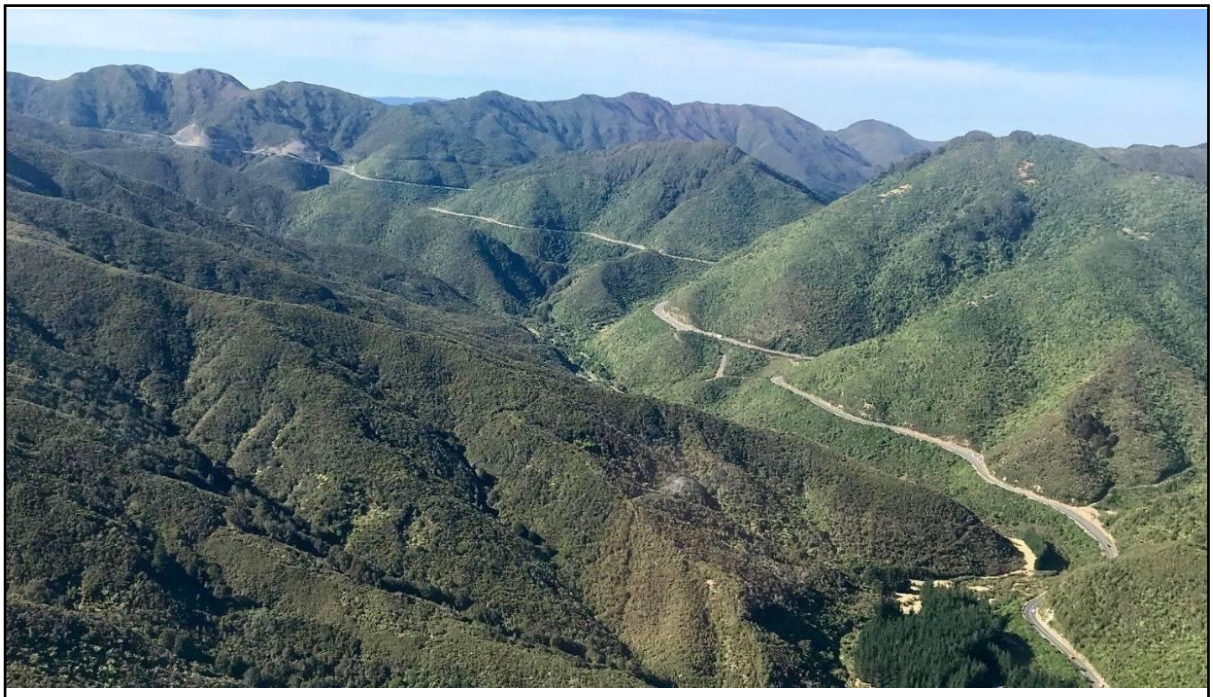

Diesel availability following a major earthquake in Wairarapa

Stakeholder report



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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

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Executive summary

Diesel fuel availability is critical for emergency response after a major earthquake. Diesel keeps backup generators running, emergency service vehicles moving, lifeline utility restoration operations progressing, and essential supplies reaching communities. In areas vulnerable to road isolation, such as Wairarapa, diesel shortages can become severe when road-based fuel resupply is disrupted and local stocks are insufficient to meet critical service demand.

This report considers a three-month post-earthquake road isolation scenario and evaluates whether diesel held in Wairarapa fuel stations would be sufficient to support identified critical customers. The customers include emergency services, lifeline utilities, healthcare providers, and essential supply providers (including food deliveries). The results show that the estimated available diesel is insufficient to meet the demand of all identified critical customers, resulting in substantial shortages during the isolation period. Modelling suggests that allocating diesel to all customers week by week without prioritisation would exhaust the region's available diesel stocks during Week 3. Although prioritisation could help by supporting power grid restoration and extending coverage for higher-priority customers, significant shortages would remain.

The report also assesses three mitigation strategies for reducing diesel shortage risk: holding emergency stock at selected fuel stations, prepositioning dedicated diesel tanks, and airlifting diesel through Hood Aerodrome. Each strategy is analysed based on the level of service it provides to critical customers, measured as days of coverage, and its associated cost.

The analysis demonstrates that emergency stockholding under a prioritisation scheme can provide full coverage for emergency services and the hospital, although shortages remain for other customer groups. Without prioritisation, however, allocating the available diesel week by week would exhaust stocks during Week 4, even if all fuel stations held the assumed emergency stock. Prepositioning provides a more effective preparedness option, with full coverage of all identified customers possible by installing six tanks across the region, at an estimated annual cost of NZD 256,500. Airlifting diesel can also close the gap during response, but full coverage would require 39 flights over the isolation period, at an estimated one-off cost of NZD 2,730,000.

This study focuses on fuel-related mitigation strategies. Road network improvements could also reduce the duration of regional isolation and enable faster diesel resupply. However, these measures are beyond the scope of this study and require further investigation and comparison with the assessed strategies.

The key message of this study is that Wairarapa cannot rely on fuel station diesel stocks alone during a prolonged isolation scenario. Existing diesel stocks would not be enough to meet the needs of all critical customers. However, the mitigation strategies assessed in this study show that meaningful improvements are possible at different levels of service and cost. The findings provide a starting point for future discussions on how to strengthen diesel resilience in Wairarapa after a major earthquake.

1. Introduction

1.1. Background

Diesel is a critical resource for emergency response. It supports backup generation, restoration equipment, and vehicle operations. Any shortage post-event could cascade across critical services, including emergency services, healthcare, lifeline utilities, and the provision of essential supplies. Wairarapa is especially vulnerable to diesel shortages after a major earthquake because it relies heavily on road-based fuel resupply. If the region is isolated for an extended period, local fuel stocks will not be replenished while demand will rise across critical services.

This report evaluates whether diesel held in Wairarapa fuel stations would be sufficient to support identified critical customers under a three-month post-earthquake isolation scenario. It also assesses mitigation strategies that could reduce diesel shortage risk, including emergency stockholding at fuel stations, prepositioned diesel tanks at high-turnover sites, and diesel airlift through Hood Aerodrome.

1.2. Regional context

Wairarapa's main settlements and transport routes are concentrated along the valley floor between the Remutaka and Tararua ranges to the west and the Maungaraki Range to the east, with the eastern hill country extending beyond it towards the Pacific coast. State Highway 2 links the main towns, including Featherston, Greytown, Carterton and Masterton, while State Highway 53 connects Martinborough to this network through Featherston.

Wairarapa's supply network is largely road-based, with State Highway 2 providing the main connection to Wellington via Remutaka Hill Road and to Tararua District in the north. The region's active faults create a significant risk of road failure, including landslides, liquefaction, bridge damage, and dropouts (Clarke & Barnhill, 2022). Such impacts could cause regional isolation, disrupt freight movement, and affect the supply of diesel.

Wairarapa has no bulk diesel storage facility, such as a fuel terminal, and depends on road tanker deliveries from outside the region for diesel supply. During an emergency, the Local Controller may require fuel companies to prioritise critical fuel customers. Without mitigation interventions, the region would mainly rely on diesel held in fuel station tanks during prolonged post-earthquake isolation.

1.3. Scenario assessed

The scenario assessed in this report involves Wairarapa being isolated by road following a major earthquake. Informed by several available studies and reports, including Clarke and Barnhill (2022), Khadka et al. (2026), Staples (n.d.) and Wairarapa Engineering Lifelines Association (2003), this isolation is assumed to result from the closure of Remutaka Hill Road (Figure 1), the failure of the Ruamāhanga Bridge at Mt Bruce on State Highway 2 (Figure 2), and the unavailability of alternative routes to the wider national road network. Rail is also excluded as a resupply option because parts of the network may experience prolonged closure following a major earthquake (Brabhaharan, 2021).



Figure 1: Remutaka Hill Road



Figure 2: Ruamāhanga Bridge at Mt Bruce, under-bridge view

Road access is assumed to remain unavailable for three months (Khadka et al., 2026) until a Bailey bridge is installed at the Ruamāhanga Bridge site (Staples, n.d.). As a result, diesel cannot be bulk resupplied to the region by road during the isolation period. For modelling purposes, road access across the valley floor is assumed to remain available, although localised constraints may occur in some locations. This assumption is supported by the results of Khadka et al. (2026), the NZ Transport Agency State Highway Resilience map (Figure 3) (NZ Transport Agency Waka Kotahi, 2026), Wairarapa Engineering Lifelines Association (2003), and Clarke and Barnhill (2022).

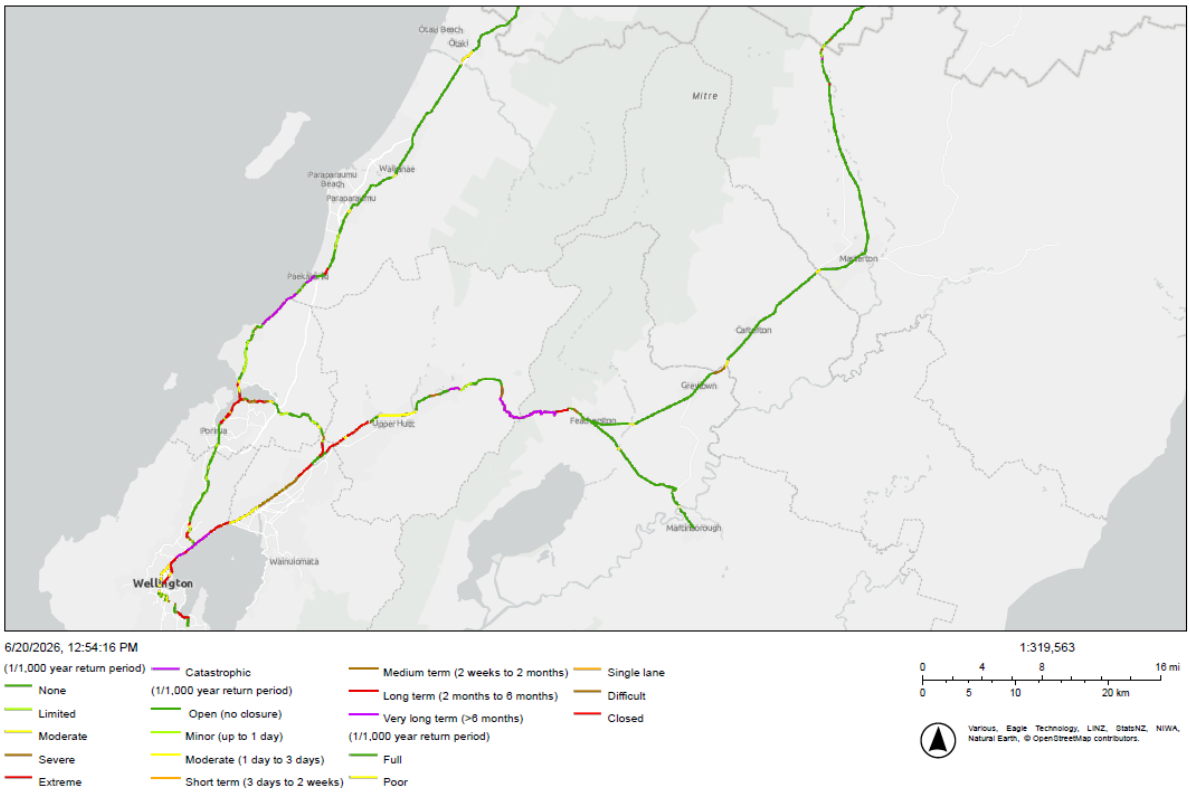

Figure 3: State highway resilience: earthquake (NZ Transport Agency Waka Kotahi, 2026)

A widespread electricity outage is assumed for the first four weeks after the earthquake. This duration is a best-guess assumption, informed by practitioner judgement and benchmarked against nearby Wellington region lifeline restoration planning, where power restoration after a major earthquake may take several weeks (Mowll, 2012). During this period, critical services rely heavily on diesel for backup generation until the grid supply is restored.

1.4. Report overview

The structure and flow of the sections are shown in Figure 4.

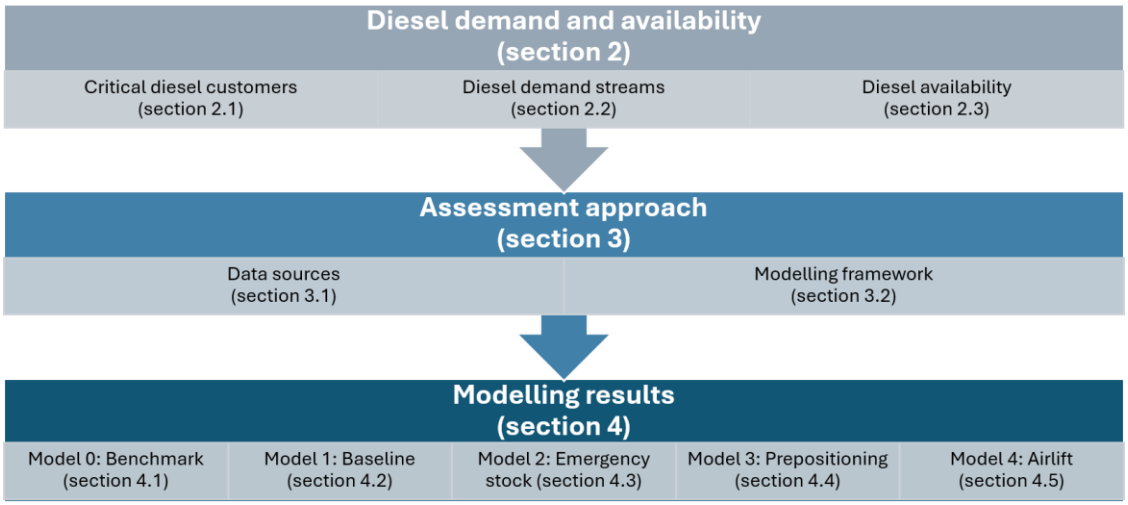

Figure 4: Report structure and section flow

2. Diesel demand and availability

2.1. Identified critical diesel customers

Critical customers in the region were identified through consultation with the local emergency management team and classified using the National Fuel Plan framework, with alignment to the Wellington CDEM Group Fuel Plan. The identified customers fall into four categories:

- **Emergency services:** Police, Fire and Emergency New Zealand, ambulance services (including Wellington Free Ambulance and Hato Hone St John), and Civil Defence Emergency Management.
- **Lifeline utilities:** power, water, telecommunications, road networks, service teams, and restoration operations.
- **Healthcare:** hospitals, medical centres, rest homes, and pharmacies.
- **Essential supplies:** supermarkets, stock feed providers, and fast-moving consumer goods (FMCG) transport operations.

For diesel allocation, the identified customers were classified into three priority groups:

- **Priority group 1:** emergency services and hospitals.
- **Priority group 2:** lifeline utilities and healthcare providers, excluding hospitals.
- **Priority group 3:** essential supplies (including food deliveries).

2.2. Diesel demand streams

- **Backup generation:** Diesel is required to keep backup generators operating until grid power is restored. This includes generators used by critical customers and by fuel stations that continue distributing diesel during the power outage.
- **Lifeline utility restoration equipment:** Diesel is required for equipment used to repair and restore lifeline utilities after the earthquake. Restoration durations vary by utility.
- **Vehicles:** Diesel is required for emergency service vehicles, lifeline utility service teams, FMCG distribution, and diesel distribution from supply points to customers.

Appendix 1: Demand estimations provides the assumptions used to calculate diesel demand for each demand stream.

2.3. Diesel availability

There is no bulk diesel reserve held in Wairarapa. Without mitigation strategies, the diesel available for allocation after the earthquake is assumed to be the stock held in fuel station tanks across the region. The region has 20 fuel stations and truck stops, including 13 staffed sites and 7 self-service sites located around Masterton. Appendix 2: Available diesel provides the assumptions on fuel station tank capacities and expected fill levels used to estimate available diesel stock.

3. Assessment approach

Quantitative models were developed to evaluate the level of service, measured as days of coverage, for identified critical customers under the earthquake scenario. The assessment first

examined outcomes under existing diesel availability, before any mitigation strategies were applied. It used a benchmark model, where diesel was allocated without customer prioritisation, and a baseline model, where diesel allocation followed a prioritisation scheme. It then evaluated two preparedness strategies, emergency stockholding in fuel station tanks and prepositioned diesel tanks, and one response strategy, diesel airlift through Hood Aerodrome. Each mitigation strategy was assessed in terms of service level improvement and associated cost. These models generate a range of solutions across different cost levels, rather than a single service-level outcome.

3.1. Data sources

The assessment drew on available reports, national and regional fuel planning documents, lifeline utilities information, and input from local practitioners and emergency management personnel. These sources informed the model inputs and the modelling framework, including diesel demand, available fuel stocks, customer identification, prioritisation, allocation rules, restoration assumptions, and the mitigation strategies assessed in this report. Where data were incomplete or unavailable, assumptions were developed using practitioner input, available documents, and reasonable best-guess estimates for emergency planning purposes.

3.2. Modelling framework

The models were developed using a mix of common inputs, model-specific inputs, and decision rules. Common inputs included diesel demand for each customer over the 13-week planning horizon, available diesel in fuel station tanks, and customer and fuel station locations. Model-specific inputs were used where relevant, including emergency stock uplift levels, prepositioning candidate sites and tank sizes, and airlift delivery capacity. Each mitigation strategy also included strategy-specific cost inputs. The models applied decision rules for diesel allocation and fuel station prioritisation. Appendix 3: Model assumptions outlines the common assumptions and model-specific assumptions used in the assessment. The modelling framework is shown in Figure 5.

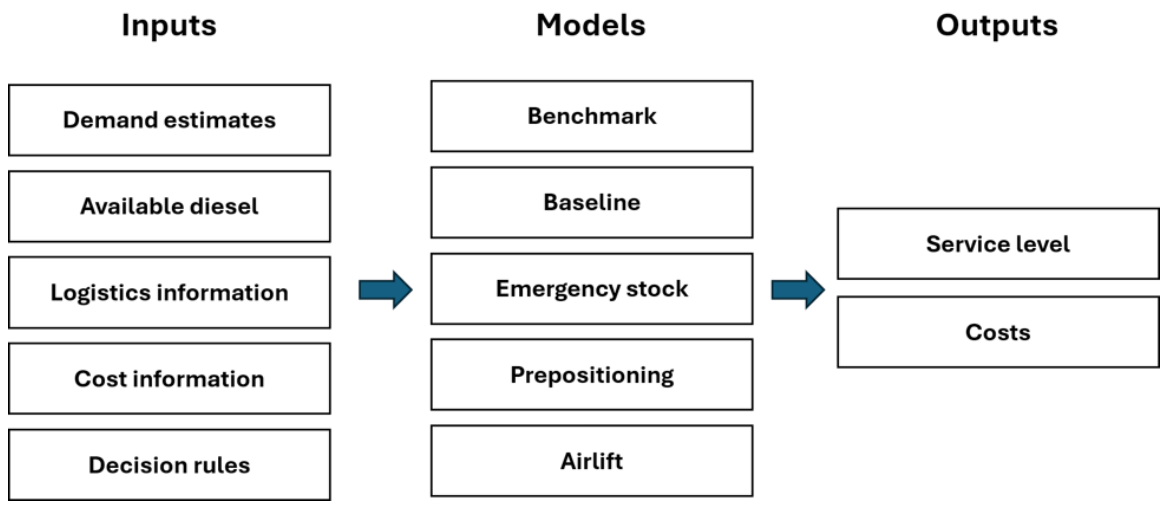

Figure 5: Modelling framework

The five models used in the assessment are summarised in Table 1.

Table 1. Summary of models used in the assessment

Model	Assessment case	Brief description
Model 0: Benchmark	Reference case	Shows outcomes under week-by-week diesel allocation, without customer prioritisation or mitigation strategies.
Model 1: Baseline	Current-condition case	Shows outcomes under prioritised allocation using a full-horizon view of demand and shortages, without mitigation strategies.
Model 2: Emergency stock	Preparedness option	Evaluates the effect of holding additional emergency diesel at selected fuel stations under prioritised allocation using a full-horizon view of demand and shortages.
Model 3: Prepositioning	Preparedness option	Evaluates the effect of prepositioned diesel tanks at high-turnover sites under prioritised allocation using a full-horizon view of demand and shortages.
Model 4: Airlift	Response option	Evaluates the effect of airlifting diesel through Hood Aerodrome under prioritised allocation using a full-horizon view of demand and shortages.

4. Modelling results

This section presents the five models developed for the assessment and summarises their key results. Selected figures are included throughout this section to support the main findings, while additional graphs and detailed outputs are provided in Appendix 4: Detailed results.

4.1. Model 0: Benchmark

The benchmark model does not assign priorities to customers. Diesel allocation is made week by week, based only on current-week demand. Any remaining inventory is rolled over to the following week. This process continues until the available diesel inventory across all fuel stations is exhausted. The main output is the week when the fuel stations' diesel stock runs out under non-prioritised allocation.

The benchmark results show that, without a prioritisation system, available diesel in the region would be exhausted during Week 3 under a week-by-week allocation approach (Figure 6). These results demonstrate that estimated existing fuel station stocks are not sufficient to cover all critical customer demand during the isolation period. They provide a reference point for assessing the value of prioritised allocation and mitigation strategies, including emergency stock, prepositioning, and airlift.

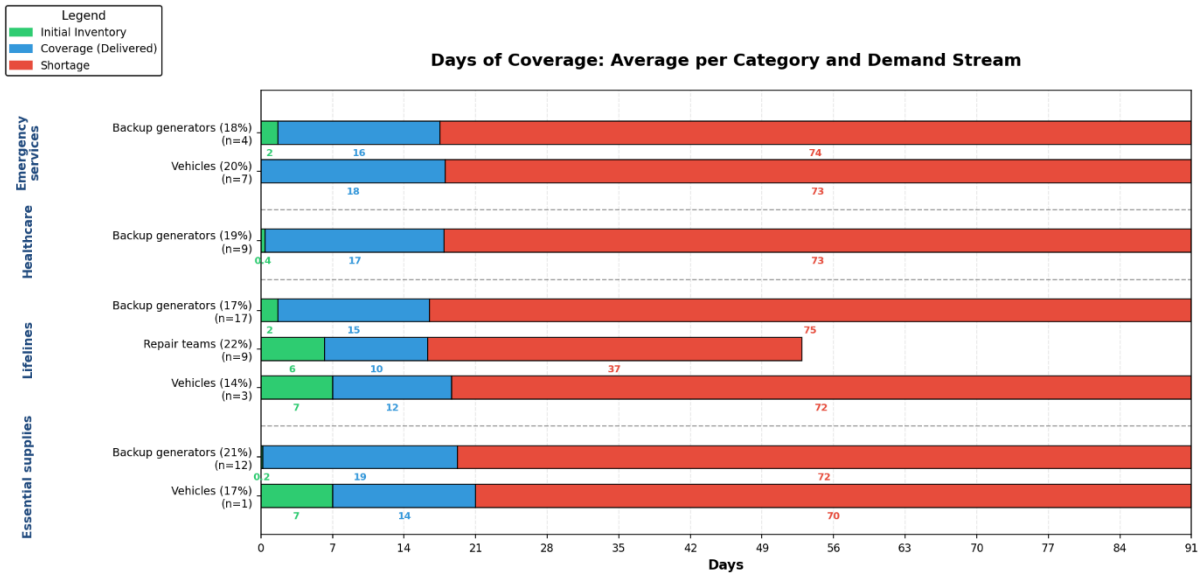

Figure 6: Average self-sufficiency, coverage, and shortage days by customer category for model 0: Benchmark

4.2. Model 1: Baseline

This model allocates diesel using the priority weighting scheme and aims to minimise total weighted diesel shortages over the planning horizon, subject to the allocation rule and early satisfaction preference. The output shows the best achievable service level under prioritised allocation without mitigation strategies.

The baseline model results show that prioritised allocation and longer-term planning improve service outcomes, as the model considers weighted shortages across the planning horizon rather than allocating diesel through week-by-week allocation. This helps direct diesel to higher-priority customers. The results show that power restoration operations receive sufficient diesel, allowing grid supply to be restored at the beginning of Week 5. Once the grid supply is restored, diesel is no longer required for backup generation, eliminating a substantial demand stream (Figures 7 and 8). Despite these improvements, coverage for the first priority group, including emergency services and the hospital, extends to just over seven weeks, but significant shortages remain for emergency services and other customer categories.

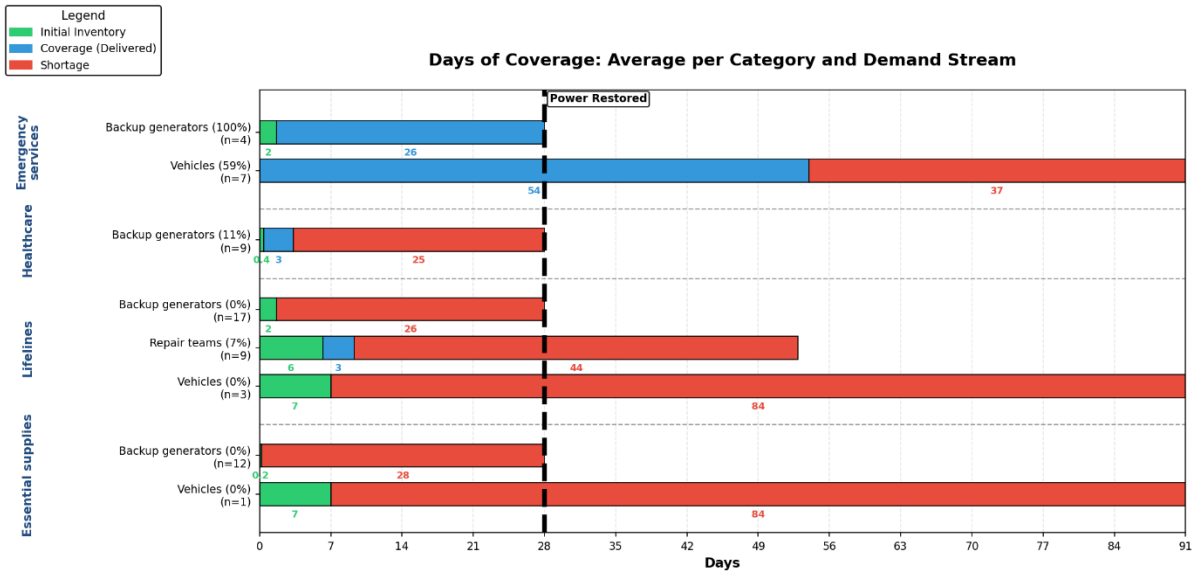

Figure 7: Average self-sufficiency, coverage, and shortage days by customer category for model 1: Baseline

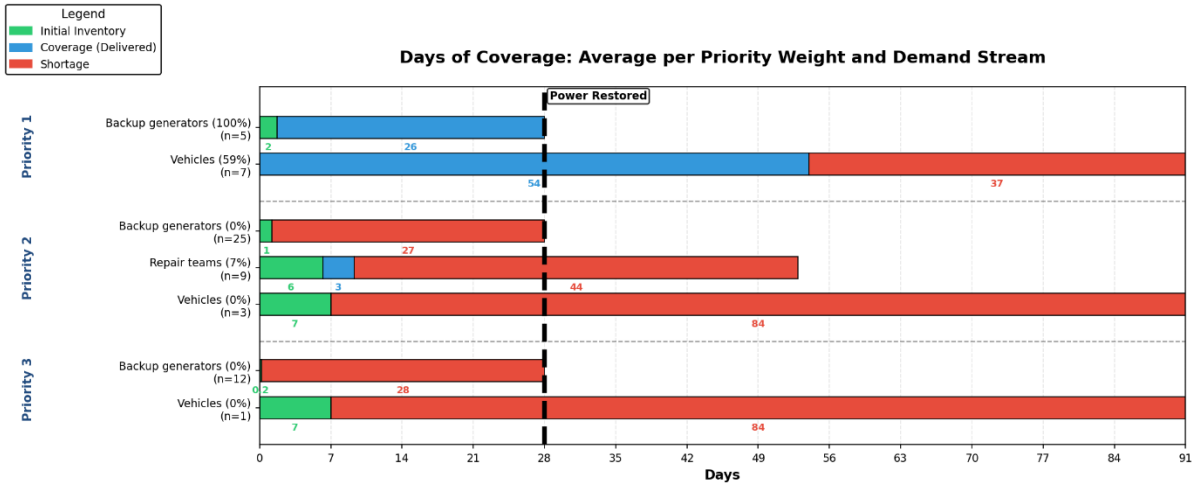

Figure 8: Average self-sufficiency, coverage, and shortage days by priority group for model 1: Baseline

4.3. Model 2: Emergency stock

This model assumes that selected fuel stations hold emergency diesel stock as part of their business-as-usual operations. The emergency stock model uses the same priority weighting scheme as Model 1. It identifies which fuel stations should hold emergency stock at different cost levels. Costs are assumed to be limited to the opportunity cost of capital tied up in additional diesel inventory.

Two predefined emergency stock uplift levels were assessed: Level A and Level B (details are available at Appendix 3: Model assumptions). For Level A, full coverage of the emergency services and the hospital over the planning horizon can be achieved by selecting eight fuel stations to hold emergency stock (Figure 9). For Level B, the same coverage can be achieved with six fuel stations, due to the higher stock uplift (Figure 12). However, emergency stock alone is not sufficient to

meet demand across all customer categories. Even when all fuel stations are selected, only the first priority group, including emergency services and the hospital, achieves full coverage, while considerable shortages remain for other customer groups over the 13-week period (Figures 10,11,13 and 14). The annual cost of this all-station solution is estimated at NZD 40,320 for Level A and NZD 49,440 for Level B.

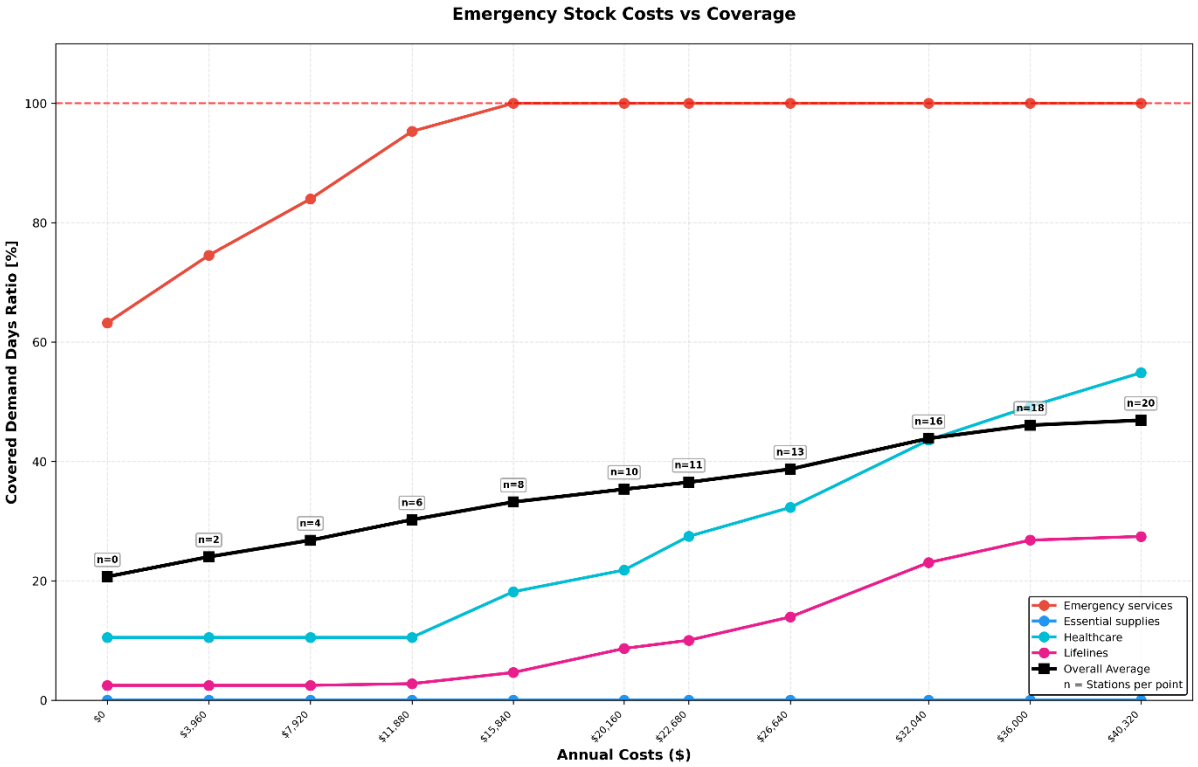

Figure 9: Average covered-days ratio by customer category across annual cost levels for model 2: Emergency stock (uplift Level A)

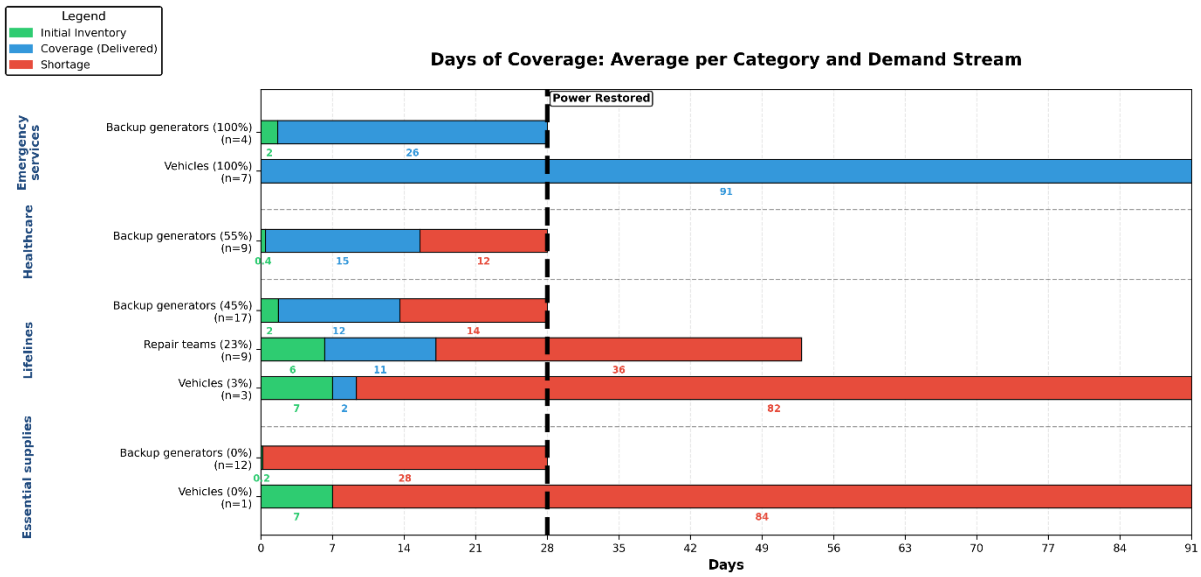

Figure 10: Average self-sufficiency, coverage, and shortage days by customer category for the best-coverage solution for Emergency stock (uplift Level A)

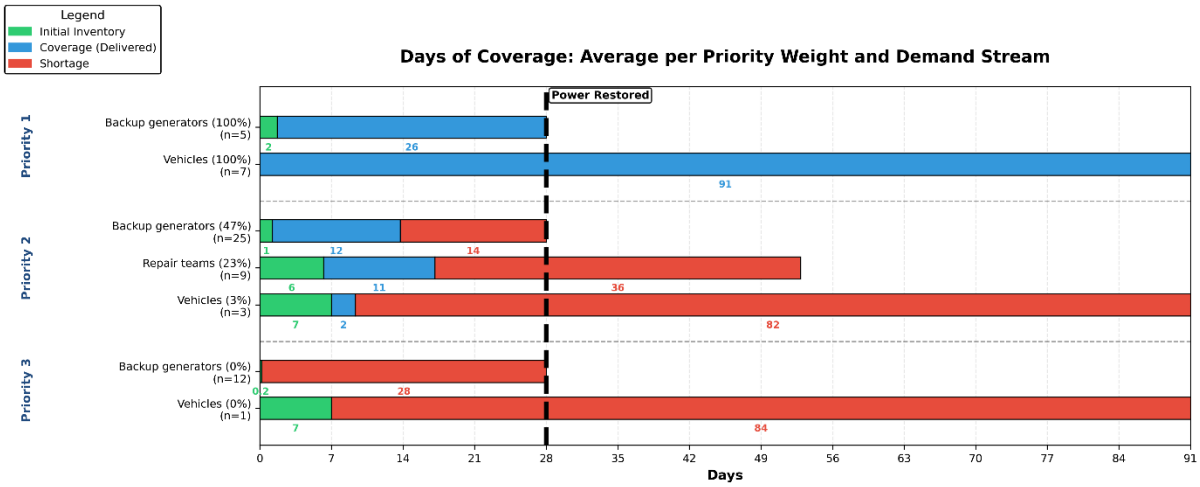

Figure 11: Average self-sufficiency, coverage, and shortage days by priority group for the best-coverage solution for Emergency stock (uplift Level A)

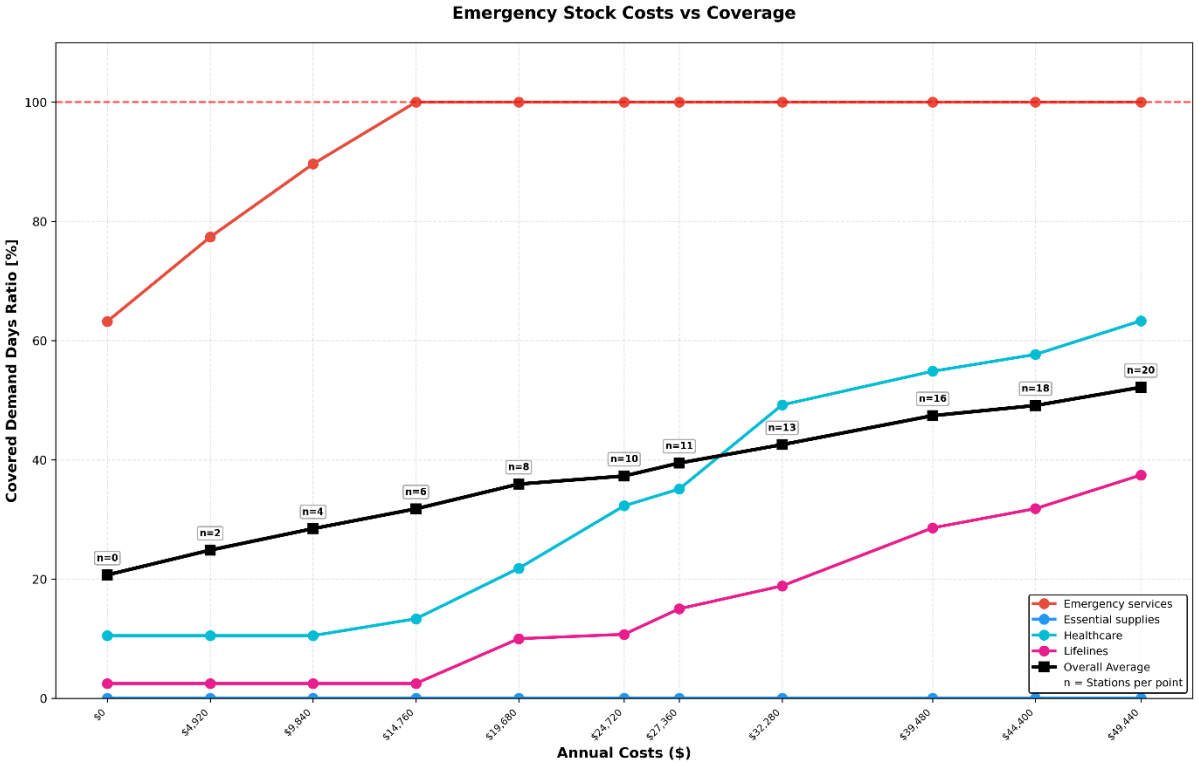

Figure 12: Average covered-days ratio by customer category across annual cost levels for model 2: Emergency stock (uplift Level B)

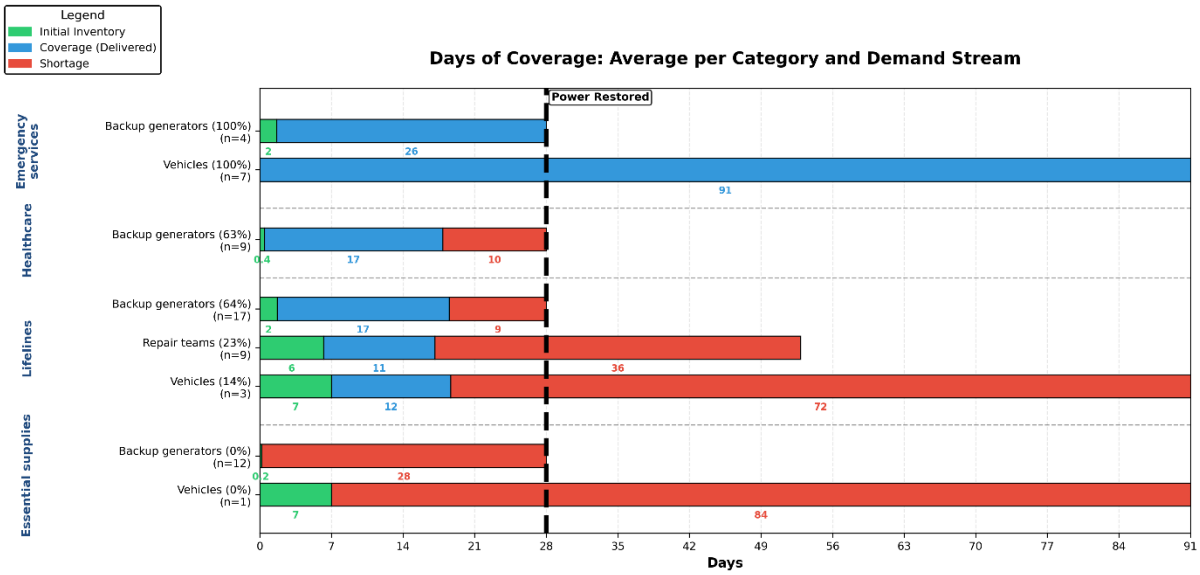

Figure 13: Average self-sufficiency, coverage, and shortage days by customer category for the best-coverage solution for Emergency stock (uplift Level B)

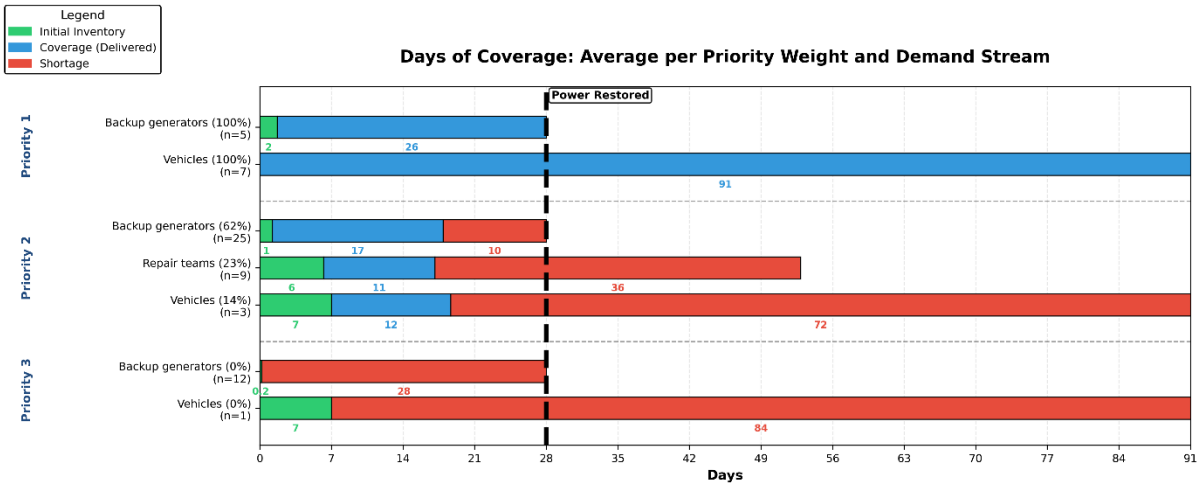

Figure 14: Average self-sufficiency, coverage, and shortage days by priority group for the best-coverage solution for Emergency stock (uplift Level B)

As a supplementary comparison, the Model 0's benchmark allocation approach was applied to the higher stock levels from the Model 2 all-station solutions. Without prioritisation, diesel would be exhausted during Week 4 under both Levels A and B (Figures 15 and 16).

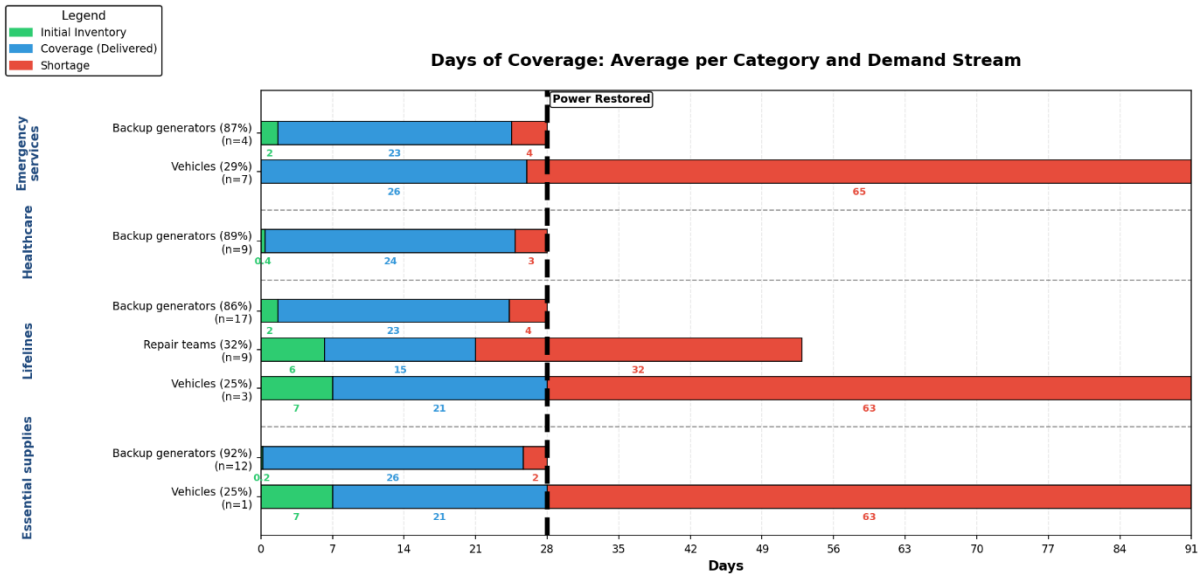

Figure 15: Average self-sufficiency, coverage, and shortage days by customer category for the best-coverage solution for Emergency stock (uplift Level A) with a non-prioritised allocation approach

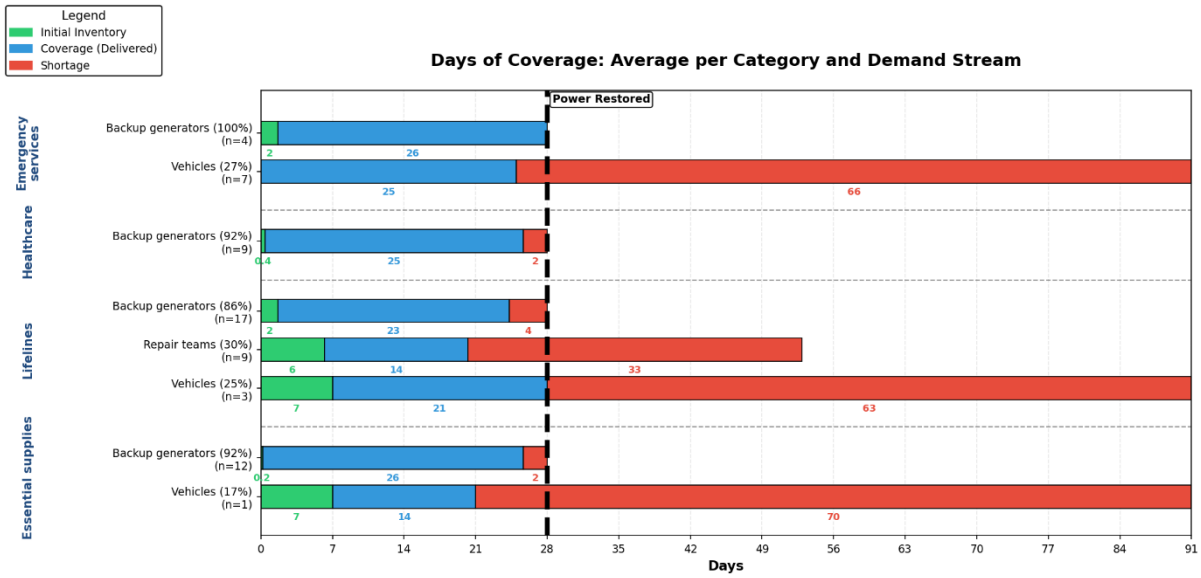

Figure 16: Average self-sufficiency, coverage, and shortage days by customer category for the best-coverage solution for Emergency stock (uplift Level B) with a non-prioritised allocation approach

4.4. Model 3: Prepositioning

This model is based on the same priority weighting scheme as Model 1. In this model, the available post-earthquake diesel supply comes from two sources: diesel stored in prepositioned tanks and diesel held in fuel station tanks. It places dedicated diesel tanks at selected sites to support emergency response. The model identifies the preferred prepositioning sites and tank sizes under different cost levels. Tanks could be selected from three size options: small, medium, and large (details are available at Appendix 3: Model assumptions). Based on practitioner input, only sites with high diesel turnover were considered as candidates for prepositioned diesel tanks. Potential sites could include the yards of main road contractors, agricultural contractors, and transport companies.

The prepositioning model shows that one large tank could fully cover emergency services and the hospital. At a higher cost level, one small and three large tanks could provide full coverage for these customers and the healthcare sector, along with approximately 72% coverage for lifeline utilities. Full coverage for all identified customers over the 13-week horizon could be achieved with two small, one medium, and three large tanks at the estimated annual cost of NZD 256,500 (Figures 17 and 19).

An alternative configuration using only small and medium-sized tanks could achieve similar coverage outcomes through a more decentralised network (Figures 18 and 19). Two small tanks could fully cover emergency services and the hospital. Three small and two medium tanks could fully cover emergency services, the hospital, and the healthcare sector, while providing approximately 61% coverage for lifeline utilities. Full coverage for all identified customer groups could be achieved with two small and five medium tanks.

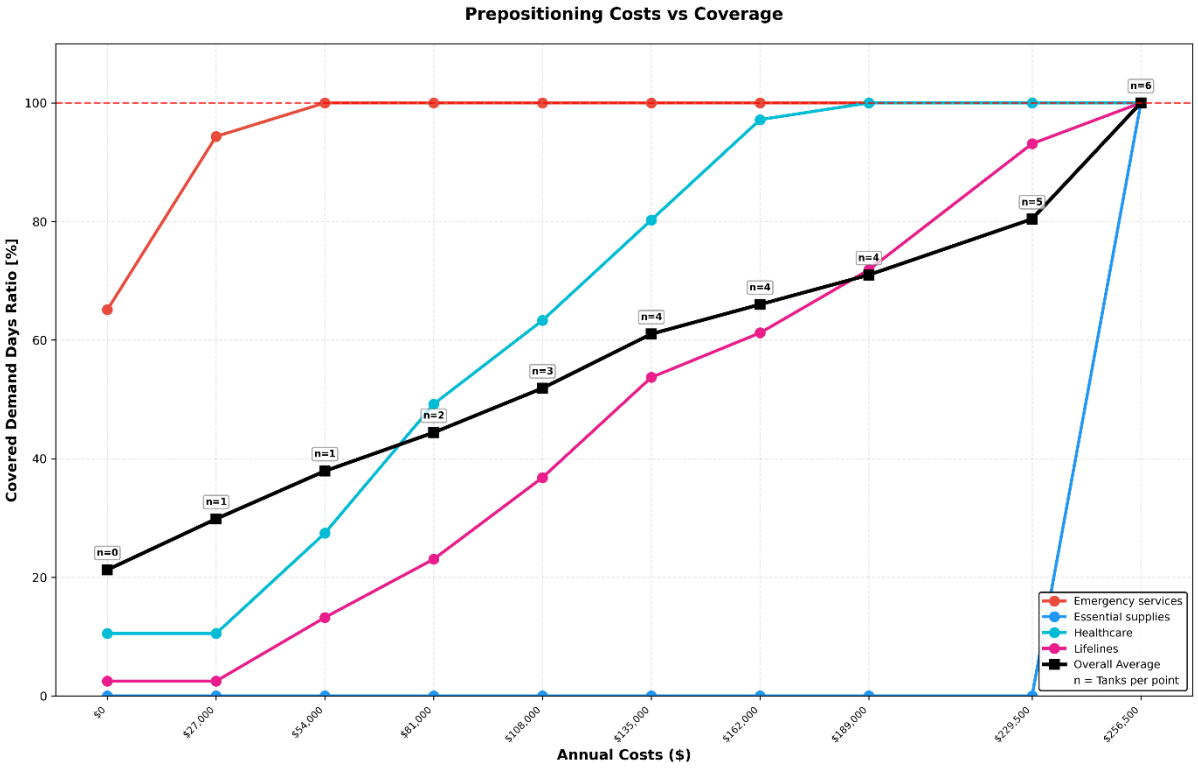

Figure 17: Average covered-days ratio by customer category across annual cost levels for model 3: Prepositioning (three tank size options)

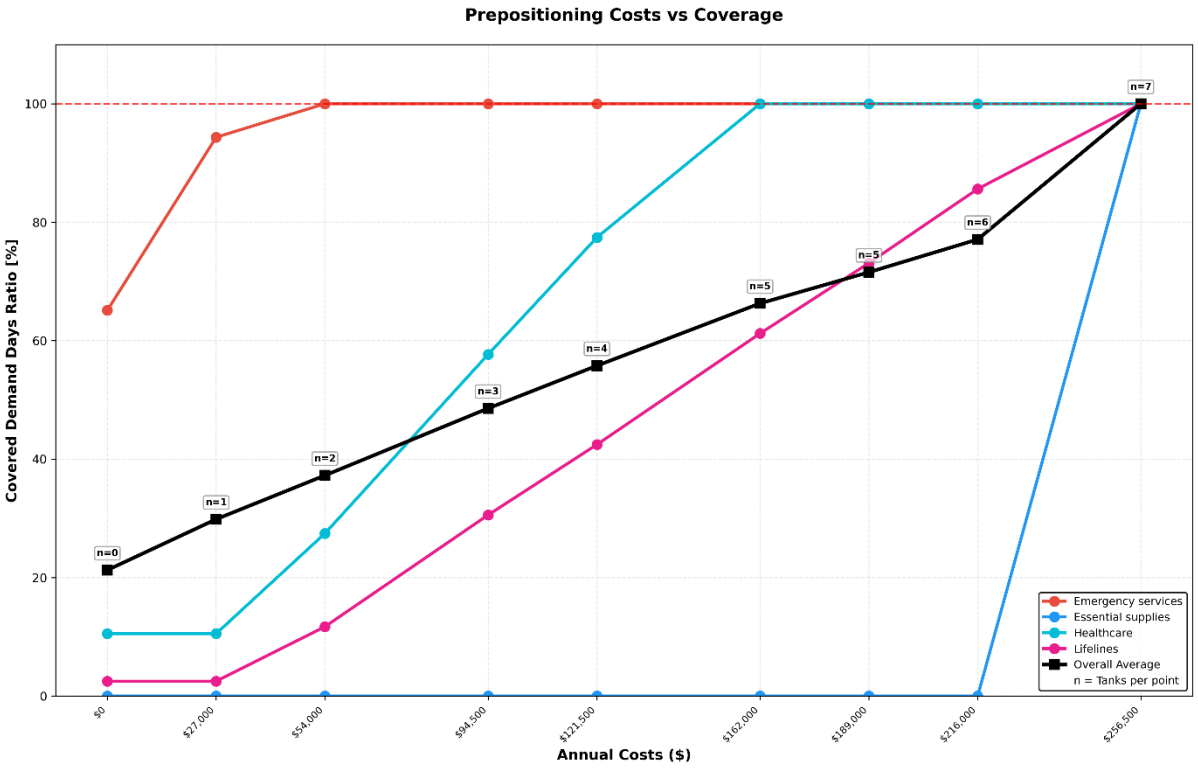

Figure 18: Average covered-days ratio by customer category across annual cost levels for model 3: Prepositioning (two tank size options)

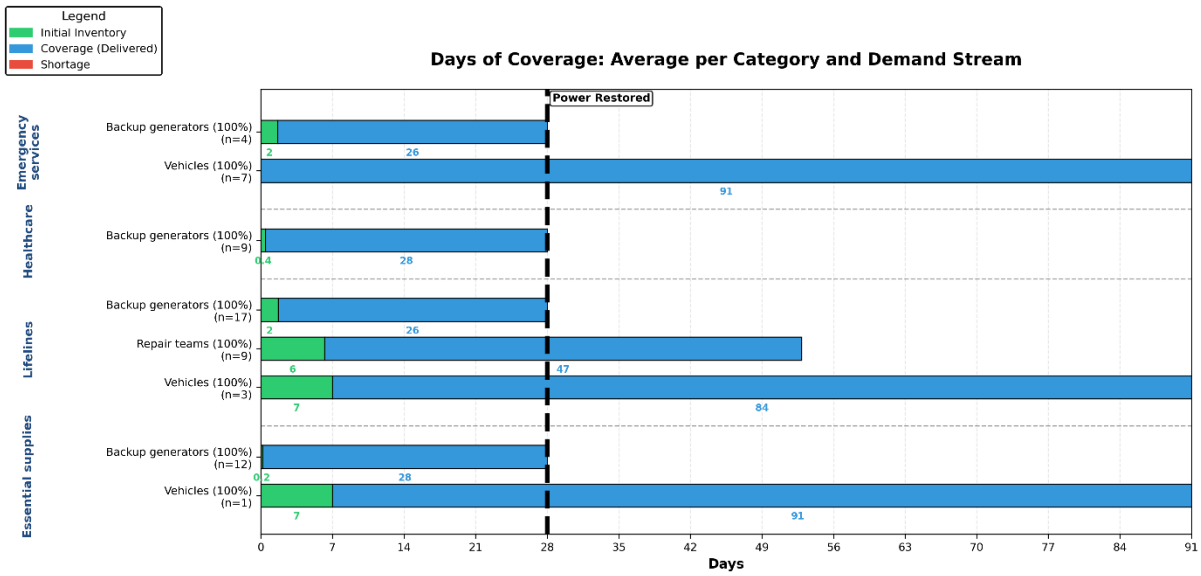

Figure 19: Average self-sufficiency, coverage, and shortage days by customer category for the best-coverage solution for model 3: Prepositioning (two/three tank size options)

4.5. Model 4: Airlift

This model evaluates diesel airlift into Wairarapa as a response strategy using the same priority weighting scheme as Model 1. It is assumed that, alongside existing diesel stocks in fuel station tanks, additional diesel could be delivered through Hood Aerodrome using New Zealand Defence

Force (NZDF) capability, specifically C-130J-30 Hercules aircraft. Military airlift capacity is assumed to be allocated at the discretion of the Director of the National Emergency Management Agency, with airlift costs covered by the central government for the duration of the operation.

The conceptual flow of airlift operations is presented in Figure 20. Diesel is assumed to be shipped in 200-litre steel drums. Flights are assumed to originate from an undetermined North Island airbase, with each airlift involving approximately two hours of flight time. Once delivered, diesel is distributed to selected fuel stations and then allocated to customers, consistent with the approach used in other models. The model determines the number of airlifts, the flight schedule over the three-month horizon, and the weekly diesel delivery plan for selected fuel stations.

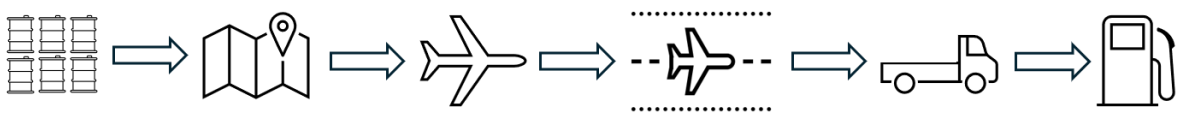

Figure 20: Conceptual flow of airlift operations

The airlift model shows that seven flights are required to achieve full coverage of emergency services and the hospital. Extending full coverage to the healthcare sector requires 27 flights, while full coverage of all customer categories requires 39 flights over the 13-week period (Figures 21 and 22). The timing of flights is important, particularly during the first four weeks, when diesel demand for backup generation is high due to the assumed power outage (Figure 23). During this period, local diesel inventory is insufficient to meet all critical customer demand without resupply, so the maximum weekly number of flights must be used. After the first four weeks, different flight schedules can achieve the same full-coverage outcome, provided that 39 flights are delivered in total. The estimated cost of full coverage across all customer categories is NZD 2,730,000 as a one-off response expense.

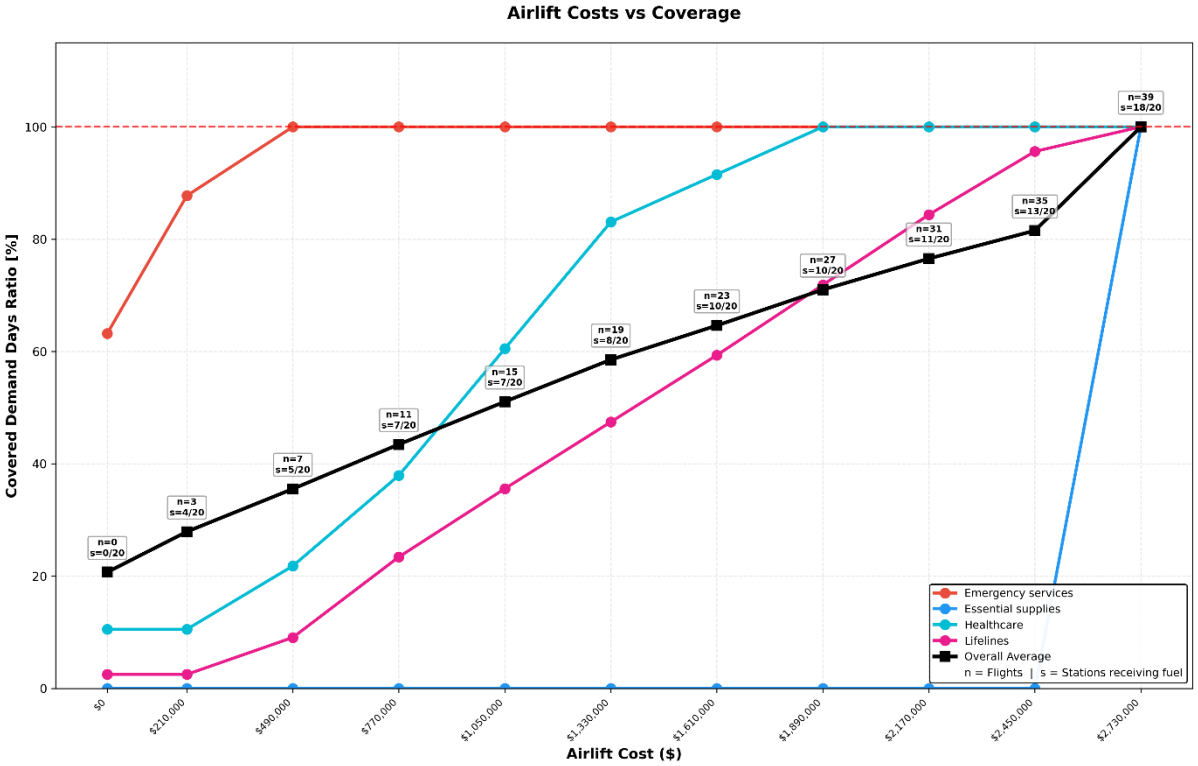

Figure 21: Average covered-days ratio by customer category across annual cost levels for model 4: Airlift

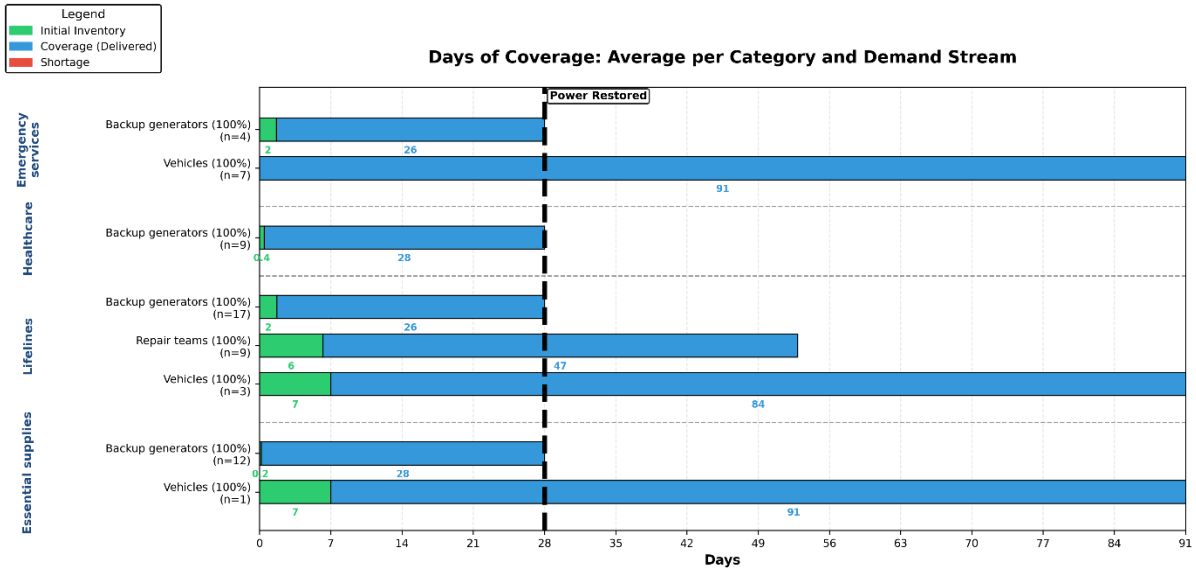

Figure 22: Average self-sufficiency, coverage, and shortage days by customer category for the best-coverage solution for model 4: Airlift

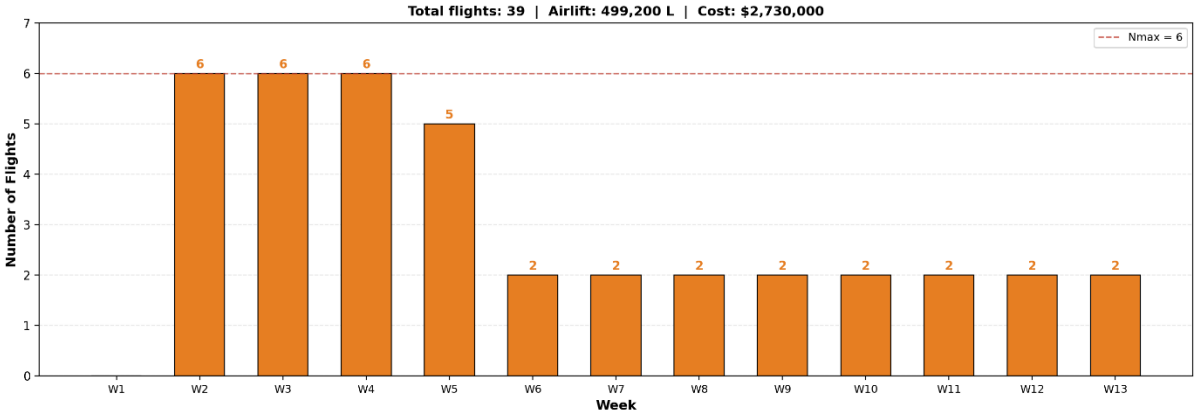

Figure 23: Flight schedule over the 13-week horizon for the best-coverage solution for model 4: Airlift

5. Conclusions

This report concludes that Wairarapa cannot rely on existing diesel stocks alone during a prolonged post-earthquake isolation scenario. Estimated current fuel station inventories are insufficient to support all identified critical customers fully. However, the modelling shows that mitigation strategies can substantially improve diesel coverage and reduce shortage risk. The key takeaways are summarised below:

- Estimated existing diesel in Wairarapa fuel station tanks is not enough to meet the demand of all identified critical customers during prolonged isolation.
- Under a non-prioritised and week-by-week allocation approach, the estimated existing diesel stock would by exhausted during Week 3.
- Prioritised allocation improves outcomes for higher-priority customers and supports power restoration, but further interventions are needed to reduce remaining shortages.
- Emergency stockholding in fuel station tanks can fully support the highest-priority customers, but it does not eliminate shortages across all groups.
- Under a non-prioritised and week-by-week allocation approach, emergency stockholding in all stations would be exhausted during Week 4.
- Prepositioning dedicated diesel tanks, combined with existing diesel in fuel station tanks, can achieve full coverage of all identified critical customers across the 13-week isolation period, with higher associated costs compared to the emergency stock approach.
- Resupplying diesel through airlift, in combination with existing fuel station stocks, could result in the full coverage of all identified critical customers. However, its feasibility depends on operational factors, including runway usability, weather conditions, aircraft availability, and national emergency priorities. It also involves a high one-off response cost.
- Improving the resilience of critical road connections could shorten regional isolation and allow road-based diesel resupply to resume sooner. Assessing this potential option was outside the study scope and would require further investigation.

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Appendices

Appendix 1: Demand estimations

Table A1: Detailed demand estimated over 13-week horizon

Code	Category	On stock inventory (Liters)	Weekly demand (Liters)	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13
C007	Emergency services	500	1680	1180	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680
C008	Emergency services	480	1680	1200	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680
C009	Emergency services	120	1680	1560	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680
C010	Emergency services	1000	3500	2500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C015	Emergency services	0	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
C016	Emergency services	0	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
C017	Emergency services	0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
C018	Emergency services	0	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
C019	Emergency services	0	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
C020	Emergency services	0	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
C021	Emergency services	0	420	420	420	420	420	420	420	420	420	420	420	420	420	420
C001	Essential supplies	0	756	756	756	756	756	756	756	756	756	756	756	756	756	756
C002	Essential supplies	0	756	756	756	756	756	756	756	756	756	756	756	756	756	756
C003	Essential supplies	0	756	756	756	756	756	756	756	756	756	756	756	756	756	756
C004	Essential supplies	0	756	756	756	756	756	756	756	756	756	756	756	756	756	756
C005	Essential supplies	216	756	540	756	756	756	756	756	756	756	756	756	756	756	756
C006	Essential supplies	400	400	0	400	400	400	400	400	400	400	400	400	400	400	400
C070	Essential supplies	0	756	756	756	756	756	756	756	756	756	756	756	756	756	756
C071	Essential supplies	0	756	756	756	756	756	756	756	756	756	756	756	756	756	756
C072	Essential supplies	0	378	378	378	378	378	378	378	378	378	378	378	378	378	378
C073	Essential supplies	0	378	378	378	378	378	378	378	378	378	378	378	378	378	378
C074	Essential supplies	0	378	378	378	378	378	378	378	378	378	378	378	378	378	378
C075	Essential supplies	0	378	378	378	378	378	378	378	378	378	378	378	378	378	378
C076	Essential supplies	0	378	378	378	378	378	378	378	378	378	378	378	378	378	378
C011	Healthcare	9000	33600	24600	33600	33600	33600	33600	33600	33600	33600	33600	33600	33600	33600	33600
C061	Healthcare	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C062	Healthcare	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C063	Healthcare	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C064	Healthcare	400	1400	1000	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C065	Healthcare	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C066	Healthcare	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C067	Healthcare	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C069	Healthcare	0	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
C022	Lifelines	636	1260	624	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260
C023	Lifelines	704	1260	556	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260
C024	Lifelines	636	1260	624	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260
C025	Lifelines	704	1260	556	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260
C026	Lifelines	2400	5712	3312	5712	5712	5712	5712	5712	5712	5712	5712	5712	5712	5712	5712

C027	Lifelines	150	1015	865	1015	1015	1015	1015	1015	1015	1015	1015	1015	1015	1015	1015
C028	Lifelines	270	945	675	945	945	945	945	945	945	945	945	945	945	945	945
C029	Lifelines	0	350	350	350	350	350	350	350	350	350	350	350	350	350	350
C030	Lifelines	100	350	250	350	350	350	350	350	350	350	350	350	350	350	350
C031	Lifelines	0	945	945	945	945	945	945	945	945	945	945	945	945	945	945
C038	Lifelines	1000	3500	2500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C039	Lifelines	0	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C040	Lifelines	0	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C041	Lifelines	0	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C042	Lifelines	0	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C043	Lifelines	1000	3500	2500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C044	Lifelines	1000	3500	2500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
C049	Lifelines	0	2450	2450	2450	0	0	0	0	0	0	0	0	0	0	0
C050	Lifelines	820	820	0	820	820	820	820	820	820	820	820	820	820	820	820
C051	Lifelines	25600	6400	0	0	0	0	6400	6400	6400	6400	6400	6400	6400	6400	6400
C052	Lifelines	25600	6400	0	0	0	0	6400	6400	6400	6400	6400	6400	6400	6400	6400
C053	Lifelines	210	210	0	210	210	210	210	210	210	210	210	210	210	210	210
C054	Lifelines	0	18900	18900	18900	18900	18900	0	0	0	0	0	0	0	0	0
C055	Lifelines	210	210	0	210	210	210	210	210	210	210	210	210	210	210	210
C056	Lifelines	0	1400	1400	0	0	0	0	0	0	0	0	0	0	0	0
C057	Lifelines	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C058	Lifelines	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	0	0	0	0	0
C059	Lifelines	0	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
C060	Lifelines	0	1400	1400	0	0	0	0	0	0	0	0	0	0	0	0

Backup generation

On-site inventory

- Customers with backup generators at their site were assumed to hold two days of on-site diesel supply. They were considered self-sufficient until this stock was depleted, unless more accurate information was available from official documents or interviews.

Emergency services

- C007 has a 100 kVA generator at L001 that is expected to consume 240 litres of diesel daily. On-site diesel inventory is 500 litres (information provided through practitioner correspondence).
- C008 was assumed to have the same diesel demand profile as C007.
- C009 was assumed to have the same diesel demand requirement as C007. Its on-site diesel supply was assumed to cover 12 hours of generator operation (as per DOC001).
- C010: The diesel requirement was adopted from DOC002.

Healthcare

- C011: The diesel requirement was adopted from DOC002. On-site diesel inventory was assumed to equal the midpoint of the range provided through practitioner input.
- C061-C065: The diesel requirements were based on the T001 figures provided in DOC002 and were assumed to also include T002 needs.
- C066, C067,C069: Diesel demand for C066 and C067 was assumed to be the same as the estimate used for C061 and C063, at 1,400 litres per week. For C069, the requirement was set at 4,000 litres per week to account for multiple facilities in the area. L002 and L003 were excluded as no operating facilities are identified.

Lifeline utilities

- C022-C026: Diesel demand figures were obtained from DOC003. On-site diesel inventory was assumed to be 80% of the installed storage capacity stated in the same document. C022 was assumed to have the same figures as C024, and C025 was assumed to have the same figures as C023.
- T003: Diesel required to operate T003 backup generators during the power outage was assumed to be supplied from their own stock. It was estimated based on a 40 kVA generator operating for 8 hours per day, with a fuel consumption rate of 9 litres per hour.
- C027: Diesel demand was estimated at 1,015 litres per week, assuming the site's available backup generator operates continuously, 24 hours per day, seven days per week.
- C028: The diesel requirement was adopted from DOC002.
- C029-C030: Diesel requirements were informed by practitioner input and estimated at 350 litres per week for each site.
- C031: The diesel requirement was assumed to be the same as C028.

- C038-C044: Diesel demand for C039-C044 was adopted from DOC002. For C038, diesel demand was assumed to match the requirement used for C043.

Essential supplies

- C072-C076: The diesel requirement was assumed to be 50% of C001-C005 and C070-C071. This is a planning estimate reflecting their limited operating requirements during a power outage.
- C001-C005 and C070-C071: The diesel requirement was estimated at 756 litres per week based on a 40 kVA backup generator, 12 hours of operation per day, and a fuel consumption rate of 9 litres per hour.

Lifeline utility restoration operations

- C049: Weekly diesel demand was assumed to be 2,450 litres per week, slightly above one third of C056-C060 consumption all together. A two-week restoration period was assumed. This is a planning estimate reflecting the smaller scale of C049.
- C054: The restoration duration was set at four weeks, and diesel demand was estimated at 18,900 litres per week, based on practitioner-provided best-guess estimates.
- C051-C052 were assumed to be self-sustaining for the first four weeks after the earthquake, based on practitioner input. Weekly diesel demand was estimated at 6,400 litres, using monthly business-as-usual consumption levels obtained through interviews. The estimate assumes that a similar level of activity would be maintained after the earthquake, but redirected to restoration operations.
- C056-C060: Diesel demand was estimated using best-guess restoration durations provided by practitioners for each area. Interview input indicated an overall regional requirement of 1,000 litres per day, represented as five restoration teams consuming 200 litres per team per day.

Vehicles

- C015: Diesel demand was informed by business-as-usual consumption data, based on 3,622 litres per month in February 2026. Weekly diesel demand was estimated at 1,100 litres to account for higher post-earthquake demand and potential T004 requirements in the area.
- Fuel requirement for T005 was estimated as a function of delivered volume and travel distance. A rate of 0.000335 litre per litre-kilometre was applied and multiplied by two to account for the return trip.
- C016-C020: The figure from DOC002 was assumed to represent the regional diesel requirement both for backup generators and fleet vehicles. Town-level requirements were estimated using equipment and the local population as guiding factors.
- C006: Diesel demand for C006 was estimated using population data from Wellington Earthquake National Initial Response Plan- Appendix C and an assumed daily requirement of 1 kg gross weight per person. This included 0.6 kg of food per person per day, adapted from WFP Emergency Field Operations Pocketbook- section 6, plus 0.4 kg per person per day for non-food essentials and packaging. Each truckload was assumed to carry 18 metric tonnes, with 17 to 18 truckloads per week required to meet regional

demand. Each delivery from the airport to a town was assumed to use 23 litres of diesel on average.

FMCG was assumed to be airlifted to Hood Aerodrome from Week 2 and then distributed to supermarkets across the region. FMCG airlift capacity was not included in the planned diesel airlift capacity and would require a separate delivery arrangement.

- C050, C053, C055: Vehicles were assumed to carry sufficient diesel to cover the first week of operations. C050 diesel demand was informed by practitioner input. C053 and C055 vehicle demand were assumed to be 50% and 25% of the C050, respectively.
- C021 was assumed to operate two diesel utes, with each ute consuming 30 litres per day.

Appendix 2: Available diesel

Truck stops (Figure A1) and fuel stations with four fuel dispensers were classified as large stations (Figure A2), while all others were classified as small stations (Figure A3). This resulted in eight large stations and 12 small stations.

Based on practitioner input, diesel tank capacity was assumed to vary by station size within a range of 30,000 to 50,000 litres. Large stations were assumed to have a tank capacity of 50,000 litres and an expected fill level of 50%, while small stations were assumed to have a capacity of 30,000 litres and an expected fill level of 35%.

Individual fuel station representatives were not consulted as part of this study. Therefore, the assumptions and estimates presented do not necessarily reflect their views or site-specific operating conditions.



Figure A1: A truck stop



Figure A2: A large fuel station



Figure A3: A small fuel station

Appendix 3: Model assumptions

General assumptions

The following assumptions apply across the modelling framework, unless otherwise specified for individual models.

- **Allocation rule:** Weekly customer demand must be either fully satisfied or not served. Partial weekly allocations are not allowed. In addition, demand must be allocated across consecutive weeks, meaning that interrupted service is not permitted.
- **Diesel price:** The unit price of diesel fuel was assumed to be NZD 3.00 per litre.
- **Early satisfaction preference:** The models favour meeting demand in earlier weeks.
- **Fuel station availability:** Fuel stations are assumed to remain undamaged after the earthquake, with the diesel stored in their tanks accessible for distribution.
- **Fuel station priorities:** In the emergency stock and airlift models, staffed stations are prioritised over self-service stations. In addition, an ordinal preference ranking among stations is applied within each zone.
- **Interdependency:** Power grid restoration occurs only when diesel demand for power restoration operations is fully covered. Once grid supply is restored, diesel demand for backup generation is eliminated.
- **On-site inventory:** Any diesel inventory held by a critical customer was used to estimate the customer's initial self-sufficiency period. Once this inventory was depleted, the customer was assumed to require allocated diesel.
- **Time unit:** The three-month isolation period was represented as 13 weekly time units, with demand, diesel allocation, and inventory balances updated weekly.
- **Weighting scheme:** Each priority group was assigned a weighting factor: 0.500 for Group 1, 0.333 for Group 2, and 0.167 for Group 3. This assumption did not apply to the benchmark model.

Emergency stock model

Uplift levels

Based on practitioner input, fuel stations were assumed to have a current minimum diesel fill level of 10% for small stations and 15% for large stations. Individual fuel station representatives were not consulted as part of this study. Therefore, the assumptions and estimates presented do not necessarily reflect their views or site-specific operating conditions.

Two emergency stock uplift levels were considered (Figures A4 and A5):

- **Level A:** increases the minimum fill level to 40% for small stations and 30% for large stations.
- **Level B:** increases the minimum fill level to 45% for small stations and 35% for large stations.

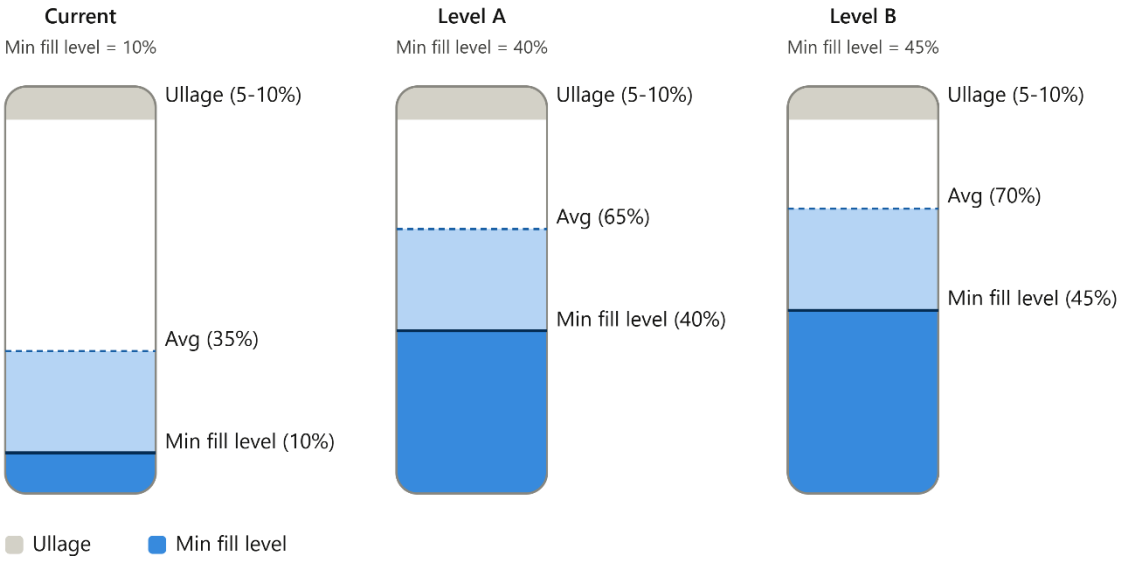

Figure A4: Assumed fill levels for small fuel station tanks under the current situation, Level A, and Level B

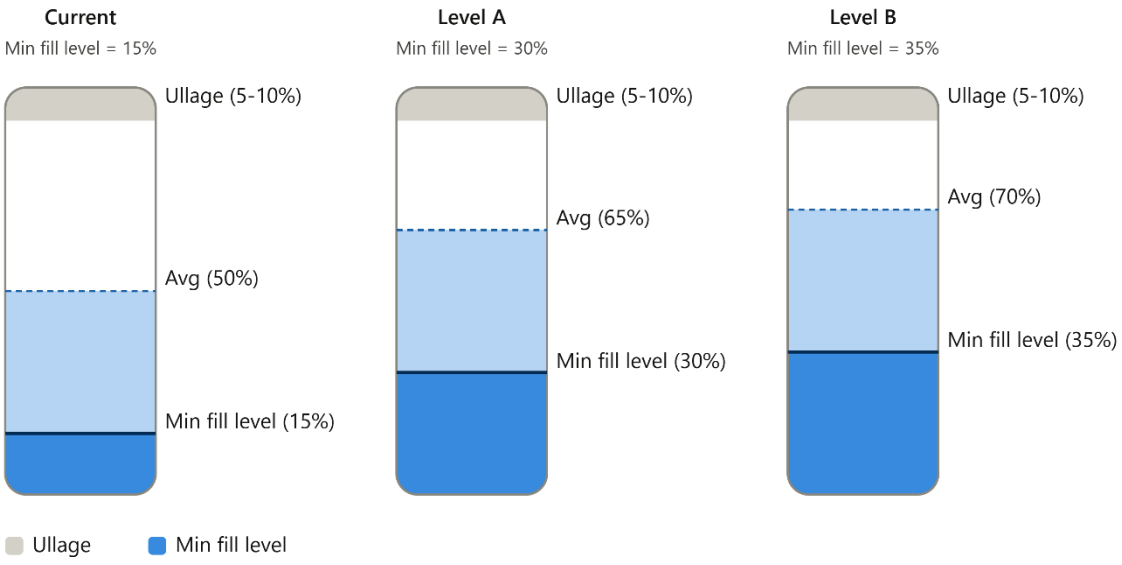

Figure A5: Assumed fill levels for large fuel station tanks under the current situation, Level A, and Level B

Cost assumptions

Emergency stock approach costs were limited to the opportunity cost of capital tied up in additional diesel inventory, using an annual capital cost rate of 8%. No additional maintenance costs were included, as the strategy relies on existing fuel storage infrastructure. Costs related to changes in ordering or delivery arrangements were also excluded.

Prepositioning model assumptions

Tank sizes

- Three usable tank capacity options were considered in the model:
    - Small tank: 50,000 litres
    - Medium tank: 75,000 litres
    - Large tank: 100,000 litres

Cost assumptions

- The total cost of installed tanks was assumed as follows:
    - Small tank: NZD 300,000
    - Medium tank: NZD 450,000
    - Large tank: NZD 600,000
- An annual capital cost rate of 8% was applied to diesel stock held in prepositioning tanks. A further 2% per annum was also considered to account for maintenance and other costs.
- Tanks were assumed to have a 25-year lifespan for annual cost calculations.

Airlift model assumptions

Airport availability

Hood Aerodrome was assumed to be capable of accommodating C-130J-30 aircraft, with airlift operations starting in Week 2.

Payload assumptions

Four diesel drums were assumed to be packed onto one timber pallet, and four timber pallets were assumed to be loaded onto one air cargo pallet.

- 200 litres of diesel: 168 kg
- One empty drum: 19.5 kg
- One wooden pallet: 25 kg
- One air cargo pallet: 130 kg

Total gross weight per air cargo pallet: 3,230 kg
(16 × filled drums + 4 × wooden pallet + 1 × air cargo pallet)

The maximum payload capacity of a C-130J-30 aircraft is 21 tonnes (New Zealand Defence Force, n.d.). Based on the calculations above, the aircraft could theoretically carry up to six air cargo pallets. However, actual load capacity may vary depending on weather conditions, runway conditions, and other operational constraints on the day. For this reason, a practical loading capacity of four air cargo pallets per flight was assumed, equivalent to 12,800 litres of diesel per flight.

Maximum weekly flights

The number of available flights was assumed to be a maximum of six per week. This assumption was based on one flight per day, with one weekly flight reserved for aviation gasoline (AVGAS)

delivery, informed by practitioner input. Although AVGAS delivery was outside the scope of this research, it reduced the available diesel airlift capacity to six flights per week.

Minimum weekly delivery per station

Each selected fuel station was assumed to receive a minimum of 2,000 litres of airlifted diesel per week.

Fuel station tank capacity

A 10% ullage allowance was applied, limiting the usable capacity of each fuel station tank to 90% of its total capacity.

Specific handling equipment

Cargo handling equipment required for unloading air cargo pallets was assumed to be provided by NZDF at the start of the operation.

Appendix 4: Detailed results

Model 0: Benchmark

Table A2: Average coverage and shortage days by customer category

Category	Average need (days)	Average coverage (days)	Average shortage (days)	Coverage %
Emergency services	90.4	17.2	73.2	19.0 %
Healthcare	90.6	17.5	73.1	19.3 %
Lifelines	75.5	13.0	62.5	17.2 %
Essential supplies	90.3	18.7	71.6	20.7 %
Overall	83.4	15.6	67.9	18.7 %

Table A3: Coverage and shortage volume by customer category

Category	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Emergency services	252,180.0	50,200.0	201,980.0	19.9 %
Healthcare	606,800.0	92,400.0	514,400.0	15.2 %
Lifelines	757,521.0	142,931.0	614,590.0	18.9 %
Essential supplies	97,950.0	20,240.0	77,710.0	20.7 %
Overall	1,714,451.0	305,771.0	1,408,680.0	17.8 %

Table A4: Coverage and shortage volume by priority group

Priority group	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Priority 1 (W=0.5)	679,980.0	108,400.0	571,580.0	15.9 %
Priority 2 (W=0.333)	936,521.0	177,131.0	759,390.0	18.9 %
Priority 3 (W=0.167)	97,950.0	20,240.0	77,710.0	20.7 %
Overall	1,714,451.0	305,771.0	1,408,680.0	17.8 %
Overall priority-weighted (Priority weight × Litres)	668,209.1	116,564.7	551,644.4	17.4 %

Table A5: Diesel availability and use by customer category

Component	litres
Opening inventory (all stations)	326,000.0
Delivered to Emergency services	50,200.0
Delivered to Healthcare	92,400.0
Delivered to Lifelines	142,931.0
Delivered to Essential supplies	20,240.0
Self-consumption (all stations)	17,640.0
Transport consumption	2,234.5
Remaining inventory (all stations)	354.5

Model 1: Baseline

Table A6: Average coverage and shortage days by customer category

Category	Average need (days)	Average coverage (days)	Average shortage (days)	Coverage %
Emergency services	67.5	43.9	23.5	65.1 %
Healthcare	27.6	2.9	24.7	10.5 %
Lifelines	38.6	1.0	37.6	2.5 %
Essential supplies	32.2	0.0	32.2	0.0 %
Overall	40.8	8.7	32.1	21.3 %

Table A7: Coverage and shortage volume by customer category

Category	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Emergency services	175,320.0	115,220.0	60,100.0	65.7 %
Healthcare	180,200.0	125,400.0	54,800.0	69.6 %
Lifelines	407,808.0	75,600.0	332,208.0	18.5 %
Essential supplies	33,312.0	0.0	33,312.0	0.0 %
Overall	796,640.0	316,220.0	480,420.0	39.7 %

Table A8: Coverage and shortage volume by priority group

Priority group	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Priority 1 (W=0.5)	300,720.0	240,620.0	60,100.0	80.0 %
Priority 2 (W=0.333)	462,608.0	75,600.0	387,008.0	16.3 %
Priority 3 (W=0.167)	33,312.0	0.0	33,312.0	0.0 %
Overall	796,640.0	316,220.0	480,420.0	39.7 %
Overall priority-weighted (Priority weight × Litres)	309,971.6	145,484.8	164,486.8	46.9 %

Table A9: Diesel availability and use by customer category

Component	litres
Opening inventory (all stations)	326,000.0
Delivered to Emergency services	115,220.0
Delivered to Healthcare	125,400.0
Delivered to Lifelines	75,600.0
Delivered to Essential supplies	0.0
Self-consumption (all stations)	8,568.0
Transport consumption	1,211.6

Model 2: Emergency stock

Table A10: Average covered-days ratio by customer category across annual cost levels (uplift Level A)

Cost ($)	Selected stations	Overall coverage %	Emergency services coverage %	Essential supplies coverage %	Healthcare coverage %	Lifelines coverage %
3,960	2	24.04	74.54	0.00	10.53	2.50
7,920	4	26.53	83.03	0.00	10.53	2.50
11,880	6	30.25	95.29	0.00	10.53	2.78
15,840	8	33.22	100.00	0.00	18.19	4.65
20,160	10	35.35	100.00	0.00	21.81	8.68
22,680	11	36.52	100.00	0.00	27.46	10.05
26,640	13	38.72	100.00	0.00	32.29	13.95
32,040	16	43.86	100.00	0.00	43.58	23.07
36,000	18	46.08	100.00	0.00	49.22	26.82
40,320	20	46.91	100.00	0.00	54.86	27.44

Table A11: Selected fuel stations for emergency stockholding across annual cost levels (uplift Level A)

Station ID	$3,960	$7,920	$11,880	$15,840	$20,160	$22,680	$26,640	$32,040	$36,000	$40,320
S002					✓	✓	✓	✓	✓	✓
S001					✓	✓	✓	✓	✓	✓
S003						✓	✓	✓	✓	✓
S004				✓	✓		✓	✓	✓	✓
S006						✓	✓	✓	✓	✓
S005							✓	✓	✓	✓
S020	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S007		✓	✓	✓	✓	✓	✓	✓	✓	✓
S012		✓	✓	✓	✓	✓	✓	✓	✓	✓
S009			✓	✓	✓	✓	✓	✓	✓	✓
S015			✓	✓	✓	✓	✓	✓	✓	✓
S016				✓	✓	✓	✓	✓	✓	✓
S008								✓	✓	✓
S011								✓	✓	✓
S019								✓	✓	✓
S014									✓	✓
S018									✓	✓
S017										✓
S013										✓

Table A12: Average coverage and shortage days by customer category for the best-coverage solution (uplift Level A)

Category	Average need (days)	Average coverage (days)	Average shortage (days)	Coverage %
Emergency services	67.5	67.5	0.0	100.0 %
Healthcare	27.6	15.1	12.4	54.9 %
Lifelines	38.6	10.6	28.0	27.5 %
Essential supplies	32.2	0.0	32.2	0.0 %
Overall	40.8	19.1	21.6	46.9 %

Table A13: Coverage and shortage volume by customer category for the best-coverage solution (uplift Level A)

Category	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Emergency services	175,320.0	175,320.0	0.0	100.0 %
Healthcare	180,200.0	152,600.0	27,600.0	84.7 %
Lifelines	407,808.0	156,629.0	251,179.0	38.4 %
Essential supplies	33,312.0	0.0	33,312.0	0.0 %
Overall	796,640.0	484,549.0	312,091.0	60.8 %

Table A14: Coverage and shortage volume by priority group for the best-coverage solution (uplift Level A)

Priority group	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Priority 1 (W=0.5)	300,720.0	300,720.0	0.0	100.0 %
Priority 2 (W=0.333)	462,608.0	183,829.0	278,779.0	39.7 %
Priority 3 (W=0.167)	33,312.0	0.0	33,312.0	0.0 %
Overall	796,640.0	484,549.0	312,091.0	60.8 %
Overall priority-weighted (Priority weight × Litres)	309,971.6	211,575.1	98,398.5	68.3 %

Table A15: Diesel availability and use by customer category (uplift Level A)

Component	litres
Opening inventory (all stations)	326,000.0
Emergency stock added (all stations)	168,000.0
Total available	494,000.0
Delivered to Emergency services	175,320.0
Delivered to Healthcare	152,600.0
Delivered to Lifelines	156,629.0
Delivered to Essential supplies	0.0
Self-consumption (all stations)	8,064.0
Transport consumption	1,387.0

Table A16: Selected fuel stations for emergency stockholding across annual cost levels (uplift Level B)

Station ID	$4,920	$9,840	$14,760	$19,680	$24,720	$27,360	$32,280	$39,480	$44,400	$49,440
S002				✓	✓	✓	✓	✓	✓	✓
S001					✓	✓	✓	✓	✓	✓
S003						✓	✓	✓	✓	✓
S004				✓	✓		✓	✓	✓	✓
S006						✓	✓	✓	✓	✓
S005							✓	✓	✓	✓
S020	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S007		✓	✓	✓	✓	✓	✓	✓	✓	✓
S012		✓	✓	✓	✓	✓	✓	✓	✓	✓
S009			✓	✓	✓	✓	✓	✓	✓	✓
S015			✓	✓	✓	✓	✓	✓	✓	✓
S016					✓	✓	✓	✓	✓	✓
S008								✓	✓	✓
S011								✓	✓	✓
S019								✓	✓	✓
S014									✓	✓
S018									✓	✓
S017										✓
S013										✓

Table A17: Average coverage and shortage days by customer category for the best-coverage solution (uplift Level B)

Category	Average need (days)	Average coverage (days)	Average shortage (days)	Coverage %
Emergency services	67.5	67.5	0.0	100.0 %
Healthcare	27.6	17.5	10.1	63.3 %
Lifelines	38.6	14.5	24.1	37.5 %
Essential supplies	32.2	0.0	32.2	0.0 %
Overall	40.8	21.3	19.5	52.2 %

Table A18: Coverage and shortage volume by customer category for the best-coverage solution (uplift Level B)

Category	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Emergency services	175,320.0	175,320.0	0.0	100.0 %
Healthcare	180,200.0	159,400.0	20,800.0	88.5 %
Lifelines	407,808.0	187,661.0	220,147.0	46.0 %
Essential supplies	33,312.0	0.0	33,312.0	0.0 %
Overall	796,640.0	522,381.0	274,259.0	65.6 %

Table A19: Coverage and shortage volume by priority group (uplift Level B)

Priority group	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Priority 1 (W=0.5)	300,720.0	300,720.0	0.0	100.0 %
Priority 2 (W=0.333)	462,608.0	221,661.0	240,947.0	47.9 %
Priority 3 (W=0.167)	33,312.0	0.0	33,312.0	0.0 %
Overall	796,640.0	522,381.0	274,259.0	65.6 %
Overall priority-weighted (Priority weight × Litres)	309,971.6	224,173.1	85,798.5	72.3 %

Table A20: Diesel availability and use by customer category (uplift Level B)

Component	litres
Opening inventory (all stations)	326,000.0
Emergency stock added (all stations)	206,000.0
Total available	532,000.0
Delivered to Emergency services	175,320.0
Delivered to Healthcare	159,400.0
Delivered to Lifelines	187,661.0
Delivered to Essential supplies	0.0
Self-consumption (all stations)	8,064.0
Transport consumption	1,555.0

Model 3: Prepositioning

Table A21: Average covered-days ratio by customer category across annual cost levels (three tank size options)

Cost ($)	Number of tanks	Overall coverage %	Emergency services coverage %	Essential supplies coverage %	Healthcare coverage %	Lifelines coverage %
27,000	1	29.85	65.11	0.00	10.53	2.50
54,000	1	37.93	94.34	0.00	27.46	13.24
81,000	2	44.42	100.00	0.00	49.22	23.07
108,000	3	51.89	100.00	0.00	63.32	36.83
135,000	4	61.03	100.00	0.00	80.25	53.71
162,000	4	66.02	100.00	0.00	97.18	61.22
189,000	4	71.00	100.00	0.00	100.00	71.85
229,500	5	80.42	100.00	0.00	100.00	93.12
256,500	6	100.00	100.00	100.00	100.00	100.00

Table A22: Selected locations and tank sizes for diesel prepositioning across annual cost levels (three tank size options)

Location ID	$27,000	$54,000	$81,000	$108,000	$135,000	$162,000	$189,000	$229,500	$256,500
P001	—	—	—	—	—	—	—	—	—
P005	—	—	—	—	—	—	—	Medium	Large
P006	—	—	Small	—	Small	Medium	Large	Large	Large
P008	—	—	—	Small	Small	Small	Small	Small	Small
P009	—	—	—	Small	Small	Medium	Large	Large	Medium
P010	—	—	—	—	—	—	—	—	—
P012	Small	Large	Large	Large	Large	Large	Large	Large	Large
P013	—	—	—	—	—	—	—	—	Small

Table A23: Average coverage and shortage days by customer category for the best-coverage solution (three tank size options)

Category	Average need (days)	Average coverage (days)	Average shortage (days)	Coverage %
Emergency services	67.5	67.5	0.0	100.0 %
Healthcare	27.6	27.6	0.0	100.0 %
Lifelines	38.6	38.6	0.0	100.0 %
Essential supplies	32.2	32.2	0.0	100.0 %
Overall	40.8	40.8	0.0	100.0 %

Table A24: Coverage and shortage volume by customer category for the best-coverage solution (three tank size options)

Category	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Emergency services	175,320.0	175,320.0	0.0	100.0 %
Healthcare	180,200.0	180,200.0	0.0	100.0 %
Lifelines	407,808.0	407,808.0	0.0	100.0 %
Essential supplies	33,312.0	33,312.0	0.0	100.0 %
Overall	796,640.0	796,640.0	0.0	100.0 %

Table A25: Coverage and shortage volume by priority group (three tank size options)

Priority group	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Priority 1 (W=0.5)	300,720.0	300,720.0	0.0	100.0 %
Priority 2 (W=0.333)	462,608.0	462,608.0	0.0	100.0 %
Priority 3 (W=0.167)	33,312.0	33,312.0	0.0	100.0 %
Overall	796,640.0	796,640.0	0.0	100.0 %
Overall priority-weighted (Priority weight × Litres)	309,971.6	309,971.6	0.0	100.0 %

Table A26: Diesel availability and use by customer category (three tank size options)

Component	litres
Opening inventory (all stations)	326,000.0
Prepositioning inventory (2 Small + 1 Medium + 3 Large)	475,000.0
Total available	801,000.0
Delivered to Emergency services	175,320.0
Delivered to Healthcare	180,200.0
Delivered to Lifelines	407,808.0
Delivered to Essential supplies	33,312.0
Self-consumption (all stations)	2,016.0
Transport consumption	2,344.0

Table A27: Average covered-days ratio by customer category across annual cost levels (two tank size options)

Cost ($)	Number of tanks	Overall coverage %	Emergency services coverage %	Essential supplies coverage %	Healthcare coverage %	Lifelines coverage %
27,000	1	29.85	94.34	0.00	10.53	2.50
54,000	2	37.25	100.00	0.00	27.46	11.71
94,500	3	48.57	100.00	0.00	57.68	30.57
121,500	4	55.77	100.00	0.00	77.43	42.46
162,000	5	66.29	100.00	0.00	100.00	61.22
189,000	5	71.55	100.00	0.00	100.00	73.10
216,000	6	77.09	100.00	0.00	100.00	85.61
256,500	7	100.00	100.00	100.00	100.00	100.00

Table A28: Selected locations and tank sizes for diesel prepositioning across annual cost levels (two tank size options)

Location ID	$27,000	$54,000	$94,500	$121,500	$162,000	$189,000	$216,000	$256,500
P001	—	—	—	—	—	—	Small	Medium
P005	—	—	—	—	Small	Medium	Medium	Medium
P006	—	—	—	Small	Medium	Medium	Medium	Medium
P008	—	—	Small	Small	Small	Small	Small	Small
P009	—	Small	Medium	Small	Small	Medium	Medium	Medium
P010	—	—	—	—	—	—	—	—
P012	Small	Small	Small	Medium	Medium	Medium	Medium	Medium
P013	—	—	—	—	—	—	—	Small

Table A29: Average coverage and shortage days by customer category for the best-coverage solution (two tank size options)

Category	Average need (days)	Average coverage (days)	Average shortage (days)	Coverage %
Emergency services	67.5	67.5	0.0	100.0 %
Healthcare	27.6	27.6	0.0	100.0 %
Lifelines	38.6	38.6	0.0	100.0 %
Essential supplies	32.2	32.2	0.0	100.0 %
Overall	40.8	40.8	0.0	100.0 %

Table A30: Coverage and shortage volume by customer category for the best-coverage solution (two tank size options)

Category	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Emergency services	175,320.0	175,320.0	0.0	100.0 %
Healthcare	180,200.0	180,200.0	0.0	100.0 %
Lifelines	407,808.0	407,808.0	0.0	100.0 %
Essential supplies	33,312.0	33,312.0	0.0	100.0 %
Overall	796,640.0	796,640.0	0.0	100.0 %

Table A31: Coverage and shortage volume by priority group (two tank size options)

Priority group	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Priority 1 (W=0.5)	300,720.0	300,720.0	0.0	100.0 %
Priority 2 (W=0.333)	462,608.0	462,608.0	0.0	100.0 %
Priority 3 (W=0.167)	33,312.0	33,312.0	0.0	100.0 %
Overall	796,640.0	796,640.0	0.0	100.0 %
Overall priority-weighted (Priority weight × Litres)	309,971.6	309,971.6	0.0	100.0 %

Table A32: Diesel availability and use by customer category (two tank size options)

Component	litres
Opening inventory (all stations)	326,000.0
Prepositioning inventory (2 Small + 5 Medium + 0 Large)	475,000.0
Total available	801,000.0
Delivered to Emergency services	175,320.0
Delivered to Healthcare	180,200.0
Delivered to Lifelines	407,808.0
Delivered to Essential supplies	33,312.0
Self-consumption (all stations)	2,016.0
Transport consumption	2,344.0

Model 4: Airlift

Table A33: Average covered-days ratio by customer category across annual cost levels

Cost ($)	Number of flights	Overall coverage %	Emergency services coverage %	Essential supplies coverage %	Healthcare coverage %	Lifelines coverage %
210,000	3	27.91	87.74	0.00	10.53	2.50
490,000	7	35.53	100.00	0.00	21.81	9.08
770,000	11	43.46	100.00	0.00	37.93	23.42
1,050,000	15	51.06	100.00	0.00	60.50	35.58
1,330,000	19	58.54	100.00	0.00	83.07	47.46
1,610,000	23	64.63	100.00	0.00	91.54	59.34
1,890,000	27	71.00	100.00	0.00	100.00	71.85
2,170,000	31	76.54	100.00	0.00	100.00	84.36
2,450,000	35	81.52	100.00	0.00	100.00	95.62
2,730,000	39	100.00	100.00	100.00	100.00	100.00

Table A34: Airlift delivery per station per week for the best-coverage solution

Station ID	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Total (Litres)
S002	-	2,000	2,000	-	3,254	19,384	3,807	-	-	23,386	9,887	2,000	5,798	71,516
S001	-	2,000	2,000	-			2,000	-	-	2,000	2,000	2,000	-	12,000
S003	-	2,000	2,000	-	-	2,000	2,000	23,027	-	-	-	-	13,426	44,453
S004	-	2,000	-	-	2,000	-	-	2,000	21,170	-	-	-	-	27,170
S006	-	2,000	2,000	2,000	2,000	-	-	-	2,000	-	11,248	2,000	-	23,248
S005	-	2,000	-	-	2,000	-	-	-	2,000	-	2,000	2,000	-	10,000
S020	-	2,000	2,000	2,000	14,136	2,000	17,654	-	-	-	-	2,000	2,000	43,790
S010	-	11,443	33,557	45,000	21,409	2,000	-	-	-	-	-	2,000	2,000	117,409
S007	-	2,000	2,000	27,626	4,522	-	-	-	-	-	-	2,000	2,000	40,148
S012	-	2,000	2,000	-	2,000	-	-	-	-	-	-	2,000	-	8,000
S009	-	2,000	2,000	-	12,403	-	-	-	-	-	-	2,000	-	18,403
S015	-	16,500	27,000	-	-	-	-	-	-	-	-	2,000	-	45,500
S016	-	2,000	-	-	-	-	-	-	-	-	-	5,412	-	7,412
S008	-	24,521	-	-	-	-	-	-	-	-	-	-	-	24,521
S011	-	2,000	-	-	-	-	-	-	-	-	-	-	-	2,000
S019	-		-	-	-	-	-	-	-	-	-	-	-	-
S014	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S018	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S017	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S013	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total (Litres)	-	76,464	76,557	76,626	63,724	25,384	25,461	25,027	25,170	25,386	25,135	25,412	25,224	495,570

Table A35: Average coverage and shortage days by customer category for the best-coverage solution

Category	Average need (days)	Average coverage (days)	Average shortage (days)	Coverage %
Emergency services	67.5	67.5	0.0	100.0 %
Healthcare	27.6	27.6	0.0	100.0 %
Lifelines	38.6	38.6	0.0	100.0 %
Essential supplies	32.2	32.2	0.0	100.0 %
Overall	40.8	40.8	0.0	100.0 %

Table A36: Coverage and shortage volume by customer category for the best-coverage solution

Category	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Emergency services	175,320.0	175,320.0	0.0	100.0 %
Healthcare	180,200.0	180,200.0	0.0	100.0 %
Lifelines	407,808.0	407,808.0	0.0	100.0 %
Essential supplies	33,312.0	33,312.0	0.0	100.0 %
Overall	796,640.0	796,640.0	0.0	100.0 %

Table A37: Coverage and shortage volume by priority group

Priority group	Need (litres)	Covered (litres)	Shortage (litres)	Coverage %
Priority 1 (W=0.5)	300,720.0	300,720.0	0.0	100.0 %
Priority 2 (W=0.333)	462,608.0	462,608.0	0.0	100.0 %
Priority 3 (W=0.167)	33,312.0	33,312.0	0.0	100.0 %
Overall	796,640.0	796,640.0	0.0	100.0 %
Overall priority-weighted (Priority weight × Litres)	309,971.6	309,971.6	0.0	100.0 %

Table A38: Diesel availability and use by customer category

Component	litres
Opening inventory (all stations)	326,000.0
Airlift dispatched (39 flights × 12,800 L/flight)	499,200.0
Total available	825,200.0
Delivered to Emergency services	175,320.0
Delivered to Healthcare	180,200.0
Delivered to Lifelines	407,808.0
Delivered to Essential supplies	33,312.0
Self-consumption (all stations)	16,632.0
Airlift transport consumption (airport to stations)	2,736.0
Transport consumption (stations to customers)	4,962.4
Remaining inventory (all stations)	4,229.7

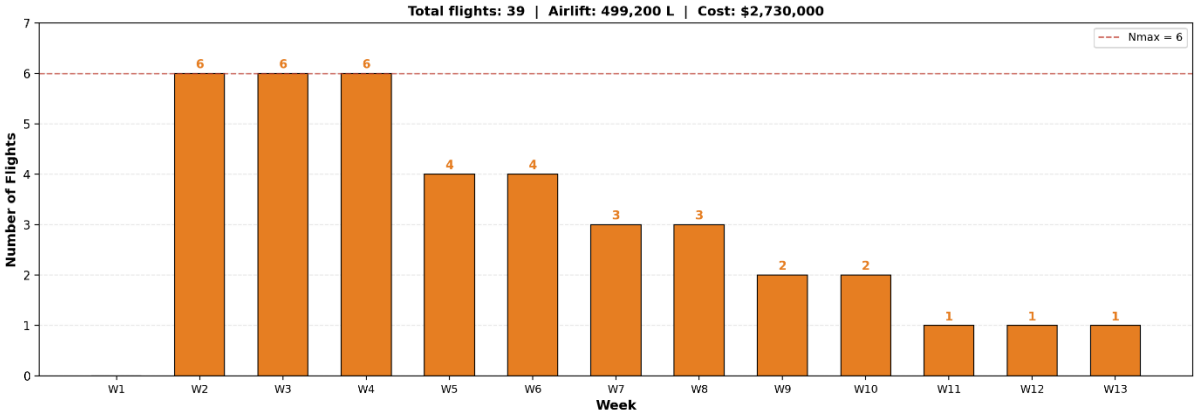

Figure A6: Alternative flight schedule over the 13-week horizon for the best-coverage solution

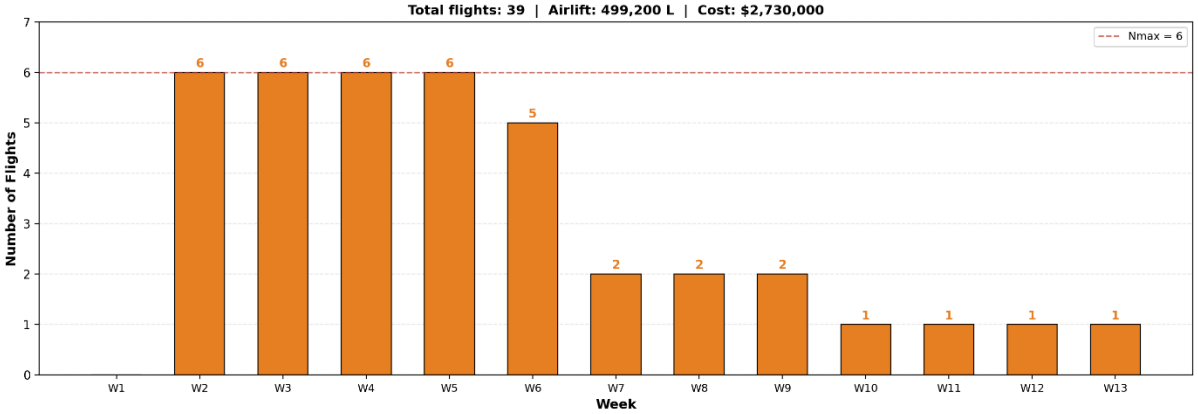

Figure A7: Alternative flight schedule over the 13-week horizon for the best-coverage solution

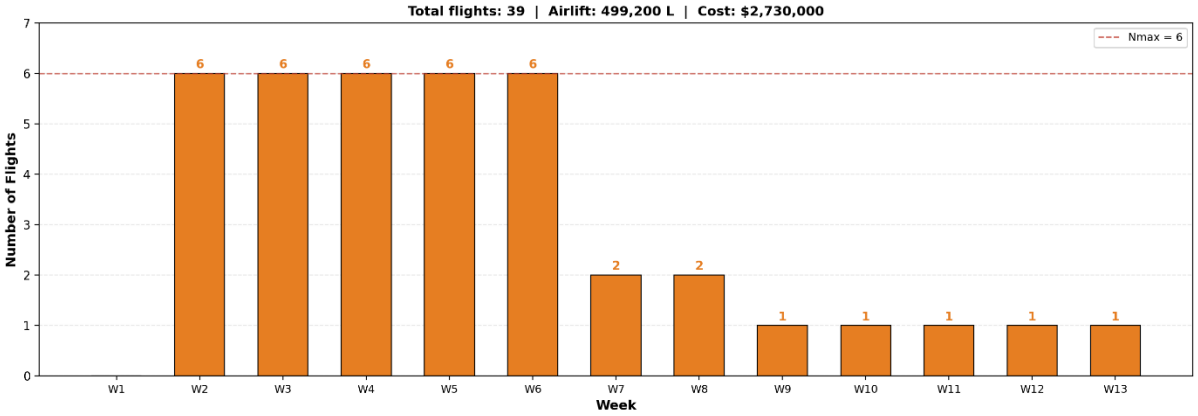

Figure A8: Alternative flight schedule over the 13-week horizon for the best-coverage solution