptions close to the eruption site (eruption imminent)
- Increased gas output at the ground surface

Section 4: Risk Assessment

One of the key requirements for civil defence emergency management is to understand the areas most likely to be at risk. As the future sites of volcanic eruption cannot be predicted, predicting the hazards and risks associated with volcanic eruption in the AVF is more complex. For example, hazards from a volcanic eruption will be dependent on whether the eruption occurs on land or below water and the risks will depend on the location of the eruption in the AVF.

Hazard Zone Assessment Tool

For the purposes of contingency planning, a uniform distribution of hazard zones is proposed as a *preliminary* guide for impact assessment. The *Hazard Zone Assessment Tool* is to be used for *initial* assessment of the likely area at risk from volcanic eruption following detection of a change in seismicity by the AVSN.

Because early estimates of the eruption site are likely to be loosely constrained, the application of a uniform hazard zone (indicated below) should be applied around the vent zone using GIS or other mapping software.

Hazard Zone	**Radial distance from identified vent zone**
Extreme risk	0-3km
High risk *(large eruption only)*[5]	3-5km
Ash zone 1 (>10mm ash thickness)	5-15km
Ash zone 2 (5-10mm ash thickness)	15-18km
Ash zone 3 (1-5mm ash thickness)	18-30km

As the HZAT is an *initial* assessment tool it should be reviewed in conjunction with ongoing scientific updates, provided by the AVSAG, to refine understanding of the likely areas and impacts. Ash distribution will be highly directional and dependent on wind conditions, and lava flow distribution will be highly dependent on topography.

[5] It is not possible to predict if the eruption will be large or small. Extreme and High risk zones should be used for prioritising evacuation only.

Section 5: Evacuation Planning

Evacuations will be undertaken in accordance with the process outlined in the Auckland Scalable Evacuation Plan. This section outlines the process for determining volcanic evacuation zones, and volcano-specific considerations to be used in evacuation planning.

Evacuation planning requires the involvement of a diverse range of organisations and will not be undertaken in isolation.

Assessing the Need for an Evacuation

An evacuation will be needed if:

- Hazard assessment indicates urban or strategic area may lie within 5km of the inferred eruption centre;
- Potential risk to life

Evacuation Zones

Identify Primary Evacuation Zone (PEZ)

- Area at risk of catastrophic impact from volcanic hazards (Extreme Risk Hazard Zone as defined by the HZAT or as modified in consultation with AVSAG to recognise factors such as predominant wind direction, topography etc).
- Identify highest priority areas within this zone if population density is high.
- Review when AVSAG provides updated advice:
    - Extreme Risk Hazard Zone boundaries may be modified according to topography;
    - Priority areas may be identified on the basis of prevailing winds and weather conditions;
    - Boundaries may be altered to include tsunami or other hazards if the eruption is off-shore;
    - Boundaries may be altered to consider secondary hazards.

Identify Secondary Evacuation Zone (SEZ)

This zone may include the following areas:

- Areas at risk of catastrophic impact from volcanic hazards if eruption is large (High Risk Hazard Zone);
- Areas which have become isolated due to the eruption hazard;
- Areas where lifeline services have been or are likely to be severed;
- Areas where winds or topography have the potential result in greater hazard impacts; or
- Areas deemed to have a level of risk based on updated advice from AVSAG.

Operational Considerations

Evacuation Controls

- Consideration should be given to limited or partial evacuation of the SEZ.
- Consider allowing access to evacuation zone to utility contractors as soon as it is safe to do so.

Cordons

When planning an evacuation cordon the following will be considered:

- Volcanic hazards and potential secondary hazards;
- Potential for the area to become isolated due to eruption or loss of lifelines;
- Ability to provide personnel support (including shift changes, communications, shelter and staff welfare);
- Ability to evacuate from post, if required.

When to commence an evacuation

Consideration should be given to the following matters when deciding when to commence an evacuation.

Risk

- Time required for an evacuation vs scientific advice on the probability, timing and location of an eruption (and uncertainties);
- The 'cost' of an evacuation relative to the 'benefits' (using the Bayesian event tree model[6] or similar assessment tool);
- The safety of personnel assisting in evacuation (from primary and secondary hazards);
- Potential for evacuation routes to be affected by volcanic activity.

Logistics

- Resource availability (people and materials) to assist in evacuation;

Complicating Factors

- The potential for 'panic' from the wider community to hinder the evacuation process (e.g. residents from outside the PEZ self- evacuating on the same routes or through areas and routes needed for evacuation of the PEZ);
- Likely duration of evacuation;
- Area to be evacuated to – within-region, outside-region;
- Impact on local infrastructure, disruption to businesses, schools, etc.;
- Evacuating vulnerable communities – prisons, care facilities, hospitals, those receiving 24hr home care, zoo;
- Availability of supplies for those not evacuated;
- Staged evacuation;
- Pets.

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[6] To be undertaken in conjunction with the AVSAG – refer to Lindsay, J.M, Jolly, G, Sandri, L, Marzocchi, W, Holland, G. 2010: New probabilistic hazard assessment tools for mitigating volcanic risk in Auckland, New Zealand. In: Williams, et. al. eds. *Geologically Active.* IAEG Conference proceedings.

- Registration of evacuees.
- Possibility of severe weather conditions restricting one or more evacuation routes or methods (e.g. ferry).

Section 6: Roles and Responsibilities

In the event of a volcanic eruption it is important to recognise that a diverse range of specialist advice will be required.

Lead Agency

The **ACDEMG** will be the Lead Agency unless a national declaration is implemented.

Roles and Responsibilities - Key Response Agencies

The roles and responsibilities of different agencies in the event of an AVF eruption are summarised in Table 3. This Table is intended to outline specific roles and responsibilities in the event of volcanic eruption and does not devolve any organisation of the responsibilities identified under the National Plan, CDEM Plan or other legislative requirements.

Table 3: Roles of Key Response Agencies

Organisation	Key Roles *(in addition to normal CDEM response roles)*
ACDEMG	**Lead Agency** *(Refer to **Appendix 2 for GECC team checklists**)* ■ Assess Risk - identify hazard zones ■ Plan Evacuation ■ Manage volunteers and resources ■ Public Information and Media Management ■ Liaise and coordinate with emergency services, welfare providers, AELG, and other stakeholders/groups. ■ Source and prioritise allocation of health and safety equipment ■ Assess and coordinate mitigation options ■ Provide for welfare and recovery – including registration
MCDEM	■ Assess national consequences – economic and infrastructure ■ Source and prioritise allocation of nationally scarce resources: – Health and safety equipment – face masks – Filters for generators etc – Fuel ■ Coordinate international and national resources, aid and scientific advisors
GNS Science	■ Provide Volcanic Alert Levels and Volcanic Alert Bulletins to the **ACDEMG, MCDEM, media and public**. ■ Through AVSAG, provide advice on the ongoing and potential effects of a volcanic eruption to the **Lead Agency**. ■ Set Aviation Alert Codes and provide Volcano Observatory Notices to Aviation (VONAs). ■ Monitoring volcanic activity. ■ Provide Health Advice – liaison and monitoring with MOH regarding health issues.

NZ Police	■ Plan and implement the evacuation plan. ■ Security.
NZ Fire Service	■ Member of the Technical Advisory Group – mitigation. ■ Assess secondary hazards – fires from lava, gas explosions etc. ■ Provide specialist equipment for working in a hazardous environment.
Met Service	■ Provide warnings on volcanic ash emissions including: – Issuing appropriate NOTAMS (Notice to aviation) on volcanic hazard areas through Airways; – Issuing SIGMETS (significant meteorological advice for pilots) on ash cloud and dispersion to aviation; – Issuing volcanic ash advisory messages (VAA) about ash-cloud and dispersion to aviation. ■ Responsible for Volcanic Ash Advisory Centre.
Airways Corporation	■ Advise the **Lead Agency** of civil aviation conditions. ■ Advise aviation operators of volcanic SIGMET and appropriate VAA information. ■ Collect, from aircraft, Volcanic Activity reports (VAR), pass this information to GNS and MetService and report to **Lead Agency**.
Civil Aviation Authority of New Zealand	■ Maintain a regulatory oversight that a means exists whereby civil aviation aircraft operations can be safely carried out in proximity volcanic ash. ■ Liaise with airline operators, Airways and MetService.
AWAG	■ Provide welfare assistance and support to all affected communities. ■ Assess needs of affected communities. ■ Provide advice and guidance to NWCG and seek support as appropriate.
Lifeline Utilities	■ As requested by the lead agency, manage supply or disconnection to the areas at risk. ■ Assess network risks and secondary hazards.
NZDF	■ Member of the Technical Advisory Group - providing advice and operational resources for mitigation and response.
Harbourmaster	■ Assess risk to strategic marine assets especially those required for evacuation, response and recovery efforts. ■ On-water navigational safety, especially in response to risk from submarine eruption.
DHBs	■ Assess risk to health services and need for hospital evacuations. ■ Coordinate evacuations and ensure rest homes and care facilities have the necessary support.

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Time-Sequence Response Roles

The table below indicates key response activities as they relate to Volcanic Alert Levels.

Table 4: Time-sequenced response roles

Volcanic Alert Level	Volcano Status	Period**	Response Activities - GECC[7]	Response Activities – Other Agencies
0	Usual dormant or quiescent state.	Not applicable	■ **Auckland Volcanic Scientific Advisory Group (AVSAG)** established /and meet on a regular basis to confirm and discuss AVF activity, changes or refinements in contingency plans or other planning and response documents, explore the use of probabilistic eruption forecasting and decision-making thresholds. ■ Make recommendations for **update of the Contingency Plan** as appropriate. ■ **Public education** programme and awareness campaigns.	
1	Initial signs of possible volcano unrest. No significant eruption threat.	A few days and up to a few weeks	■ Establish Operational Response Group (SOP G201). ■ **AVSAG** notified and convened (see Appendix 4). ■ Nomination of **Lead Agency – CDEM Group.** ■ Issue regular **public information** statements. ■ Alert of threat provided from the **ACDEMG** direct to: – KRAs – Civil Aviation Authority; – New Zealand Airways Corporation. ■ Perform **risk assessment** using the Hazard Zone Assessment Tool (refer to Section 4). ■ Convene **AWAG**. ***If the HZAT suggests a high-density population area or key strategic resource may be affected, escalate response activities.***	**GeoNet (GNS Science)** ■ GNS Science continues to monitor volcanic activity, set VAL and issue Volcanic Alert Bulletins as appropriate.
2	Confirmation of volcano unrest. Eruption threat.	Up to 1 to 3 days	■ **Consider commencement of *Evacuation*** within PEZ and SEZ and management of this area as an 'Incident Control' area (as per CIMS). ■ **Issue warnings** to public using media and other available local warning systems. ■ Convene all **recovery task groups**. ■ **AVSAG** mobilised to advise the lead agency on the volcanic activity and likely hazards.	**GeoNet (GNS Science)** ■ GNS Science continues to monitor volcanic activity, set VAL and issue Volcanic Alert Bulletins as appropriate.
3	Commencement of minor eruptions. Real possibility of hazardous eruptions.	A few hours to 1 day	■ **Evacuate immediately**, if not already undertaken. ■ AVSAG continues to advise the lead agency on the volcanic activity and likely hazards.	**GeoNet (GNS Science)** ■ GNS Science continues to monitor volcanic activity, set VAL and issue Volcanic Alert Bulletins as appropriate. **Met Service** ■ Issue **volcanic ash advisory**

[7] Refer to Appendix 2 for GECC team checklists.

Volcanic Alert Level	Volcano Status	Period**	Response Activities - GECC[7]	Response Activities – Other Agencies
				Airways Corporation ■ **Assess risk to aviation** from volcanic ash
4	Hazardous local eruption in progress. Large-scale eruption now appears imminent.	Up to a few hours	■ AVSAG continues to provide regional scientific advice and respond to hazards as these develop. In particular, base surges, lava flow, wind direction and ash fall, air quality, gas emissions.	**GeoNet (GNS Science)** ■ GeoNet continues to monitor volcanic activity, set VAL and issue Volcanic Alert Bulletins as appropriate. ■
5	Large hazardous volcanic eruption in progress.	Not applicable	■ Plan for disposal of volcanic ash ■ Assess consequences and secondary impacts	**GeoNet (GNS Science)** ■ GNS Science continues to monitor volcanic activity, set VAL and issue Volcanic Alert Bulletins as appropriate.

Appendix 1: List of Acronyms

AELG	Auckland Engineering Lifelines Group
AVF	Auckland Volcanic Field
AVSAG	Auckland Volcanic Scientific Advisory Group
AVSN	Auckland Volcano-Seismic Monitoring Network
AWAG	Auckland Welfare Advisory Group
CAA	Civil Aviation Authority
CDEM	Civil Defence Emergency Management
ACDEMG	Auckland Civil Defence Emergency Management Group
CIMS	Co-ordinated Incident Management System
DHB	District Health Board
GECC	Group Emergency Coordination Centre
GNS Science	Institute of Geological and Nuclear Sciences
HZAT	Hazard Zone Assessment Tool
MCDEM	Ministry of Civil Defence Emergency Management
MoH	Ministry of Health
MoT	Ministry of Transport
MCDEM	Ministry for Civil Defence Emergency Management
NWCG	National Welfare Coordination Group
NZDF	New Zealand Defence Force
PIM	Public Information Manager
PEZ	Primary Evacuation Zone
SEZ	Secondary Evacuation Zone
TAG	Technical Advisory Group
VAB	Volcanic Alert Bulletin
VAL	Volcanic Alert Level

Appendix 2: GECC Team Checklists

Planning and Intelligence

- ☐ Establish **AVSAG and TAG** when atypical seismicity is detected (See Appendix 4).

- ☐ Provide advice on **Safety Equipment** (PPE) (See Appendix 5) with advisory assistance from the AVSAG and TAG. Prioritise distribution of equipment.

- ☐ **Transport Routes**: advise transport network providers on the following matters:
  - Ash fall and ash disposal locations (for clearance of ash and debris from routes and networks);
  - Overall impact areas and hazard zones (for establishment of detour corridors should sections of highway be within 3-5km of the eruption site.

- ☐ **Risk Assessment:** using Hazard Zone Assessment Tool (see Section 4) provide an initial assessment (rapid, though course) of the likely impacts of volcanic eruption. That is:
  - The population within each hazard zone;
  - The number of households within each hazard zone; and
  - Strategic lifelines within each hazard zone (with Lifelines Liaison input).

- ☐ **Evacuation: Identify the following:**
  - Areas where damage is likely if eruption hazards escalate (SEZ);
  - Areas likely to be isolated in the event of eruption (particularly in terms of water supply, wastewater disposal, power and road access);
  - Areas where there is potential for significant damage due to secondary hazards (e.g. fire, hazardous substance leakage).
  - Areas that may be impacted by tsunami.

- ☐ **Ash Disposal:** (See Appendix 6)
  - Identify and get approval for ash disposal sites.
  - Direct logistics/operations to implement collection.

- ☐ **Consequences Assessment:** information on the effects of eruption on the social, economic and built environments.

- ☐ **Evacuation Planning:** assess and input the following information for evacuation planning (See Section 5)
  - Population in PEZ and SEZ;
  - Special needs of people within the above areas;
  - The time required for effective evacuation of the resident population from the PEZ;
  - The safety of personnel assisting in evacuation;

- The potential for 'panic' from the wider community to hinder the evacuation process (e.g. residents from outside the PEZ self- evacuating on the same routes or through areas and routes needed for evacuation of the PEZ);
- Best estimate of probability, location and timing of an eruption (use AVSAG);
- Assessment of the 'cost' of an evacuation relative to the 'benefits'.
- Registration of evacuees.
- Evacuation within region or out of region options

☐ **Mitigation Options:** assess mitigation options with TAG (see Appendix 3).

Logistics

- [ ] Plan for **disposal of ash** – collection and transport.
- [ ] Consider resources required for **mitigation.**
- [ ] **Signage** requirements for evacuation zones (erect early to minimise health and safety risk).
- [ ] Source and distribute **health and safety** equipment as advised by Planning and Intelligence (likely to be in high demand).
- [ ] **Evacuation Planning**: assess resource availability for evacuation.

Liaison

- [ ] **Lifelines Liaison:** assess volcanic impacts on strategic lifeline utilities and identify knock-on effects from utility failures. Identify potential for widespread impacts (e.g. power outages)
- [ ] **Lifelines Liaison:** provide an overview of utility mitigation plans.
- [ ] **Lifelines Liaison:** determine utilities logistics requirements, particularly regarding health and safety equipment and other resources that will be in high-demand.
- [ ] **Lifelines Liaison:** refer utilities to AELG volcanic impacts posters and reports available on the AELG website.
- [ ] **Health Liaison:** get information on health impacts from Planning and Intelligence (sourced from the AVSAG) and provide this to appropriate health agencies.

Welfare

- [ ] **Minimise ash impacts** on welfare centers (e.g. instructions for clearing ash off roofs etc.).
- [ ] Ensure Welfare Centres have access to appropriate **health and safety equipment** (See Appendix 5)
- [ ] **Minimise transportation** in areas affected by ash
- [ ] **Monitor** the **health** of people evacuees and internally displaced people, particularly in response to volcanic ash exposure (see Appendix 5).
- [ ] Ensure **affected communities** have access to appropriate **support**.

Operations

☐ **GECC Location:** Ensure that any GECC site is located away from areas of impact from the HZAT and from any valleys which may become lava flow corridors.

☐ **GECC Location:** Consider potential impact on utilities supplying the site and ability for alternatives:

- Communications
- Water supplies (ash contamination and disruption to network)
- Land-based transportation
- Power (ash impacts and damage to network)

☐ **GECC Maintenance:** Consider arrangements for:

- Ash removal and disposal from building;
- Building services (maintenance of air conditioning, air re-circulation services may need to be considered);
- Specialist cleaning services (e.g. for acid rain, ash deposits)

☐ **Identification:** Provide official identification for the following groups:

- AVSAG and TAG representatives;
- GNS Science

☐ **Rescuing Belongings:** Consider and coordinate activities to rescue valued belongings from evacuation zone. This should only be undertaken if safe for workers. Valued belongings may include:

- Photographs
- Pets
- Important Documents

Public Information and Media Management

Uncontrolled reporting and assessment of hazard and impact from unofficial sources is a strong possibility. Establish a strong media presence early with trustworthy spokesperson in order to mitigate risk.

- ☐ Use volcano messages from **MCDEM's 'Working from the same page: Consistent messages for CDEM'**. **Planning and Intelligence will assist in composing all public information messages to confirm** appropriateness for Auckland before they are released.
- ☐ Ensure **public information is aligned** with GNS Science Volcanic Alert Bulletins – both in terms of timing and content. Use tables below for guidance on the messages required at each VAL.
- ☐ Use Group Controller-approved Scientific and Technical Advisors as **spokesperson**.
- ☐ **Public Information Content:** Add value to scientific information being disseminated by GNS Science such as hazards, consequences, evacuation zones, population affected etc.
- ☐ **Signage:** Identify signage requirements: evacuation zones, restricted access, health and safety information, evacuation routes, notice of potential hazard zones.
- ☐ **Signage:** Prepare text for signage

*The following information is from the **"Community Behaviour-Based Communication Framework"** developed by MCDEM, GNS Science and Massey University for Exercise Ruaumoko.*

- ☐ **Uncertainty:** Unfortunately one or more of the important attributes required of warning messages (specificity, consistency, certainty, accuracy, clarity) is usually deficient or missing during a volcanic crisis. Responding authorities must recognise this.
- ☐ **Construction:** Five topics are important when constructing a warning message:

Topic	Function
hazard or risk	the warning message must contain information about the impending hazard with sufficient simple detail that the public can understand the characteristics of the hazard that they need to protect themselves from
guidance	the message should include guidance about what they should do to maximize their safety
location	the warning message must describe the exact location that is at risk
time	the message should address the timeframes required for response
source	who is issuing the warning, by what authority

- ☐ **Credible Sources:** Warnings are more likely to be believed if they come from 'credible' sources. The public's perception of credibility of information sources is a subjective judgment and has

been shown to be related to notions of expertise and trustworthiness. Credibility can be judged on:

- the "credentials" of the person or agency issuing the warning;
- the relationship of the organisations to other "credible" organisations; and
- the past history of job performance.

☐ **Rumour Control:** Rumour control is a critical function for agencies responsible for giving out public information and these agencies should be proactive in identifying and correcting incorrect or misleading information. However, some caution is needed because immediate and harsh official denouncement of popular views may be counterproductive and treated with suspicion as the public often prefer to hear a range of opinions before drawing their own conclusions on a subject.

☐ **Correcting Incorrect Information:** During a crisis systems often break down, data are misinterpreted and conditions rapidly change rendering previously released information 'out-of-date'. Incorrect or misleading information should be corrected by follow-up information, accompanied by explanations as to the origins of apparently 'unreliable' information.

☐ **Care with Forecasting and Predictions:** When the current information is full of uncertainty (a common situation prior to and during an eruption) it is important to avoid making or disseminating unrealistic forecasts. This will lessen concerns about the "cry wolf syndrome" which is common among many public officials.

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Te Rakau Whakamarumaru

Auckland Council
Te Kaunihera o Tāmaki Makaurau

TABLE 1		Phase	Pre-Event 'Quiet Time'
		Volcanic Alert Level	0
		Human Status	Learning, preparing
CONTEXT	1	What the scientists will be saying	• Usual dormant or quiescent state. • Typical background surface activity; seismicity, deformation and heat flow at low levels. Some science information on GeoNet site (e.g. small non-volcanic earthquakes)
	2	Expected community behaviour	• Low salience of it as a threat. Don't believe it will happen. • Knowledge and understanding can be improved over time, but it is really difficult to shift preconceptions. • People not too scared to prepare or believe risk, but are sceptical of reality of risk.
OBJECTIVES	3	Aims of this period	• Build trust in authorities (if you don't get trust here, it will be a lot harder to get later / in an emergency). • Get people to prepare – understand risk, warning systems, response actions including evacuation, have home and work emergency plans and kits.
	4	Advice to communicators	• Ensure consistent messaging • Must be pragmatic. • Positive messages that it can be done (trying to engender trust). • Capitalise on any opportunities, e.g. paper publications, eruptions elsewhere, tectonic earthquakes affecting Auckland.
MESSAGING	5	KEY MESSAGE THEMES	• Key public education messages, e.g. Auckland is a volcano, the risks associated with it, that consequences can be reduced by being prepared, having knowledge and plans.
	6	'Warning' messages	• None, but know what warnings to expect and actions to take when unrest starts.
	7	'Information' messages	• Auckland is a volcano. It could erupt. This is how it could erupt. These are the precursors we might see. This is the monitoring we routinely do. Here is the uncertainty around precursors, and what it might lead to. • What are Scientific Alert Levels, what is a seismograph. • Preparedness actions of authorities. • Living and working in an ash environment. • 'What we want to do' items from '3' above.
	8	Dealing with probability and uncertainty	• Eruptions are possible in your lifetime. Currently no signs on which to say there will be an eruption any time soon. • Eruptions do not appear to be regularly spaced over time. They are possible at any time. • The lead time to an eruption is most likely to be weeks to months, but could be much shorter.
	9	'What to do' messages	• Preparedness actions of individuals (the types of preplanning they could do, e.g. what to do with their children, how to help others), and how those actions could escalate (evacuation options) • Understand risk, warning systems, response actions including evacuation, have home and work emergency plans and kits. • Standard CDEM messaging re. preparedness.
HOW	10	Mechanisms	• CDEM Group public education programme. • Museum. Public lectures. Media stories. • Community networks empowered to educate. • Exercise evacuation procedures.

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TABLE 2		Phase	Unfelt Activity
		Scientific Alert Level	0 – 1 →
		Human Status	First community 'shock'
CONTEXT	1	What the scientists will be saying	• Initial signs of possible volcano unrest. No eruption threat. • Seismic, geodetic, thermal or other unrest indicators below the AVF. Science Alert Bulletins on GeoNet website and sent out.
	2	Expected community behaviour	• Anxiety. Some positive, which can be channelled into action. But in a few cases there may be 'negative anxiety' (extreme fear leading to total inaction). • Massive public information searching. People will search tv, radio, internet, everywhere. • Social networks operating – calling friends/family. Social amplification of risk (risk perception goes up as you go away from the situation). • Self-evacuation may begin
OBJECTIVES	3	Aims of this period	• Calm and reassure the public. Describe the phenomena, risk and possible trends, official responses (monitoring, emergency management), and what the correct public response is.
	4	Advice to communicators	• Ensure consistent messaging • Try to explain the uncertainty and the real risk in an uncertain period. • Demand for information will be intense. Guidance on how/where they can get information. • Pre-planned information becomes useful. • Be proactive in correcting misleading and incorrect information – this is essential. • Messaging must be beyond affected region (to minimise social amplification of risk phenomena) • But focus is still on Auckland residents. Bulk of time and energy should go into those at risk. Regular communication is needed.
MESSAGING	5	KEY MESSAGE THEMES	• What is happening, and what the authorities are doing about it.
	6	'Warning' messages	• There is a possibility of a future eruption. There is no current threat.
	7	'Information' messages	• Repeat information of SAL0, but more frequently and higher profile
	8	Dealing with probability and uncertainty	• There is unrest, although unfelt • It may or may not be related to volcanic activity • There is no immediate threat. • Unrest can lead to eruptions in periods of months to days. • Authorities are monitoring the unrest, any changes will be notified immediately to the public.
	9	'What to do' messages	• Understand risk, warning systems, response actions including evacuation • Urgently prepare home and work emergency plans and kits.
HOW	10	Mechanisms	• Media

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Te Rakau Whakamarumaru

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Te Kaunihera o Tāmaki Makaurau

TABLE 3		Phase	Felt Activity BEFORE Decision to Evacuate
		Scientific Alert Level	1 – 2 →
		Human Status	Physical confirmation of threat
CONTEXT	1	What the scientists will be saying	• Initial signs of unrest. • Confirmation of volcano unrest. Eruption threat. • Earthquakes become shallower and/or larger. May be other indicators such as gas, hot springs, steam, ground deformation.
	2	Expected community behaviour	• Physical confirmation will convert most doubters (visual/felt cues). • Many people will have delayed any action until this time. • Perception may be different if their first warning is a physical warning (no unfelt activity prior to this phase). • Massive information searching for confirmation of status, validity (reassurance).
OBJECTIVES	3	Aims of this period	• Calm and reassure the public. Describe the phenomena, risk and possible trends, official responses (monitoring, emergency management), and what the correct public response is.
	4	Advice to communicators	• Ensure consistent messaging • Try to explain the uncertainty and the real risk in an uncertain period. • Demand for information will be intense. Guidance on how/where they can get information. • Pre-planned information becomes useful. • Be proactive in correcting misleading and incorrect information – this is essential. • Messaging must be beyond affected region (to minimise social amplification of risk phenomena) • But focus is still on Auckland residents. Bulk of time and energy should go into those at risk. Regular communication is needed.
MESSAGING	5	KEY MESSAGE THEMES	• What is happening, and what the authorities are doing about it. • Calm and reassure.
	6	'Warning' messages	• Those at risk prepare for possible evacuation.
	7	'Information' messages	• Repeat information of SAL0, but more frequently and higher profile. • Discussion about when and how to evacuate. Who will announce decision to evacuate.
	8	Dealing with probability and uncertainty	• Increasing likelihood. Slightly decreasing uncertainty (eruption more likely). • Dilemma: risk to life vs. uncertainty of making the wrong call. • Public don't want to hear probabilities, they only want to hear certainties.
	9	'What to do' messages	• Prepare for the possibility of evacuation. Gather family, prepare Get Away Kit if not already ready. Plan where to go. Go to family and friends if at all possible. • Refer to Notifications Annex of Evacuation Plan for detailed actions text. • Prepare for possible ash fall outside of potential evacuation zone.
HOW	10	Mechanisms	• TV, Radio, internet news, CDEM web, GeoNet web, newspaper, public meetings.

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Te Rakau Whakamarumaru

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Te Kaunihera o Tāmaki Makaurau

TABLE 4

		Phase	Felt Activity AFTER Decision to Evacuate
		Scientific Alert Level	1 – 2 →
		Human Status	Searching, deciding, evacuating
CONTEXT	1	What the scientists will be saying	• Confirmation of volcano unrest. Eruption threat. • Earthquakes become shallower and/or larger
CONTEXT	2	Expected community behaviour	• Massive information searching for confirmation of evacuation order, validity (reassurance). • Will look for official and informal support and direction on what to do. Will check to see if others are acting or intending to act. Decision to act will be based on a mixture of all of these pieces of information and social connections – e.g. children at school, family at other locations, friends. • Many people who are not officially told to evacuate will want to evacuate. Some officially directed to evacuate will refuse to move.
OBJECTIVES	3	Aims of this period	• Prompt orderly and timely evacuation of only those people who need to evacuate
OBJECTIVES	4	Advice to communicators	• Ensure consistent messaging • As for felt activity (Table 3), and also: • Give clear evacuation advice on the key message themes • Expect a lot of enquiries – make it clear who needs to evacuate, why, and who needs to stay
MESSAGING	5	KEY MESSAGE THEMES	• Focus on evacuation processes
MESSAGING	6	'Warning' messages	• Evacuate from stated areas in stated timeframe.
MESSAGING	7	'Information' messages	• Auckland evacuation plan; evacuation processes • Hazards and risks of a volcanic eruption • Living and working in an ash environment.
MESSAGING	8	Dealing with probability and uncertainty	• An eruption is likely to occur but is not certain. However, evacuation will take time and must therefore commence now.
MESSAGING	9	'What to do' messages	• Who has to go and who is to stay, why; timeframe; where to go; what route to take; what to do when you get there; what assistance people will get at all stages. • Refer to Notifications Annex of Evacuation Plan for detailed actions text.
HOW	10	Mechanisms	• Radio, TV, internet news, CDEM web, GeoNet web • Message boards for people en-route. Door-to-door route alert. • Feed information to official and informal organisational networks.

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Te Rakau Whakamarumaru

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Te Kaunihera o Tāmaki Makaurau

TABLE 5		Phase	During Eruption
		Scientific Alert Level	2 (briefly) → 3, 4, 5
		Human Status	Coping, evacuating
CONTEXT	1	What the scientists will be saying	• Minor eruptions commenced; possibility of hazardous eruptions. • Escalation up to 'large hazardous eruption'. • Description of eruption phenomena – as per Science Alert Bulletin.
	2	Expected community behaviour	• Most people who had refused to evacuate will decide to evacuate now. • There will be strong pressure from people outside of the evacuation zone to also evacuate. • Ash fall will impact the personal and business activities of those who have not evacuated. • Intense information searching. • Evacuated people will at some stage start wanting to return.
OBJECTIVES	3	Aims of this period	• Evacuate remaining people from zone. • Keep people from entering the evacuated zone. • Help others to continue life as normally as possible. • Provide welfare to those evacuated.
	4	Advice to communicators	• Ensure consistent messaging. • Evacuees will need information on activities within the evacuation zone (to calm anxiety, and to provide options for action). • Evacuees will need welfare information.
MESSAGING	5	KEY MESSAGE THEMES	• Strong direction to evacuate and stay out of zone. • Focus on welfare information.
	6	'Warning' messages	• Evacuate designated zones and stay out. • Weather and ash fall forecast information.
	7	'Information' messages	• Status of the volcano, associated hazards and their locations. • Response activities of authorities. • Ash fall forecasts, and how to live and work in an ash environment. • Welfare information; how to cope as an evacuee.
	8	Dealing with probability and uncertainty	• An eruption is occurring, so no remaining uncertainty in that respect. However, a number of uncertainties remain: duration of eruption, ash fall areas and thickness; escalation and changes in eruption types; when people will be able to return.
	9	'What to do' messages	• Evacuate from zone and stay out. • Work safely in an ash environment (see resources for various aspects). • Evacuees register and contact welfare agencies early if they need support.
HOW	10	Mechanisms	• TV, Radio, internet news, CDEM web, GeoNet web, newspaper, public meetings.

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Te Rakau Whakamarumaru

Auckland Council
Te Kaunihera o Tāmaki Makaurau

TABLE 6		Phase	Later Phases of Event / Post-Event
		Scientific Alert Level	Decreasing (5→4→3→2→1→0)
		Human Status	Returning, recovering
CONTEXT	1	What the scientists will be saying	• The eruption has stabilised, de-escalated or ceased. • Description of the processes still active. • GeoNet website, Science Alert Bulletins and Science Alert Level changes
	2	Expected community behaviour	• Community trauma due to losses (physical, financial, livelihood), uncertainty, • Desire to return immediately • Questions: Who will pay for my losses? When can I return? Why can't I return yet? Is it safe to return? What welfare is available? Are all lifelines available? What employment is available? How to clean-up ashfalls?
OBJECTIVES	3	Aims of this period	• Provide clear and accurate information. • Reassure people to remain evacuated until the return order is given. • Facilitate orderly return once this begins, with effective recovery. • Provide appropriate welfare assistance at all stages. • Allow community input and participation in recovery processes including plans.
	4	Advice to communicators	• Ensure consistent messaging. • Many public questions, strong pressure to return home. • Provide clear accurate information and be honest, especially about uncertainty. • Expect and allow for community feedback and participation. • This will be a long communications process.
MESSAGING	5	KEY MESSAGE THEMES	• What is happening (volcanic and emergency management). • Remaining evacuation orders. • Detailed welfare and recovery information.
	6	'Warning' messages	• Do not return until told to. Explain why. • On return explain ongoing risks and uncertainty.
	7	'Information' messages	• Effective recovery directions. See Recovery Plan. • Welfare processes and resources available. • Auckland remains a volcano. It could erupt again. This is how it could erupt. These are the precursors we might see. This is the monitoring we routinely do. Here is the uncertainty around precursors, and what it might lead to. • Actions of authorities.
	8	Dealing with probability and uncertainty	• There is a likelihood of ongoing activity or renewed activity, but this is uncertain – authorities are continuing to monitor activity and will advise the public of any changes immediately.
	9	'What to do' messages	• People to remain evacuated until the 'all clear' or return order is given. • Where to find welfare, recovery information. • What to do about ash/other clean up.
HOW	10	Mechanisms	• TV, Radio, internet news, CDEM web, GeoNet web, newspaper, public meetings. • Detailed return and recovery information packs.

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Appendix 3: Hazard Matrix for the Auckland Volcanic Field

Hazard	Description	Area Affected	Infrastructure Risk	Risk to Life	Warning (from given VAL)	Recovery Post Cessation of Activity	Mitigation
Airfall Tephra and Eruption Column (volcanic ash)	▪ **Eruption Column** Explosive blasting apart of magma generates an eruption column of pyroclastic material rising several kilometres into the air. In phreatomagmatic eruptions, steam condensation in the eruption plume produces ash rainout. ▪ **Airfall Tephra** Includes all volcanic products aerially ejected from the vent (ash <2mm, lapilli 2 - 64mm and bombs >64mm, derived from fire fountaining, ballistic projectiles and fall-out from the eruption column).	Ash plume may rise 6km – 15km resulting in the deposition of up to 1 million m3 of tephra spread up to 100km from the vent (although at 100km, there will be no risk to infrastructure other than air traffic). The distribution of ash will be dependent on the size of eruption, prevailing winds at the time of eruption (wind direction and strength) and particle weight. As upper level westerly winds predominate in Auckland, tephra is most likely to be deposited thickest to the north-east and east of a vent. Tephra thickness is likely to range from a few mm thick up to about 600mm thick.	▪ **Domestic and Commercial Structures** Abrasion; enters buildings through broken windows etc; tephra loading may lead to collapse of roofs, walls or columns ▪ **Communications** Emergency generation and air conditioning plants vulnerable to abrasive dust and over-heating resulting in service interruption; potential for damage to CBD fibre optic ring and isolation due to power failure; land lines more vulnerable than cellular system; congestion of services ▪ **Transport (Road, Rail, Ports, Airports)** Temporary road closure, impaired visibility, vehicle damage; blockage of drains resulting in flooding; engine damage resulting in disruption of port activity; closure of air-space and airports. ▪ **Energy** Electricity supply restriction and outages due to insulator flash-overs at transmission and distribution systems; minor affect on petroleum or gas pipeline valve controls and petroleum SCADA systems; heavy ash fall may sink floating roofs on petrol tanks causing spills and creating hazardous vapour cloud with risk of explosion ▪ **Water Supply** Suspension of ash in water supply reservoirs and leaching of contaminants (eg F), lowering of pH, disruption of treatment process; interference with electrical equipment, filter stations overloaded; damage to pumps ▪ **Wastewater and Stormwater** Pipe blockage and local flooding, damage to pumps and plant equipment, interference with treatment process; operational, maintenance and odour problems, overload bypassed to land or harbour with consequences for sanitation	▪ Hinder visibility resulting in accidents ▪ Inhalation of gas and particles causing respiratory problems ▪ Burial of crops and damage to fruit ▪ Pastoral land also lost	An eruption column will be generated following commencement of the eruption. Tephra will be produced within hours over the wider area. Prediction of wind directions critical to defining likely hazard zones. Earthquakes a few hours and up to a few days prior to eruption due to upwelling may provide an indication of the area likely to be affected by these hazards at that time. Develops from VAL 3 and continues through VAL 4 and 5, Table 2.	▪ **Domestic and Commercial structures** Dependent on availability of water supply and access ▪ **Communications** May be hindered by ability to access sites and high temperatures. Some recovery within 2 to 7 days ▪ **Transport** Regular removal of ash from roads, rail, port and airport; increased maintenance of aircraft to exclude ash from engines and machinery. Some capacity within 1 week of cessation of ash fall ▪ **Energy** Temporary repairs and alternative supplies in place within 1 week ▪ **Water Supply** Turbidity and acidity of water returns to normal levels within a few hours to days of cessation of ash fall. Essential water supply recovered within 1 week; non-essential supply provided by tanker ▪ **Wastewater** Essential recovery within 1 week of cessation of ash fall A contingency plan for disposal of ash must be prepared to avoid restricting recovery.	Clean-up and removal of ash, particularly from roofs and roads. Can use tractors on flat roofs to bulldoze ash but ensure drivers are protected from lapilli and bombs. Protect windows using corrugated shutters. ▪ **Commercial structures** Prioritise key structures (eg hospitals) and check for likely ash loading; upgrade to withstand as necessary ▪ **Communications** Fit temporary pre-filters to internal/ external air-conditioning units within exchange centres; Seal off exchange centres during the event to minimise ash effects ▪ **Transport** Remove ash from roads and stockpile during eruption; Minimise driving movements; Install extra air filters in vehicles operating within ash fall-out zones ▪ **Energy** Encapsulate gas gate stations and shut down gas supply prior to eruption ▪ **Water Supply** Prevent ash ingress to water pumping stations, cover filters; Monitor water quality ▪ **Wastewater** Bypass and/or shut down vulnerable parts of the plant

Hazard	Description	Area Affected	Infrastructure Risk	Risk to Life	Warning (from given VAL)	Recovery Post Cessation of Activity	Mitigation
							during ash fall
Airfall Tephra		**Up to 100km from vent**	**Immediate Risk Low; Ongoing Risk Moderate; Anticipated loss Low**		**Hours, up to a few days**	**1 week to several months**	**Moderate**
Base surge	Ground-hugging turbulent mixtures of steam and solid ejecta that flow out laterally from the base of the eruption column in phreato-magmatic eruptions. Surges range from wet to dry and cool to hot. May develop rapidly as lateral blasts without an associated eruption column. Multiple explosions at short time intervals. Associated with 73% of AVF volcanoes.	Surges are expected to flow out over an area of up to 5km from the vent in a period of seconds to a few minutes depending on local topography and eruption energy. May surmount topography. Near-vent, deposits are likely to be more than 0.2m thick. Surge thickness, density and speed decrease towards the limits of flow.	Destroy all infrastructure in its path over a distance of 500m, and result in significant damage to or partial burial of structures (eg transport routes) at distances of 500m to 5km. Damage to all infrastructure limited to within a few to several kilometres of the vent.	Destroy all living things in their path and those affected by blast; Suffocation due to heat, burial or asphyxiation.	Little to no warning. Fluctuating intensity dependent on the availability of water, variations in the eruption column and widening of the vent (fissures) at commencement of, or possibly within hours of volcanic activity commencing. Initiated at VAL 2/3 and continues through 4 and 5, Table 2.	**All infrastructure**: Uncover buildings and services; Establish damage due to loading applied by surge; Reconstruction as required. Essential services operational within 1 week; Full recovery of non-essential infrastructure and services may take several months.	▪ No effective mitigation measure other than evacuation. ▪ Asset stripping within impact area may minimise loss. Maintain hospital based services for treatment of burns, injuries and other medical emergencies
Base Surge		**3km – 5km**	**Immediate Risk High; Ongoing Risk Low; Anticipated loss Extreme**		**Nil**	**1 week to several months**	**None**
Crater, Cone or Ring Formation (while these are strictly eruption products, as they result in significant hazards they are included here for planning purposes)	Maars, tuff rings and tuff cones may be produced during an eruption. Maars: vertical-walled craters cut into pre-eruption country rock and surrounded by low rims. Tuff rings: constructional craters lying mostly on or above pre-eruption surface. Tuff cones: smaller cones and higher rims.	Crater of up to 1.5km^2 diameter produced with anticipated maar affecting an area of 0.35km^2 (a 300m to 500m radius). Formation of steep sided scoria cones of up to 1km across.	Destroy all infrastructure at the site of the vent and for a radial distance of 500m to 1.5km; Significant damage to, or partial burial of infrastructure adjacent to this zone; May dislocate communications networks, power transmission, water supply distribution, sewage transfer pipes, and transport routes.	Immediate loss of all life within the vent crater, cone or ring.	Earthquakes recorded by the Auckland Volcano-Seismic Network (AVSN) up to 1 to 2 weeks prior to eruption, shallowing and increasing in frequency resulting in felt ground shaking within a day to a few days of eruption; slightly elevated sea-water temperature up to a few days prior to eruption; Cracking of ground resulting in steaming fissures several hundred metres long. Commence at VAL 3 and continue through 4 and 5, Table 2.	▪ **Communications** Identify extent of area affected and establish bypass over period of days. ▪ **Transport** Excavate and clear obstructions. Re-route around affected area. May take a few to several days. ▪ **Energy** Full recovery up to several weeks depending on the extent of loss of services. ▪ **Water Supply** Essential services supplied within 1 week; Full recovery within minimum of 4 months still with temporary stations. ▪ **Wastewater** Major problem areas identified and essential sites repaired within 1 week; Full recovery with use of temporary pump stations and catchments re-routed around devastated region; up to 4 months.	▪ No effective mitigation options for near vent infrastructure. ▪ Pre-event, development of infrastructure 'redundancy' or network duplication. ▪ Evacuation ▪ Asset stripping within impact area may minimise loss. ▪ **Energy, Water Supply, Wastewater** Shut down supplies in area likely to be affected prior to eruption to reduce damage
Crater, Cone or Ring Formation		**0.3km – 1.5km**	**Immediate Risk Extreme; Ongoing Risk Low; Anticipated Loss Extreme**		**Hours to Days**	**Several months to years**	**None**

Hazard	Description	Area Affected	Infrastructure Risk	Risk to Life	Warning (from given VAL)	Recovery Post Cessation of Activity	Mitigation
Earthquake (Volcanic)	Ground shaking caused by movement of magma through the crust both before and during eruptions. (Earthquakes may also be generated by fault movement. Such earthquakes are tectonic earthquakes, not caused by volcanic processes.)	Volcanogenic earthquakes, uplift and deformation are expected to affect an area of $3km^2$ to $5km^2$.	Damage to structures located close to the eruption vent and those built on low strength soils or man-made ground. Very low risk of liquefaction; low risk of damage to non-ductile pipework located in moderate slopes; low risk of damage to older multi-level brick or masonry structures (prec.1975); low risk of damage to civil structures (e.g. concrete tanks and reservoirs, embankments, earth dams), particularly where founded on steeper slopes.	Low risk of injury or death due to falling debris or loss of support to infrastructure in damaging earthquake or deformation.	Earthquakes are common pre-cursors to eruptive phenomena and are expected to be felt for a period of days prior to commencement of an eruption. Establishes Scientific Alert Level 1 (VAL 1), Table 2.	As earthquakes are likely to focus beneath the site of eruption, eruption effects will quickly override earthquake effects. Recovery unlikely to be immediate priority.	▪ **Transport** Redirect traffic away from seismic centre; avoid unnecessary work on or in structures located on reclaimed land (eg Ports) ▪ **Energy** Shut down areas of gas supply still supplied via non-ductile pipes. Conduct checks of fuel storage tanks and associated pipework ▪ **Water Supply** Undertake regular checks for pipe leakage and integrity of connections; monitor dam embankment integrity; prepare for controlled release of water if ground shaking high in these areas ▪ **Wastewater** Undertake regular checks for pipe leakage, integrity of connections and concrete tank
Earthquake		**3km – 5km**	**Immediate Risk Low; Ongoing Risk Nil; Anticipated loss small**		**Days**	**Not Applicable**	**Minor**
Fire Fountaining	Eruption of hot magma which may rise hundreds of metres above an active vent. Lumps of cooled magma are deposited as ash, lapilli and bombs. Restricted to a vent or series of vents along a fissure. Preserved at 77% of AVF volcanoes.	Most significant effects expected within a 200m to 500m radius of the vent.	Impact and fire damage to structures located within the zone of fire fountaining activity; damage to structures above ground susceptible to damage by fire; potential for spread of fires via underground service networks	Loss of life within 500m of the vent; damage, injury or death to all life due to hot debris impact and burns	Dependent on the nature of the eruption and stage in the volcanic eruption sequence. Occurs within hours of commencement of volcanic activity, therefore little warning. Commences at VAL 3 and continues through 4 and 5, Table 2.	Recovery of essential services to bypass area affected by fire fountaining within one week; Reconstruction of infrastructure within the zone of fire fountaining may take several months to years following cessation of activity.	Evacuation of immediate area. Maintain hospital based services for treatment of burns, injuries and other medical emergencies. Few mitigation options available for near vent infrastructure. Shut down gas and electricity services in area; flush water pipes.
Fire Fountaining*		**0.2km – 0.5km**	**Immediate Risk High; Ongoing Risk Low; Anticipated loss Extreme**		**Hours**	**1 week to several months**	**Minor**
Gas	CO, CO_2 and HF may escape from vents and flowing lava. CO_2 may become concentrated in low-lying areas. Boiling of seawater due to flowing lava creates dense white clouds of HCl aerosols (laze) carried downwind at low elevation. Discharge of SO_2 gas adjacent to lava flows. SO_2 and laze generate acid rain. Steam hazard.	Asphyxiating gases CO, CO_2 and HF are likely to be localised around vent, and concentrated in low-lying areas. SO_2 gas likely to accompany lava flows. Concentrations decrease sharply with distance from the source. Acid rain may be experienced up to 10km downwind of the vent.	Corrosion problems downwind.	Breathing difficulties, asphyxiation, nausea, skin irritation; hinders recovery operations; burns; acid rain damage to vegetation.	Volcanic gas clouds expected within the first few hours of onset of volcanic activity. Steam may be generated where-ever hot material impacts on water, for the duration of these hazards. Develops at VAL 2/3, and continues throughout and post event, Table 2. Vents may continue to de-gas for a period of years.	Dispersal of gases from active vents and cooling lava following cessation of activity.	Evacuation of immediate area; Maintain hospital based services for treatment of breathing difficulties, injuries and other medical emergencies Regular washing of all exterior fittings and surfaces; Check items potentially impaired by gases; Avoid low-lying areas (including cellars and underground carparks etc) adjacent to the vent or lava flows;
Gas		**Up to 3km – 5km from vent**	**Immediate Risk High; Ongoing Risk and Anticipated loss Moderate**		**Less than an hour**	**Not applicable**	**Minor to Moderate**

Hazard	Description	Area Affected	Infrastructure Risk	Risk to Life	Warning (from given VAL)	Recovery Post Cessation of Activity	Mitigation
Lava	Streams of magma which flow by gravity into and along topographic lows; hot (1000°C or more); associated with 61% of AVF volcanoes. Generated by dry eruptions. May comprise: ■ Continuous and voluminous discharge of highly fluidised lava, often with gas-driven fire fountaining of scoria to hundreds of metres above the vent; or ■ Lava flows produced directly from primary or secondary vents; possibly associated with partial cone collapse or breaching.	Fire-fountaining of lava (at temperatures in excess of 1000°C) to 200 – 300m in height, falling back to the ground and flowing as lava for periods of 1 to several months. AVF lava flows have travelled distances of 0.5km to 9.5km related to lava volume, viscosity and topographic gradient. Damage limited to within a few kilometres of the erupting vent.	Burn, crush and bury everything in their path. ■ **Domestic and Commercial Structures** Loss of integrity of structures in path; generation of fires in buildings. ■ **Communications** Interruption of distribution where transmission lines destroyed by lava flows; damage to distribution centres impacted by lava flows. ■ **Transport** Blockage of shipping channels and loss of access to ports; obstruction of transport routes. ■ **Energy** Interruption of distribution where transmission lines destroyed; damage/destruction of power stations in flow path; risk of explosion and fires if lava impacts petroleum product storage facility. ■ **Water Supply** May explode on contact with water; heat from lava flows may pressurise water remaining in underground pipes, causing local explosions; may block or break existing reticulation and alter local topography causing local flooding. ■ **Wastewater** May explode on contact with water or organic gases. May block or break existing reticulation and alter local topography leading to local ponding of sewage.	Generation of fires. May explode when coming into contact with water or as a result of organic gases produced when hot lava over-runs vegetation. Move at speeds slow enough for people and animals to move out of their way. Lethal if caught in path of lava.	Generally occur later in the sequence of volcanic activity, following fire-fountaining. Because lava flows are strongly controlled by topography, the shape of the area destroyed by a flow can be easily predicted. Develops at VAL 3 to 4 and continues through VAL 5, Table 2.	■ **Transport** Redevelopment of ship passage if feasible (if severe, may require development of new port site); lava removal and road and rail re-construction or re-routing around affected section; depending on vent location, port or airport facilities may be destroyed – partial recovery within 6 months to 1 year. ■ **Energy** Full recovery up to several weeks depending on the extent of loss of services. ■ **Water Supply** Essential services supplied within 1 week; Full recovery within 4 months, but with temporary stations, and catchments re-routed around devastated region. ■ **Wastewater** Major problem areas identified and essential sites repaired within 1 week; Full recovery with temporary pump stations within 4 months.	Immediate evacuation within 3km of the expected vent and topographic lows. Possibly slow progress by cooling with water to increase viscosity (may have been effective in Heimaey[8]). Barriers may be able to be constructed (earth) or explosives used to divert /control flow (not found to be effective elsewhere). Issue warnings of potential lava path. Maintain hospital based services for treatment of major burns, injuries and other medical emergencies. ■ **Transport** Signage to direct traffic away from areas in path of flows ■ **Energy** Shut down gas supply in area likely to be affected prior to eruption ■ **Water Supply** Controlled release of ponded surface water
Lava*		**3km – 10km**	**Immediate Risk High; Ongoing Risk Low; Anticipated loss High**		**Hours to days**	**Several weeks to several months**	**Moderate**
Lava Bombs	Blocks and bombs (cobble to boulder sized material >60mm) follow ballistic trajectories from the vent and are released from the eruption column at 100 – 500m height. Includes both cooler country rock and hot lava.	Dispersal is influenced by projectile velocity and mass and possibly to a minor extent, by wind velocity. Most blocks and bombs deposited within 0.4km of the vent, but may spread up to 1 to 2km.	All infrastructure is at high risk of impact damage due to a direct hit, potentially also resulting in fire ignition.	Severe burns and threat to life	No warning. Generally occurs earlier in the eruption sequence and again later when the lava has degassed. May occur from VAL 3; continues through VAL 4 and 5, Table 2.	Refer to fire fountaining.	Evacuation. Maintain hospital based services for treatment of burns, injuries and other medical emergencies
Lava Bombs*		**0.4km – 0.5km**	**Immediate Risk Moderate; Ongoing Low; Anticipated loss Moderate**		**Nil**	**1 week to several months**	**Minor**
Lightning	Pulses within the eruption column generated as a result of electrically charged ash in a convecting eruption column.	Immediate area of eruption column and plume and up to 10km downwind of the vent. Frequent lightning pulses will occur within the eruption column and plume within hours of eruption onset.	■ **Communications** Ash can conduct electricity causing lightning strikes or inducing short circuits in radio and telephone communication systems ■ **Energy** Induces short circuits in electricity supply systems	May result in fire – damage/partial loss of vegetation; minor damage to residential areas; low risk of human injury or death.	Nil. May occur any time during eruption, VAL 3 - 5, Table 2.	■ **Communications and Energy** Recovery as per normal maintenance procedures.	■ **Communications** Installation of lightning conductors on towers.
Lightning		**3km – 100km**	**Immediate Risk Low; Ongoing Risk Low; Anticipated loss Low**		**Nil**	**Up to 1 to 2 days**	**None**

[8] For details of the method used for diverting and cooling lava flows refer to Williams, R.S., 1997. Cooling the lava. U.S. Geological Survey Open File Report 97-924.

Hazard	Description	Area Affected	Infrastructure Risk	Risk to Life	Warning (from given VAL)	Recovery Post Cessation of Activity	Mitigation
Shock Waves	Sound and pressure waves associated with energetic eruptions.	Propagates in all directions away from the vent, usually travelling ahead of a base surge.	Shatter windows, flatten weak structures, dislodge and scatter loose items	Flatten trees and people	Nil. May occur during initial larger explosions when volcanic activity commences. May occur from VAL3 to 5, Table 2.	Not applicable.	No effective mitigation measure. Maintain hospital-based services for treatment of major burns, injuries and other medical emergencies.
Shock Waves		**3km – 5km**	**Immediate Risk High; Ongoing Risk Low; Anticipated loss High**		**Nil**	**1 week to several months**	**None**
Tsunami	Long-period waves generated by: • updoming of the seafloor or coastal area, • fall-out of the eruption column into a body of water; • base surges and accompanying shock waves impacting water; • submarine explosions.	Tsunami run-up height will be dependent on the volume of seawater displaced, direction of displacement, area affected and duration of the disturbance. The majority of these processes are likely to generate relatively small tsunami run-up. Modelling suggests wave heights will be <2.5m and mostly <0.8m. Low-lying coastal areas within 1km of the disturbance may be affected; waves may be amplified in embayments or estuaries. Likely to affect Waitemata or Manukau Harbour, but not both.	Damage to low lying areas close to the coast (eg Auckland's ports and international airport); structures or land adjacent to and down gradient of affected reservoirs. Minor erosion, settlement and possible loss of support to structures due to high velocity currents and partial removal of founding materials; partial burial of coastal roads and piling up of sediment adjacent to coastal structures; abrasion of structures by transported sediment and objects; dispersion of contaminants encountered; minor inundation and flooding.	Low risk of injury to persons directly exposed to wave due to impact by transported material, or abrasion by entrained sediment; inundation by saline waters may affect plant life.	No warning; tsunami will only occur in response to a rapid displacement of water, ie source or products need to be in or enter the sea. May be initiated by activity at VAL 3, 4 or 5, Table 2.	▪ **Communications** Few sites are considered vulnerable; recovery within 2 days. ▪ **Transport** Airport, coastal roads, rail and port facilities recover full capacity within 1 day. ▪ **Energy** Full recovery to any damaged coastal structures within 1 day. ▪ **Water Supply** Few sites are considered vulnerable; recovery within 2 days. ▪ **Wastewater** Maintenance and repairs within 1 week; Operating capacity unlikely to be affected.	▪ **Transport** Design vessel mooring systems to withstand appropriate tsunami velocities; evacuation plans at key low-lying sites in the coastal area (eg Ports, Airports and coastal communities). ▪ **Energy** Location of environmentally sensitive operations (eg petroleum installations) away from the coast. ▪ **Communications, Water, Wastewater** Waterproofing of gas, water, sewage and phone cables in coastal areas prior to event.
Tsunami		**1km**	**Immediate Risk Low; Ongoing Risk Nil; Anticipated loss Low**		**Nil**	**Up to 1 to 2 days**	**Moderate**

* Risks which are likely to be repeated over a period of time (weeks or months) following the initial event

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Appendix 4: Auckland Volcanic Scientific Advisory Group – Terms of Reference

The Auckland Volcanic Scientific Advisory Group (AVSAG) consists of representatives from the Auckland CDEM Group, the Ministry of Civil Defence & Emergency Management (MCDEM), Crown Research Institutes, State-Owned Enterprises and Universities. This body will provide advice to the Group Controller of the Auckland CDEM Group and National Controller, of MCDEM (the 'Controller(s)') on scientific matters in the lead-up to and during an emergency involving a volcanic eruption located within the Auckland Volcanic Field (AVF), enabling the Controller(s) to meet their goals and objectives.

The AVSAG provides advice covering 3 general fields of expertise:

- Volcanic Monitoring and warnings/alerts
- Social Consequences
- Volcanology (event characterisation and progression, physical consequences)

1.0 Mandate

The AVSAG's advice will be provided to the Controller(s), and will contribute to the work of the Group Emergency Coordination Centre and National Crisis Management Centre in the lead-up and response to an eruption in the AVF.

2.0 Responsibilities

2.1 Crisis Response Role

The AVSAG will play a critical role in ensuring that the Controller(s) is provided with a high standard of reliable scientific advice to support the CDEM response to a volcanic eruption in the AVF and is kept informed of any new developments in relevant science and research. Members of the AVSAG will:

- bring relevant experience to the AVSAG;
- contribute to the provision of authoritative scientific advice;
- be expected to make a full and considered contribution to the work of the AVSAG and to contribute fully to the debate and to the decision making processes of the AVSAG;
- provide expert guidance within the AVSAG when an issue, which falls within their particular area of expertise, is under discussion;
- contribute to the debate in the capacity of a well-informed professional where the issue does not fall within their expertise;
- be prepared to provide, on occasion, expert advice on relevant issues outside Group meetings, as requested by the Auckland CDEM Group or MCDEM.
- be prepared to attend as required and contribute to the deliberations of the AVSAG;
- be prepared to attend and represent the AVSAG at meetings involving the public and media.

The AVSAG will properly assist in the development of flexible responses that cover (in an appropriate and feasible way) the whole range of anticipated risks related to a volcanic eruption in the AVF. The AVSAG may play a role in coordinating the research response to a volcanic eruption in the AVF.

2.2 Role during Non-Emergency Periods

- AVSAG members will be required to participate in meetings and to contribute to the development of procedures outlining how the AVSAG will operate during an AVF eruption.
- AVSAG members will be expected to participate in AVF-scenario exercises.
- AVSAG members will be responsible for keeping all sub-group members informed of activities, procedures and events.
- All sub-group members will be expected to ensure that their correct contact details are maintained on the Auckland CDEM Group Contact Database.
- AVSAG members may be required to contribute to planning for the coordinated research response to an AVF eruption.
- AVSAG members will adopt a coordinated response to research being produced that is relevant to activities, procedures and events involving the AVSAG.

3.0 Frequency of Meetings

Face-to-face meetings will be held at least on an annual basis, in conjunction with other Auckland centred events to minimise travel costs and inconvenience.

3.1 Attendance

All Members will need to attend the AVSAG meetings. A Member who is unable to attend may nominate a replacement, from their relevant sub groups, to participate in the meeting.

4.0 Decisions

All decisions presented to the Controller(s) during an emergency involving a volcanic eruption event located within the AVF must typically be an opinion or position agreed upon and accepted by the AVSAG as a whole. This must also be the case when disseminating information to the public via the media.

Ideally, debate and conflicting views will need to be resolved within the AVSAG in order to provide a consistent message to the public to ensure confidence in the process. The Chair shall ensure that the differing opinions held by the various members of the AVSAG are fully investigated and discussed. If these views cannot be resolved then this should be accurately portrayed in communications with the Controller(s).

The AVSAG should be open about the assessment of risk or where the scientific evidence is subject to uncertainty, and reports should make clear the inadequacy of available data especially where judgement calls are required. This is especially important when other groups in the wider community, with the benefit of hindsight, draw different conclusions based on the same data.

The CDEM Group Controller and National Controller are ultimately responsible for all decisions made during an emergency event. The AVSAG will provide the best advice possible to support these decisions.

5.0 Reimbursement of Expenses

5.1 Planning

It is expected that agencies involved in the AVSAG will carry reasonable costs for day-to-day involvement themselves. However, where activities require a significant time commitment (expenses or travel) over and above that which can be reasonably expected from annual meetings as set out in these terms of reference, and/or where expenses are incurred for which costs are not met by an individual's employment condition arrangements, reimbursement can be negotiated on a case by case basis.

5.2 Response

During an emergency event where agencies are committing significant time and resources, and where expenses are incurred for which costs are not met by an individual's employment condition, applications can be made to the Auckland CDEM Group (Group Controller) for reimbursement of costs. It is necessary for advice to be available without restrictions due to cost and these claims will be met.

6.0 Amendment to Terms of Reference

The Members may discuss the AVSAG's role, activities and resources, and review these for consistency with the formal Terms of Reference. Any necessary amendments should then be considered with the Auckland CDEM Group and MCDEM. This will ensure any new developments, not foreseen when the Terms of Reference were set out, have a chance to be included.

7.0 Term of Tenure

The membership of the AVSAG and the corresponding Sub-Groups will be reviewed every 12 months from the 1 October 2007. This will allow for current members to step down as well as accommodating the addition of new members.

8.0 Membership

The AVSAG operating response procedure is depicted in Figure 8.0.1. Monitoring capability is maintained by GNS Science through the GeoNet project. Therefore, GNS Science has the ability to co-ordinate unanimous advice to ACDEMG and MCDEM through the AVSAG. Information sharing and co-ordination with the wider expert community is important and membership from these agencies forms the wider expert community contingent. Members of AVSAG include, but are not limited to, relevant individuals from:

- GNS Science
- Auckland Council
- MCDEM
- Universities (Auckland, Canterbury, Massey, Victoria, Waikato)

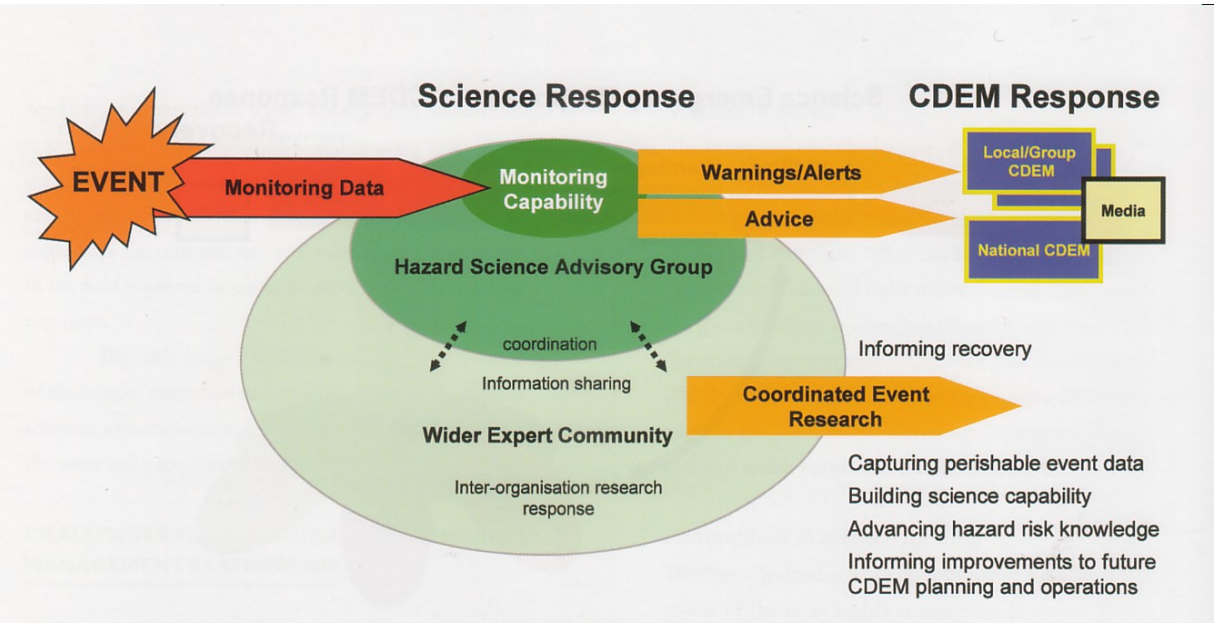

Figure 8.0.1: AVSAG operating response procedure.

Appendix 5: Health and Safety Information

For detailed information regarding health hazards of volcanic ash, refer to:

http://www.ivhhn.org/images/pamphlets/Health_Guidelines_English_WEB.pdf

Lindsay, J. M, Peace, C. 2005: AELF/7: Health and Safety in a Volcanic Ash Environment. Auckland Regional Council Technical Publication No 290

Health Effects

1. Respiratory effects *NB: People with chronic lung problems are at special risk.*

Fine ash particles and high exposure can cause:

- Nasal irritation;
- Throat irritation;
- Severe bronchitic symptoms (for people with pre-existing chest complaints);
- Airway irritation (for people with asthma or bronchitis); and
- Breathing discomfort.

2. **Eye symptoms** *NB: Contact lens wearers are at special risk*

Grit can scratch the eye causing:

- Eyes feel like they have foreign particles in them;
- Eyes become painful;
- Sticky and watery eyes;
- Corneal scratching; and
- Acute conjunctivitis.

3. Skin irritation

Acidic ash can cause:

- Irritation and reddening of skin;
- Secondary infections

Indirect Health Effects

1. Road

Traffic accidents resulting from:

- Reduced visibility;
- Ash covering road markings; and
- Ash making roads slippery.
- Thick ash may make roads impassable, cutting of access to basic supplies.

2. Power

Ash can cause power cuts and cause health problems due to:

- Lack of heating; and
- Disruption to infrastructure that requires power.
- Wet ash is conductive – safety required when operating electrical equipment.

3. Water Supply

Ash can cause:

- Contamination of water (especially open domestic water tanks);
- Lowered pH and inhibited chlorination; and
- Clogging of water supply equipment.
- Water shortages due to high demand for cleaning.

4. Sanitation

Ash can disable municipal sanitation systems leading to increased disease.

5. Roofs

Ash on roofs can cause:

- Roof collapse causing injury or death; and
- Death or injury falling from roof while clearing ash.

6. Animal health

Ash can be toxic to grazing animals.

Protection Measures

- Limit Driving
- Reduce ash in your house: **keep doors and windows closed.**
- Protection: **wear dust masks or cover face with damp cloth.**
- **Eye Protection:** wear goggles.
- **Drinking Water:** disconnect downpipes to water supply before ashfall, drink safe water.
- **Home-grown food:** wash with clean water.
- **Clean-Up:** lightly wet ash and remove with shovel.

Appendix 6: Possible Ash Disposal Sites

(Source: Potential Volcanic Ash Disposal Sites, GNS Science, Laurence Dolan, Carla Wilson, David Johnston, Client Report 2003/75, June 2003)

The following sites are potentially suitable for volcanic ash. These sites have been assessed as environmentally and physically safe, and culturally and economically acceptable to Auckland communities.

- Lloyd Elsemore Park (some areas)
- Greenmount Landfill
- Mountford Park
- Point England Reserve
- Rosedale Park
- Avondale Racecourse (central area)
- Rosedale Refuse Park
- Churchill Park (some areas)
- Barrys Point Reserve
- Moire Park
- Keith Hay Park
- Rosedale South Park
- Aorere Park
- Wainoni South Park
- Birkenhead War Memorial Park (some areas)
- Cornwall Park Sports Field

Further assessment of sites should be undertaken using the following site assessment.

Site Preparation Requirements

Site preparations may include:

- Formation of metalled access roads on site, suitable for heavy vehicles and machinery;
- Stripping back and stockpiling of topsoil for use as cover;
- Diversion of surface water upstream of the disposal site, particularly for gully sites. Tomos or pipes may develop in the ash if there is a stream above the ash and no drainage provided;
- Under-drainage, in some situations, to reduce the potential for saturation;
- Formation of a toe berm out of another, more stable and stronger, material with more predictable behaviour;
- Sediment control measures, in accordance with ARC Guidelines for Land Disturbing Activities in the Auckland Region, Erosion and Sediment Control, 1999

Site Operations

The following issues need to be considered:

- Access routes to minimise danger for trucks entering/exiting the site and other road users;
- Site layout and sequencing of disposal operations to minimise double handling of ash and cover materials;
- Vehicle movements to minimise the potential for trucks to get bogged and possible wheel wash facilities to reduce mud buildup on access routes
- Compaction of the material. Lifts of approximately 450mm (300mm when compacted) is recommended, to control settlement and make long term behaviour of the ash more predictable
- Use of water cart(s) to wet down ash to reduce dust nuisance;
- A maximum slope of 1V:3H is likely to ensure stability. Cover on slopes will be necessary to minimise erosion
- Ash should be covered with topsoil and grassed to reduce rainfall infiltration and erosion;
- Sediment control measures, in accordance with ARC Guidelines for Land Disturbing Activities in the Auckland Region, Erosion and Sediment Control, 1999.

Site Identification Criteria

If none of these sites are suitable then additional sites should be assessed against the criteria below. Refer to Potential Volcanic Ash Disposal Sites report for a full list of sites assessed in 2003.

Desirable features of disposal locations include:

- Close proximity to source
- Existing access to the main road for heavy vehicles
- Situated away from waterways (which could be affected by disposal activites)
- Availability of soil for cover (although other forms of ground cover, including planting of rye grass, ivy, or use of pre-grown lawn/turf for immediate coverage, may be options)
- End use of disposal site; and
- Resource consent requirements

The following criteria can be used for exclusion mapping:

- Public land
- 1:100 year flood plains;
- water supply catchments;
- sites of natural and cultural significance.

The following technical issues would also need to be considered, on a site specific basis, in planning for a disposal location and ash disposal operations:

- Formation of access roads
- Equipment requirements
- Stability of the ash material during and following deposition, including compaction requirements and maximum slope angles
- Potential dust nuisance (which could be mitigated by water sprays and prompt covering and grassing following completion); and
- Daily maintenance of equipment to reduce wear.