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**Waste management as a 'Lifeline'?
A New Zealand case study analysis**

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Keywords: Lifeline; critical infrastructure; disaster planning; waste management.

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Abstract (structured)

Purpose

Lifelines (also referred to as Critical Infrastructure) are referred to here as the essential infrastructure and services that support the life of our community. In a disaster response and recovery situation, provision of Lifelines, is essential. New Zealand has several mechanisms to improve the responses of lifeline service providers in a disaster situation, including pre-event planning and coordination groups and legislative provisions for timely response in an emergency. Currently waste management is not formally included in either the coordination process or the legislative provisions for Lifelines. This paper addresses whether or not waste management should be included in these.

Design / methodology / approach

Qualitative and semi-qualitative matrix based assessments were used to determine the relative importance of provision of waste management services in a disaster recovery situation.

Findings

The research argues that waste management should be included in Lifeline planning in New Zealand. Organisational complexity in the waste management system and the likely need to expand pre-disaster waste management services to deal with large amounts of disaster generated waste, however, mean that inclusion in the legislative provisions for Lifeline service providers would be challenging.

Research limitations / implications (if applicable)

The research context is specific to New Zealand, however, the general challenges, principles and overall approach and may be transferable to other jurisdictions.

Practical implications (if applicable)

Organisational and regulatory approaches recommended in this paper, if adopted, will help waste and emergency managers to respond and recover more effectively in a disaster situation.

Social implications (if applicable)

Originality / value

This research is the first to attempt to examine in detail the importance of waste management on disaster recovery in New Zealand. The findings of the research are of relevance to countries with similar organisational and legal structures.

1 Introduction

1.1 Lifelines

The New Zealand Ministry for Civil Defence and Emergency Management (MCDEM) website describes *lifeline services* as:

“the essential infrastructure and services that support the life of our community – utility services such as water, wastewater and stormwater, electricity, gas, telecommunications, and transportation networks including road, rail, airports and ports” (MCDEM, 2009).

For the purposes of this paper, this definition will be applied to the term *Lifelines*. Lifelines may also be referred to as ‘critical infrastructure’ (Gordon and Dion, 2008).

In emergencies, the provision of Lifelines, by both public and private organisations, becomes a critical priority. Internationally, (particularly given emerging focus on the threat of terrorist attacks (Rothery, 2005)) there is a growing awareness of the need for planning and coordination of Lifeline service providers for the protection and restoration of services during and after a major hazard event. Societal and economic reliance on increasingly inter-dependent infrastructure also means that planning and coordination is essential in order to reduce the impact of potential infrastructure disruption (Gordon and Dion, 2008).

1.2 Waste

The presence of solid waste in our environment has many potential public health, safety and environmental hazards associated with it. Left unmanaged waste can: become a breeding ground for disease carrying vectors (e.g. mosquitoes, vermin etc); contaminate waterways; create visual and odour problems; release toxic pollutants to the environment; introduce secondary hazards such as blocked waterways and fire hazards. Immediately following a disaster, waste and debris can block access ways and can hinder rescue efforts, welfare and Lifeline service provision. In addition to physical hazards, poor waste management can also consume vital resources after a disaster, diminishing the speed the recovery. Finally, poor waste management can provide a dispiriting visual impact, diminishing the morale of a stressed community striving for a return to normalcy.

1.3 Research aim

Currently waste management is not formally included in either the coordination process (Brunsdon et al., 2003) or the legislative provisions in New Zealand (the Resource Management Act and Civil Defence Management Act, refer Section 2.1.2). Similarly, it is unusual to read of Waste Management as part of the discussion of Lifelines or critical infrastructure internationally either in response to terrorist attacks, war, or natural disasters. However, as described above, ineffective disaster waste management can significantly impact the overall recovery process.

Therefore, the aim of this paper is to analyse whether waste management services should be integrated into the existing planning and legislative provisions for Lifelines in New Zealand.

2 Background

2.1 Lifeline coordination and legislation

2.1.1 International

Many developed countries have similar overarching strategies to Lifeline protection. A 2008 Organisation for Economic Co-operation and Development (OECD) report (Gordon and Dion, 2008), looked at the critical infrastructure approaches of several OECD countries (Australia, Canada, Germany/EU, Netherlands, United Kingdom and United States). The report found that many countries have plans for critical infrastructure protection. The plans aim to promote risk assessments of physical and non-physical infrastructure systems and to improve coordination between service providers.

From a reading of the OECD report, none of the countries covered explicitly include waste management in their critical infrastructure planning.

2.1.2 New Zealand

New Zealand has several mechanisms to improve Lifeline restoration in a disaster situation to facilitate timely response, including pre-event planning and coordination groups, and legislative provisions.

Regional Lifeline groups

Regional Lifeline groups in New Zealand were established in the early 1990s to promote planning, resource sharing and coordination within and between Lifeline service providers. The regional groups aim to identify and mitigate organisational, operational and physical vulnerabilities in regional Lifeline services both inter and intra-organisation (Brunsdon et al., 2003).

Legal provisions

New Zealand law includes provision for certain pre-defined Lifeline service providers (referred to as "*Lifeline Utilities*") to act quickly to restore critical infrastructure and services in an emergency. New Zealand's environmental

management law, the Resource Management Act (RMA) 1991, provides special emergency powers for recognised Lifeline service providers to act to restore any lost Lifelines without prior authorisation - even if activities necessary to restore the service are not strictly allowed under the RMA. The Civil Defence and Emergency Management (CDEM) Act 2002 stipulates certain obligations for Lifeline service providers to restore services in an emergency.

The RMA and CDEM Acts have slightly differing definitions of Lifeline service providers or “*Lifeline Utilities*” ^[1], but essentially they include:

- Distribution or transmission of fuel / energy
- Telecommunications and radiocommunications
- Electricity operation and distribution
- Supply and distribution of water
- Drainage or sewerage system and disposal
- Construction or operation of road or railway line
- Operation of an airport
- Operation of an air traffic control service

It is important to note that the regional Lifelines groups include Lifelines which are not legally identified as “*Lifeline Utilities*” under New Zealand Law. And also that regional Lifeline groups are strictly organisational structures and have no legal function.

2.2 Waste

2.2.1 Waste streams

In peace-time there are generally two main waste streams (Tchobanoglous et al., 1993):

- municipal solid waste (including residential, commercial, institutional, construction & demolition)
- industrial wastes (including agricultural, mining)

Following a disaster three additional waste streams may be generated:

- disaster-generated debris and waste (including construction and demolition debris, spoiled food, vegetation, vehicles, household hazardous wastes)
- emergency and relief service waste (e.g. food wrappers, plastic bottles, medical wastes)
- surplus donations

After a large scale event, waste managers must manage not only the peace-time municipal and industrial waste streams (probably slightly altered due to business disruptions and displaced persons), but the disaster waste as well. In many cases, such as the response to the 2009 Victorian Bushfires, Australia, (observed by the lead author), the municipal and disaster waste management systems will be run almost entirely independently. This is also the general approach adopted in the United States (EPA, 2008). For this reason and for

the purpose of this paper, the (altered) pre-disaster waste streams and the disaster waste streams will be considered separately – herein referred to as municipal waste and disaster waste respectively.

An additional waste stream is generated during reconstruction activities. However, this waste stream is not considered in this paper. In many cases (Victorian Bushfires 2009, Samoan tsunami 2010), this waste is managed using peace-time waste management systems after the majority of the disaster debris has been cleared and it generally does not impact the overall disaster recovery.

2.2.2 Impact of waste on Lifelines

Disaster waste management in itself is an under-represented area. Existing literature is limited to individual case study analyses, or disaster waste management assessments which observe waste management activities as separate to other disaster response and recovery activities. In particular, there is no literature on the impact of waste on Lifelines. The authors' understanding of the impact of waste on Lifelines is based on a general knowledge of the nature of disaster waste and likely infrastructure damage.

3 Methodology

As outlined in Section 1.3, waste management organisations are not routinely included in Lifeline groups and are not legally identified as Lifeline service providers in New Zealand. Therefore, the aim of this paper is to analyse whether provision of waste management services should be formally included as a Lifeline in a disaster context.

3.1 Scenario assessment

The basis of the methodology is a scenario assessment carried out by the paper authors. Hazard events are likely to have varying levels of infrastructure, damage, geographical challenges, debris volumes and types, numbers of people affected etc, depending on the context. Consequently, the nature of waste and the disruption of Lifelines (including inter-dependencies) will vary. A single disaster scenario assessment was selected to allow firstly, for a method of analysis to be presented and secondly, for a generalised understanding of the problem to be gained to enable some broader qualitative analysis to be made. The scenario selected is described in Section 3.1.1.

As discussed in Section 2.2, this assessment is based on the authors' understanding of disaster waste and the likely impact on infrastructure in the given scenario. The chair of the National Engineering Lifelines Committee in New Zealand reviewed the analysis and confirmed the researcher's approach was appropriate (D. Brunson, 2010, pers comms).

A potential extension to the research would be to present the desired scenario to a number of waste, emergency and Lifeline managers for their assessments. However, due to the hypothetical nature of the scenario and the absence of

exposure to disasters of most of these personnel in New Zealand, the scenario would have to be carefully framed.

3.1.1 Wellington Earthquake

For the purposes of this analysis a large-scale earthquake scenario in Wellington, New Zealand, has been selected. This magnitude 7.5 on the Richter Scale earthquake, with a return period of 700 years is a likely and very challenging situation for New Zealand. Wellington is a compact urban city situated in a relatively isolated and steep basin at the bottom of the north island of New Zealand. Access to the city is via the harbour or a single road leading to the north. Because of the geographic setting, there are high dependencies between Lifelines. The steep topography and narrow roads will mean that disaster debris is likely to infringe on roads and service corridors. As the capital of New Zealand an inefficient or poorly planned disaster response and recovery could have significant national consequences. The earthquake scenario includes: moderate levels of displacement (1 in 8, roughly 50,000 people, displaced); large amounts of debris (2.2 million cubic metres) (WRCDEMG, 2008); major landslides; and high road network and Lifeline disruption (Johnston et al., 2009).

3.2 Analysis steps

Three steps have been taken as part of this assessment:

1. A qualitative and quantitative assessment of the impact of waste service provision or non-provision in disaster response and recovery (Section 3.2.1 and 4.1).
2. An assessment of the impact of waste management on other Lifelines (Section 3.2.2 and 4.2).
3. An assessment of the organisational and legislative considerations in formally including waste management as a Lifeline (Section 3.2.3 and 4.3).

3.2.1 Step 1 – Waste impact on response and recovery

Firstly, emergency waste management was explored using a qualitative approach. New Zealand MCDEM states five emergency response priorities and five main (not prioritised) recovery tasks (MCDEM, 2005). Based on literature review and the authors' assessment, likely impacts of non-provision of both municipal and disaster waste services on each of these activities were listed.

Secondly, a quantitative assessment was made. A semi-quantitative matrix assessment was employed for this. Against each MCDEM response and recovery activity listed above, a selection of 12 currently identified Lifelines plus municipal and disaster waste, were each given an importance rating. 5=High importance (i.e. the recovery activity would be impossible without that particular Lifeline service) to 0=No importance (i.e. the recovery activity could occur without that particular Lifeline service). Each MCDEM activity was also given an importance weighting relative to the overall response or recovery – so that the overall Lifeline importance could be compared. The

weighting for response activities was based on the prioritised MCDEM list assuming a decrease in importance down the list. For the recovery activities it was assumed that all components were of equal weighting or importance to the overall effectiveness of the recovery. The aggregated scores are the weighted total.

Any activity scoring above 4, was considered high importance or priority, 3-4 average importance and below 2 low importance.

3.2.2 Step 2 – Lifeline dependency

A semi-quantitative matrix approach was used for this assessment also. The matrix was adapted from a number of regional interdependency analyses (Auckland Regional Council, 1999, Hawke's Bay Engineering Lifelines Project, 2001, Centre for Advanced Engineering, 1991). This approach has been used by Lifelines groups in New Zealand since 1991 to systematically assess the inter-relationships and dependencies between utility providers (Brunsdon et al., 2003). The matrix is a tool to assess and demonstrate the dependency of each Lifeline (along the top row of the matrix) on the other Lifelines (along the rows of the matrix).

A similar ranking process to the previous analysis was used. For each Lifeline along the top row of the table, a dependency rating on the other Lifelines was qualitatively assessed based on the Wellington earthquake scenario. The ranking refers to the ability of a certain Lifeline to function without the functioning of a given Lifeline. As for the previous assessment 5=high dependency on a given Lifeline (i.e. air traffic cannot function without fuel supply so it was given a 5 for high dependency) and 0=no dependency (i.e. the Lifeline service provider can provide their service without the other Lifeline functioning). The scores for each Lifeline were totalled vertically and horizontally to indicate lifeline dependency and importance respectively. This type of assessment is useful in determining the prioritisation of resources – priority given to Lifelines with higher importance than other Lifelines. Lifelines with high dependencies are very vulnerable in a disaster situation.

3.2.3 Step 3 – Legislative and organisational considerations

The legislative and organisational assessment was based on a literature review and observed data on Lifelines, disasters and waste management.

4 Analysis

4.1 Waste Impact on Response and Recovery

4.1.1 Qualitative assessment

Table 4.1 lists the MCDEM activities and the potential impact of non-provision of municipal and disaster waste management services. From this qualitative analysis it is clear that waste has a direct impact on the key response and recovery tasks. However, to determine its relative importance it needs to be measured against other key Lifelines in a particular example (see Section 4.2).

Table 4.1 Municipal and disaster waste impact on disaster response and recovery (if poorly managed)

	Municipal Waste	Disaster Waste
Response		
Preserve life	Poses a public health risk.	Blocks access.
Maintain law and order		Blocks police and armed forces access. Contributes to perception of chaos.
Care of sick, injured and welfare provision	Potentially contaminates water supply. Poses a public health risk.	Blocks access of essential services.
Property protection		Blocks access. Generates secondary hazards such as fire and flood (due to blocked waterways).
Re-establish essential services	Potentially contaminates water supply.	Blocks access to roads and service corridors. Potentially contaminates water supply.
Recovery		
Community	Contributes to a sense of abnormality through the absence of peace-time service.	Reminds of disaster.
Social Environment	Poses a public health risk.	Poses a public health and safety hazard.
Built Environment		Delays reconstruction activities.
Economic Environment	Poses a public health risk affecting workforce.	Disrupts business activities (access, health and safety concerns etc). Delays reconstruction activities and return to economic normalcy. Potential future cost of environmental remediation.
Natural Environment	Causes illegal dumping. Contaminates land and/or water. Minimises resource recovery through mixing with 'clean' debris [2].	Poses a risk of hazardous material spills. Poses a risk of long-term environmental effects from inappropriate treatment /disposal of waste.

4.1.2 Quantitative

Table 4.2 shows the relative importance of 14 Lifeline services to the MCDEM response and recovery activities.

During the response activities (up to 1 week) the highest priority activities are roading and telecommunications. Disaster waste is of average importance and municipal waste management in the response phase is very low priority, alongside rail and sea transport.

In the recovery phase (after 1 week) the relative priorities change. Roothing still remains the highest priority, while municipal waste and disaster waste (due to the potential for public health risk and social disruption if left unmanaged) are seventh equal (out of fourteen Lifelines) priorities. Rail and sea transport and gas provision are the lowest priorities in this analysis.

Despite the relatively simple nature of this assessment, it is clear that both municipal and disaster waste management rank alongside and in some cases above other currently designated Lifelines in their importance to response and recovery activities.

Table 4.2 Lifeline importance for main response and recovery activities after a major urban earthquake in Wellington, New Zealand (5 = high importance, 0 = no importance)

	Weighting	Roading	Rail Transport	Sea Transport	Air Transport	Water Supply	Sanitary Drainage	Stormwater Drainage	Electricity	Gas	Fuel Supply	Broadcasting	Telecommunications	Municipal Waste	Disaster Waste
Response (1st week)															
Preserve life	0.3	5	3	3	4	5	3	4	4	3	5	5	5	1	4
Maintain law and order	0.25	5	2	2	4	5	4	3	5	3	4	5	5	3	4
Care of sick, injured and welfare provision	0.2	5	2	3	5	5	4	2	5	4	5	4	4	3	3
Property protection	0.15	5	1	2	2	3	4	4	4	3	3	3	4	1	2
Re-establish essential services	0.1	5	2	3	4	3	3	3	3	3	5	4	5	1	3
Total Importance - response		5	2.15	2.6	3.9	4.5	3.6	3.25	4.35	3.2	4.45	4.4	4.65	1.9	3.4
Recovery (1 week onwards)															
Community	0.2	5	3	2	3	5	5	3	4	2	5	5	5	5	4
Social Environment	0.2	5	2	3	4	5	5	4	4	3	4	5	5	5	4
Built Environment	0.2	5	3	3	3	4	4	4	5	4	5	4	4	3	5
Economic Environment	0.2	5	4	5	5	5	5	4	5	4	5	4	4	3	3
Natural Environment	0.2	4	2	2	2	3	5	5	1	1	2	3	3	4	4
Total Importance - recovery		4.8	2.8	3	3.4	4.4	4.8	4	3.8	2.8	4.2	4.2	4.2	4	4

4.2 Lifeline dependency

Provision or non-provision of one Lifeline service can directly impact provision of other Lifelines – this is referred to as Lifeline dependency. Table 4.3 below shows the relative importance and dependency values assigned to each Lifeline pair.

The results of this analysis are consistent with an Auckland Engineering Lifelines Report which surveyed Lifeline services in Auckland, New Zealand, on which services they most relied on. The results showed road transportation, mains electricity, mobile telephone communications, VHF radio and backup electricity are the most important (AELG, 2005). This similarity indicates that there is likely to be some level of consistency in Lifeline dependency across different contexts.

In terms of waste, the table shows that disaster waste management is moderately important to provision of other Lifelines (7/14 in this analysis). This is primarily as a result of the potential for disaster waste to block access to Lifeline infrastructure and the potential for unmanaged waste to disrupt other Lifelines, such as blocking of sanitary sewers and obstruction of stormwater drains and overland flowpaths.

Disaster waste is very dependent on other Lifelines. In particular: roading, fuel, and telecommunications (for collection and transportation equipment and general logistics). Water supply, sanitary and stormwater drainage are also important to disaster waste management (for management of hazardous goods, treatment of recycled goods and management of disposal sites).

Municipal waste collection, however, shows a very low importance and low dependency on other Lifelines.

Table 4.3 Interdependency Analysis: 1 Week to 1 Month after a major urban earthquake in New Zealand (5= high importance, 0= no importance)

Assessing the dependency of these Lifelines															
On these Lifelines	Roading	Rail Transport	Sea Transport	Air Transport	Water Supply	Sanitary Drainage	Stormwater Drainage	Electricity	Gas	Fuel Supply	Broadcasting	Telecommunications	Municipal Waste	Disaster Waste	Total Importance
Roading		5	5	5	5	5	5	5	5	5	5	5	5	5	65
Rail Transport	4		4	4	1	1	1	4	3	4	4	4	1	2	37
Sea Transport	3	4		2	2	2	2	4	3	5	3	3	1	3	37
Air Transport	3	3	3		3	3	3	4	2	3	3	3	1	1	35
Water Supply	4	4	3	5		5	4	4	3	4	4	4	2	5	51
Sanitary Drainage	3	3	2	3	3		4	1	2	4	3	3	3	3	37
Stormwater Drainage	2	2	2	3	3	4		3	3	4	3	3	3	3	38
Electricity	5	5	4	5	3	3	3		4	5	5	5	3	4	54
Gas	5	5	3	4	3	3	3	2		4	4	4	2	2	44
Fuel Supply	5	5	5	5	1	1	1	5	4		4	4	5	5	50
Broadcasting	2	2	2	5	1	1	1	3	4	4		4	2	4	35
Telecommunications	5	5	5	5	4	4	4	5	5	5	4		3	4	58
Municipal Waste	2	2	1	1	4	4	4	1	1	1	1	1		3	26
Disaster Waste	4	4	3	2	3	4	3	3	3	4	2	3	4		42
Total Dependency	47	49	42	49	36	40	38	44	42	52	45	46	35	44	

4.3 Legislative and organisational considerations

4.3.1 Resource prioritisation

Following a large-scale disaster, resources are likely to be at a premium. During both the response and the recovery periods, private and public entities will be competing for limited plant, equipment and personnel. Prioritisation of these resource demands needs to be approached in a collaborative way.

The regional lifeline groups established in New Zealand are an effective way to plan for disasters. The groups help utility operators to prioritise their resourcing needs to effectively meet the community's needs. Given the moderate dependency of other lifeline services on disaster waste management shown in Section 4.2, the advantage of including the waste management sector as a whole in this coordination and collaboration process is clear.

4.3.2 Legislative authority

As stated above, the CDEM Act requires *Lifeline Utilities* to ensure their facilities and services are able to function to the fullest possible extent^[3]. Currently, aside from any commercial agreements, solid waste management entities are not legally required to operate and maintain their service after a disaster event. Given that the provision of solid waste management facilities and services, as shown in Section 4.1, is very important in both the recovery and response periods, legal obligations to restore functioning would seem appropriate.

The RMA provides powers to *Lifeline Utilities* to act as necessary without prior consent to mitigate adverse effects of an emergency^[4]. If the waste management facilities were identified as *Lifeline Utilities*^[5] prior to the event they would automatically have authority to undertake any repairs necessary to 'mitigate any actual or likely effect of, the emergency'^[6].

Following Hurricane Katrina, both the Louisiana and Mississippi Departments of Environmental Quality used their powers under emergency declarations to authorise waste management facilities to make all necessary repairs to their facilities without prior notification to the environmental department (LDEQ, 2005) (MDEQ, 2005). If waste management entities were established as *Lifeline Utilities* under the CDEM Act and the RMA prior to a disaster event, entities would be under obligation to repair facilities quickly. In addition any delay in waiting for consent to make repairs under the RMA would be removed.

4.3.3 Organisational complexity

Waste management systems, from collection to disposal, may be operated by a number of separate entities. Potentially several entities may be involved in each of the four waste system aspects:

- Kerbside collection (including bin / bag provision)
- Recycling / Composting facility and/or exporter
- Treatment facility (e.g. incineration, hazardous material treatment)
- Final disposal (e.g. landfill, land reclamation)

From a legislative point of view, unless entire waste management systems are vertically integrated under one organisation it is likely that each of these aspects / entities would need to be considered as separate *Lifeline Utilities*.

Following a disaster the waste management systems need to be expanded significantly (refer Section 4.3.4) and the waste management strategy may also include demolition activities (as observed by the author following the 2009 Victorian Bushfires in Australia). This may further complicate the organisational structure and/or increase the number of organisations involved and make the roles and responsibility of disaster waste management as a potential *Lifeline Utility* less clear.

4.3.4 Problem of scale

Following a disaster, as discussed in Section 2.2.1, waste and emergency managers must deal with both municipal and disaster waste. Depending on the scale and nature of the disaster, peace-time municipal waste entities will be called on, to varying degrees, to assist in the disaster waste management. There may be some aspects of the peace-time system used to handle disaster waste (such as disposal and treatment facilities), but it is likely a different system will be used to collect, handle and dispose of the disaster waste, potentially including provision of new treatment and disposal facilities.

For most *Lifeline Utilities* their task is clear-cut – to return their services to pre-disaster levels (or at least to meet the short and then longer term needs of the community). Operators will generally have in-house crews or pre-established contractors that will be able to restore Lifeline service function within a few months. However, to handle the high volumes of waste generated in a disaster, an augmented and/or different waste management system would be required with additional facilities, equipment and personnel over a long period of time. In particular there may be a need to utilise organisations not involved in peace-time waste management.

The question is then, if waste management was to be included as a *Lifeline Utility*, would the legal provisions apply to only pre-disaster waste management operators or would additional service providers, brought in to deal solely with disaster waste be granted the special emergency powers described in Section 2.1.2.

According to an Auckland Engineering Lifelines Group survey of utility operators (AELG, 2005), in general, it is in the commercial interest of utility services, as well as their legal responsibility, to act quickly and meet community expectations. Short-term or new waste facility operators, introduced to deal with disaster waste only may not feel the same level of commercial accountability to ensure long term customer satisfaction therefore, legal obligations would be needed to ensure adequate service

provision. For contractors this could be done through contract terms, however, for any new entity established to manage disaster waste, legal requirements may need to be considered. In addition, because the RMA provides flexibility to *Lifeline Utilities* to act outside the peace-time requirements of the RMA to mitigate effects of emergencies, if waste management were a *Lifeline Utility* then there would also be a potential for short term operators to use this legal flexibility for short term gain if legal boundaries for acceptable actions are not established (refer below).

4.3.5 Legal boundaries

Establishing what the law provides is extremely important. The New Zealand definition of the actions that can be taken by *Lifeline Utilities* under its RMA may need refining to clarify whether the actions to be taken are just to return to pre-disaster functioning or whether actions should be taken to manage the additional waste. ‘Mitigate any actual or likely adverse effect of, the emergency’^[7] could be interpreted to mean that *Lifeline Utilities* were entitled to not just make repairs to existing systems but to also move to augment existing facilities to handle the additional waste (as provision of waste management services would be their responsibility if they were a *Lifeline Utility*). Should ‘actions’ include expanding an existing facility to accept additional waste? Or perhaps altering incineration standards to process more waste? Or is it just to return the service to its pre-disaster functioning?

Under New Zealand’s CDEM Act, *Lifeline Utilities* must ensure they are able to “function to the fullest possible extent”. The extent of allowable / required actions under both these pieces of legislation would need to be clarified for disaster waste management.

4.3.6 System cohesion

In a complex system like waste management with multiple organisations (often augmented in a disaster situation, refer Section 4.3.4), if each entity is given latitude to act independently, there is potential for lack of coordination and strategic decision-making for overall management of disaster waste. Most utility services or networks are largely run by one organisation or in a commercial partnership with a common goal. Disaster waste management requires strategic decision-making specific to that event, and overall waste management goals and strategies need to be determined. Individual entities in the waste management system are likely to have differing and potentially conflicting goals (eg a landfill operator wants to accept as much waste as possible, a recycling operator wants to recycle as much as possible). The waste system needs overall coordination, and latitude for individual entities within the system needs to be bounded.

5 Conclusion & Recommendations

Waste management clearly meets the definition of a Lifeline as “a utility service which supports life”. Without appropriate waste management

facilities and services, in peace-time or in a disaster situation, communities would be vulnerable to public health and safety hazards and environmental pollution.

As shown in the Wellington Lifeline dependency analysis, disaster waste management can be expected to be important to the provision of many Lifelines. Great benefit would be gained from including waste management activities in Lifeline planning and coordination to facilitate more effective resource planning and prioritisation.

Due to the complexity of the waste management system, unless the individual components are vertically integrated to include all aspects of waste management from collection to recycling and disposal, the waste management system would need to be separated into disposal, treatment, recycling and collection to effectively be operated as Lifelines. In New Zealand that would imply a need to be legally identified as *Lifeline Utilities* under New Zealand law.

While most Lifelines will need to provide their pre-disaster service only, waste management entities would potentially be required to provide augmented services to deal with the disaster-generated waste. To account for this, waste activities need to be separated into municipal (or pre-disaster) and disaster (or post-disaster) services. Provision of municipal waste services may remain largely unchanged, however, certain new aspects of the waste management system, such as disposal and treatment facilities, are likely to be required to handle disaster waste as well.

In addition disaster waste management will often involve entities which are not part of the municipal system. It is questionable (for commercial and accountability reasons) whether these additional, potentially short-term operations / operators should be given extensive new powers after a disaster. Given these factors and the need for overall strategic and cohesive management of disaster waste (Brown and Milke, 2009), it would seem beneficial to limit the autonomy of waste entities to restoring pre-event services or until a clear and coordinated approach to management of the disaster generated waste can be established.

Within New Zealand's particular social and legal setting it is recommended that the following actions are taken to include waste management as a Lifeline in terms of planning and coordination and/or a legally recognised *Lifeline Utility*:

- Waste management should be included in regional Lifeline coordination, prioritisation and planning.
- Municipal (pre-disaster) waste management entities should be included as *Lifeline Utilities*.
- Under the RMA provisions for *Lifeline Utilities*, actions should be limited to restoration of pre-disaster functioning.
- Waste management entities and facilities established specifically for disaster recovery should not be operated as *Lifeline Utilities*.

- Expansion of existing services and/or facilities should be carried out under a strategic disaster waste management plan and should be authorised / directed under the designated RMA authority, not the waste entity itself.

In broader terms, the case study analysis of Wellington and New Zealand provided here suggests the following recommendations for other settings:

- Legal provisions to facilitate the functioning of pre-disaster waste management systems following a disaster, both in terms of legal obligation to operate and provision to make repairs without consent, are critical to an expeditious disaster waste response.
- Legal frameworks and Lifeline coordination groups need to ensure that any organisations and waste management systems that are not used in peace-time waste collection are accounted for.
- Emergency legal provisions need to be bounded to ensure that operators do not act unlawfully or cause unnecessary environmental damage either for commercial gain or by mismanagement.
- Disaster waste needs to be managed strategically across the disaster affected area. The autonomy given to individual entities needs to be bounded to ensure all entities are focussed on a common goal.

6 References

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[1] RMA s167 (a)-(h) and CDEM Act Schedule 1 Part B

[2] Clean debris refers to material that may be separated for recycling or reuse. If mixed with municipal waste then recycling and reuse of debris becomes more labour intensive and time consuming.

[3] CDEM Act s60(a)

[4] RMA s330(1)(c)

[5] Referred to as network utility in the RMA s167

[6] RMA s330(1)

[7] RMA s330(1)