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Assessment and Optimization Study for Fire and Rescue Stations in Armenia

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Assessment and Optimisation Study for Fire/Rescue Stations in Armenia

Task 4 - Fire Service Optimisation Study

October 2020

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Preface

This report was developed under the project Selection # 1265186 *"Assessment and optimization study of fire/rescue stations in Armenia"* funded by the World Bank.

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Abbreviations and Acronyms

Abbreviation/Acronym	Description
AFRS	Armenian Fire and Rescue Service
BRV	Battalion Response Vehicle
BI	Building Infrastructure
BII	Building Infrastructure Index
BS	Back-up Systems
CAFS	Compressed Air Foam Systems
CBRNE	Chemical, Biological, Radiological, Nuclear and Explosive
CMC	Crisis Management Centre
CMNC	Crisis Management National Centre
DRM	Disaster Risk Management
DS	Damage State
EDG	Emergency Diesel Generator
EE	Energy Efficiency
ERC	Emergency Response Centre
ERF	Emergency Response Faciities
ET	Emergency Tender
FSO	Fire Service Optimization
FRS	Fire and Rescue Station
GDP	Gross Domestic Product
HRV	Heavy Rescue Vehicles
HRVA	Hazard, Risk and Vulnerability Analysis
HUSAR	Heavy Urban Search And Rescue
IARC	International Agency for Research on Cancer
ICT	Information and Communications Technology
KPI	Key Performance Indicator
MRP	Mean Return Period
MoES	Ministry of Emergency Situations
MML	Mott MacDonald Limited
MOD	Ministry of Defence
MUSAR	Medium Urban Search and Rescue
NGO	Non-Government Organisation
NO	Normal Operation
OC	Operational Capacity
PC	Personal Computer
PPE	Personal Protective Equipment
RTA	Road Traffic Accident
R2R	Ready to Respond
SAR	Search & Rescue Activities
SCBA	Self-Contained Breathing Apparatus

Abbreviation/Acronym	Description
SI	Site Infrastructure
UL	Underwriters Laboratories
VOIP	Voice Over Internet Provider

Executive summary

Introduction

Mott MacDonald was hired by the World Bank to support the World Bank and the Armenian Government in developing a service optimization plan for the fire/rescue and emergency response facilities in Armenia. The project has three stages with three main technical deliverables:

- **Baseline Assessment**: A high-level assessment of all fire/rescue facilities in Armenia. The high-level assessment is achieved through analysis of data collected for 56 out of 63 stations[1] in terms of functionality and response capacity, buildings adequacy, seismic vulnerability, and exposure to site hazards.
- **Seismic Structural Assessment:** A more detailed structural and seismic assessment of selected facilities to identify seismic retrofitting options at conceptual level and the relevant cost for each retrofit option.
- **Fire/Rescue Service Optimization Study (this report):** A service optimization study based on the gathered information in the previous tasks. The aim is to provide recommendations to improve the fire/rescue services on a national level considering innovative approaches tailored to the context of Armenia in terms of capital and financial sustainability.

Context

The Ministry of Emergency Situations of Armenia (MoES) is a government agency overseeing the civil emergency services in Armenia. The ministry is composed of 5 main agencies: Rescue Service, National Seismic Protection Service, Armgosgidromet, State Reserves Agency, National Center for Technical Security. The fire rescue stations are part of the agency responsible for Rescue services. There are 60 fire/rescue stations in Armenia and 3 fire bases/posts. In addition, there are 10 regional Emergency Response Centres that administrate the 911 emergency line and provide coordination to the local fire/rescue stations. Five of these centres share the same building with a fire/rescue station and five are in separate buildings. There are 13 fire stations in Yerevan, 3 in Vanadzor (one of which in Gugark) and 2 in Gyumri (one of which is in the nearby town of Akhuryan). All other towns have one fire/rescue station. Practically all firefighters are full-time employed professionals but there are some recent activities to introduce volunteer firefighting service in some small communities.

Armenia is classified as a developing country and upper-middle income economy and has a restricted financial capacity to build and maintain a large and complex fire and rescue service comparable with the fire and rescue service maintained in the more developed countries of similar size. In addition, the urbanisation patterns, industry developments and demographic processes do not economically justify the need of a large and complex fire and rescue service. In the same time, the relatively remote location, challenging road conditions (long travel times between towns) and high seismic hazard suggests that Armenia needs largely autonomous fire and rescue service, both at national level and at individual fire and rescue stations. However, due to the long period of underfinancing of the fire/rescue service operations, the current situation is that the physical infrastructure, the fire engines, and the specialised equipment of the Armenian

[1] Sufficient data for the assessment was collected for 56 facilities during the mission to Armenia. When the text in this report refers to all fire/rescue stations without further defining what all means, that reference is to the 56 facilities with available data.

fire/rescue stations are far from the international best practice. While there is a noticeable improvement in capacitating the Armenian Fire and Recue Service (AFRS) by establishing a National Crisis Management Centre (NCMC), building of a National Medium Urban Search and Rescue (MUSAR) Team, repair works and interior improvements in some fire and rescue stations, increasing salaries of firefighters and acquisition of new equipment and vehicles, there is more to be done in order to stabilise, expand and optimise the Armenian Fire and Recue Service (AFRS) and bring it closer to good international practice.

On overall the building stock is degraded, many Fire and Rescue Stations (FRSs) are located in buildings that were never intended to be fire stations, and those which were specifically designed for fire stations are based on outdated standards, proper back-up systems are rarely present, technical training facilities are rarely present, too, and where present are often in an unusable condition. The situation with the fleet of fire engines and the specialised equipment is similar, despite that in many locations the fire engines fleet was significantly improved in the recent years mainly due to donor programmes. However, the absence of an integral long-term strategy with synchronised e interventions led to unbalanced investments with examples of improved buildings equipped with aged fire engines (e.g. Artashat) or more often, new fire engines and equipment supplied to FRSs with buildings in poor condition (e.g. Ashotsk). In the most extreme cases, the new ISUZU fire engines are left outside the FRS buildings or in self-made shelters because they cannot fit in the garages of the existing stations. The high average altitude and the continental climate with cold winters and hot summers provide additional challenges to both the FRS' building envelopes and the fire engines.

Another significant challenge for the Armenian fire stations is the regional seismicity. This from one side puts the FRS buildings at risk of damage and collapse, which in combination with potentially damaged equipment and fire engines may lead to significant financial impact for the Ministry of Emergency Situations (MoES). On the other side, the relatively high seismic hazard in Armenia with the combination of relatively vulnerable building stock is likely to lead to significant demand for firefighting of seismically induced fires and for heavy urban search and rescue activities. The tragedy from Spitak in 1988 is a serious reminder for the potential consequences from a strong earthquake near Yerevan.

Key Deficiencies in Armenian Fire and Rescue Stations

During the implementation of this project, the project team managed to visit 56 fire and rescue stations across Armenia. There is a noticeable positive trend and many positive actions have been started, or already implemented, from the MoES. Examples are interior improvement works in around 30 stations, new equipment and fire engines (thought mostly due to international aid), new garage doors and/or ventilation systems in some stations, some provisions for back-up power supply. However, these positive interventions are still limited in coverage and in depth, and hence do not have significant impact on the fire rescue service capacity and efficiency to respond to day-to-day emergencies, not to mention rare high consequence events. In the same time, this project identified many and serious deficiencies observed across the Armenian fire and rescue stations with the most critical ones summarised below:

- Aged fleet of specialised vehicles dominated by vehicles on truck chassis with a very small share of Brigade Response Vehicles (on a pick-up or light truck chassis) which restricts operational flexibility and leads to higher running costs and increased time out of service while waiting for parts and repairs.
- Firefighting clothing is generally below the international relevant good practice and where new equipment is available it is usually stored and maintained inappropriately.

- Very few stations have any technical training facilities but where these are available, they are usually unusable due to poor conditions.
- Most stations lack computers and modern digital communication equipment which leads to ineffective reporting of calls and make data collection and processing for decision making difficult.
- The current poor condition of the building infrastructure is a common deficiency of the portfolio of fire and rescue stations in Armenia. Many fire and rescue stations are in buildings that were never intended to be fire and rescue stations, and those that were specifically designed are based on outdated standards. The majority of the fire and rescue stations are too small compared to the modern requirements.
- Only one of the visited 56 fire and rescue stations has a proper back-up power system and only few have some form or back-up water and back-up fuel supply. None of the stations have a communication system that can operate in full autonomy from external providers.
- The majority of the fire and rescue station buildings are with low seismic resistance and are not expected to remain functional (at least not without compromising staff safety) after a strong earthquake.
- About 20% of the FRSs have private co-owners. It should be noted that these are not tenants which provide additional income to the FRS, but co-owners of the building that will need to provide at least a consent for any major reconstruction works. In some cases, the shared ownership increases the disaster risk of the FRS. For example, part of the FRS in Masis uses the ground floor of a 3 storey-high multifamily residential building which increase the seismic vulnerability of the FRS; The private residents that use half of the 2nd floor of the FRS with ID70 in Yerevan have extended their floor area with seemingly non-engineered construction with directly attached gas pipelines which increase both the seismic and the fire risk.

Needed Investments

A bottom-up approach specifying the needed improvements to each fire and rescue station was used to build up the budget estimates at regional/marz and country level. In the bottom-up approach the investment needs are estimated for each individual FRS, however this is based on a generalised approach, where all FRSs are grouped in six groups based on common deficiencies to which identical sets of interventions are applied.

The identified investment needs were estimated to be between $75M and $210M depending on the selected modernisation programmes. Each variant of a modernisation programme aims a holistic approach with improvement of all physical components of the fire and rescue service – buildings, communication system, specialised equipment and vehicles. However, the scale of improvement varies and hence the needed investment differs significantly. While the most expansive variant (Variant 4) leads to complete transformation of the AFRS, the lowest cost option (Varian 2) achieve mainly stabilisation of the AFRS with some aspects of expansion of the capacity. The four modernisation programmes variants are summarised below and in Table 0.1 :

- **Variant 1 Stabilisation with Expansion and elements of Optimisation of the AFRS ($100M):**

- Refurbishment[2] of 16 FRSs keeping their original size, major remodelling[3] with area expansion for another 35 FRSs and construction of 5 new FRSs at a new site with a total cost of the building infrastructure improvements of $41.7M;
- Acquiring of 167 new vehicles, of which 26 Brigade Response Vehicles (BRVs), 18 Wildland Apparatus, 25 Emergency Tenders (ET) of different types/sizes, 26 tanker pumpers (to pair each BRV), 7 Heavy Rescue Vehicles (HRV) and 65 specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of about $41.5M;
- Buying of 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 12 sets of heavy rescue equipment with a total expected cost of $12.1M;
- Buying and installing 3 computers per FRS and modern communication equipment to equip the dispatcher rooms of all FRSs with a total expected cost of $0.5M;
- Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
- Developing new or retrofit[4] of the existing technical training facilities in 42 of the FRSs with a total expected cost of $3.3M;

- **Variant 2 Stabilisation with Expansion of the AFRS ($75M):**
  - Refurbishment of 40 FRSs keeping their original size, partial renovation[5] and refurbishment of the 11 FRS with shared ownership and construction of 5 new FRSs at a new site with a total cost of the building infrastructure improvements of $26.9M;
  - Acquiring of 140 new vehicles, of which 21 BRVs, 17 wildland apparatus, 25 ETs of different types/sizes, 21 tanker pumpers, 4 HRVs and 52 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $31.2M;
  - Buying 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 4 sets of heavy rescue equipment with a total expected cost of $11.7M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new or retrofit of the existing technical training facilities in 21 of the FRSs with a total expected cost of $2.1M;

- **Variant 3 Expansion and Optimisation with elements of Transformation of the AFRS ($195M):**
  - Refurbishment of 6 FRSs keeping their original size, construction of 34 new FRSs at their current site and construction of 16 new FRSs at a new site with a total cost of the building infrastructure improvements of $95.3M;

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[2] Refurbishment relates to finishing works such as painting, tiling, cleaning, as well as decoration.

[3] Remodelling refers to complete change of interior space of a building comprising of demolishing existing interior walls and rebuilding them with alternate distribution. It also comprises of finishing works and decoration.

[4] For definition of retrofit refer to footnote 2 on page 15.

[5] Renovation refers to refurbishment and rehabilitation, for reference see footnote 1 on page 15, of structural elements.

  - Acquiring of 251 new vehicles of which 34 BRVs, 18 wildland apparatus, 63 ETs of different types/sizes, 34 tanker pumpers and 14 HRVs and 88 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $73.1M;
  - Buying of 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 20 sets of heavy rescue equipment with a total expected cost of $12.5M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new or retrofit of the existing technical training facilities in 43 of the FRSs with a total expected cost of $11.3M;

- **Variant 4 Expansion and Optimisation with Transformation of the AFRS ($210M):**
  - Construction of 21 new FRSs at their current site and construction of 35 new FRSs at a new site with a total cost of the building infrastructure improvements of $89.7M;
  - Acquiring of 282 new vehicles, of which 34 BRVs, 18 wildland apparatus, 63 ETs of different types/sizes, 34 tanker pumpers, 14 HRVs and 119 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $83.7M;
  - Buying 1937 sets of firefighting clothes and 441 sets of SCBA, 56 specialised/rescue equipment and 38 sets of heavy rescue equipment, 2 sets of water rescue equipment with a total expected cost of $13.4M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new technical training facilities in 51 of the FRSs with a total expected cost of $22.9M;

Table 0.1: Summary of interventions and costs for the four variants of modernisation programme

Modernisation Projects	Variant 1	Variant 2	Variant 3	Variant 4
Building infrastructure				
- New construction	- 5	- 5	- 50	- 56
- Remodelling w/ expansion	- 35	- 0	- 0	- 0
- Refurbishment	- 16	- 51	- 6	- 0
- **Estimated Total Cost**	- **$41,7M**	- **$26,9M**	- **$95,3M**	- **$89,7M**
Fleet of special vehicles				
- BRVs	- 26	- 21	- 34	- 34
- ETs	- 25	- 25	- 63	- 63
- HRVs	- 7	- 4	- 14	- 14
- Other Vehicles	- 109	- 90	- 140	- 171
- **Estimated Total cost**	- **$41,5M**	- **$31,2M**	- **$73,1M**	- **$83,7M**

Modernisation Projects	Variant 1	Variant 2	Variant 3	Variant 4
PPE and specialised equipment				
- Firefighting clothing sets	- 1937	- 1937	- 1937	- 1937
- SCBA sets	- 441	- 441	- 441	- 441
- Light rescue equipment	- 56	- 56	- 56	- 56
- Heavy rescue equipment	- 12	- 4	- 20	- 38 + 2*
- **Estimated Total Cost**	- **$12,1M**	- **$11,7M**	- **$12,5M**	- **$13,4M**
ICT equipment				
- Computers	- 168	- 168	- 168	- 168
- Communication equipment	- 56	- 56	- 56	- 56
- **Estimated Total Cost**	- **$500,000**	- **$500,000**	- **$500,000**	- **$500,000**
EDG				
- Number	- 55	- 55	- 55	- 55
- Stations	- 55	- 55	- 55	- 55
- **Estimated Total Cost**	- **$400,000**	- **$400,000**	- **$400,000**	- **$400,000**
Technical Training Facilities				
- Stations	- 42	- 21	- 43	- 51
- **Estimated Total Cost**	- **$3,3M**	- **$2,1M**	- **$11,3M**	- **$22,9M**
Total	**$99,5M**	**$72,8M**	**$193,1M**	**$210,6M**

While all variants achieve great improvement of the Operational Capacity, each variant achieves very different level of improvement of the Building Infrastructure and the other two functionality groups. The results of the functionality scores for the current situation and after implementing the interventions for the four variants are summarised in Appendix D. It is the MoES to decide what is the target functionality level that they want to achieve across their portfolio of fire stations.

Variant 4 and to large extend Variant 3 will lead to transformational change in the Armenian Fire and Rescue Service (AFRS) but is associated with an investment cost in the range of $200M. In addition, Variant 3 and 4 are scalable and provide great flexibility for modification and reorganisation (in the timeline) of the interventions. This is because the most static/inertial element of the AFRS, namely the building stock, is fully replaced (almost fully replaced for Variant 3) with new modern buildings and the floor area is doubled compared to current figures (see Having modern spacious FRSs provide the mentioned above flexibility and scalability of the modernisation programme, e.g., changing type/size of vehicles, staff number, etc.

At the other extreme is Variant 2 which will achieve mainly stabilisation of the current AFRS by improving the building infrastructure, strengthening the communication system, adding back-up power capacity and technical training facilities. It will, however, lead also to some expansion of the capacity due to the acquisition of new vehicles and new specialised equipment. The cost of Variant 2 could be reduced even further to about $50M by reducing the number of procured vehicles. The main disadvantage of Variant 2 is that this is not a scalable modernisation programme. The FRS total floor are will be increased just slightly and will be still only 60% of the minimum needed (see Table 0.2). This means that the FRSs will be still too small to meet the needs of modern fire and rescue station and this will restrict the number and type of vehicles that can be assigned to the FRS, the equipment that can be safely stored and maintained, the staff number, etc.

Variant 1 describes a more balanced modernisation programme which for 50% of the cost of “best case” options and for 25% more than Variant 1 is likely to achieve stabilisation and expansion of the AFRS with some elements of optimisation of the service. The main difference and advantage of Variant 2 compared to Variant 1 is that it is scalable modernisation programme and provides greater flexibility to modify the type of interventions. Variant 1 leads to 50% increase of the total floor area compared to current situation and achieves total floor area at about 75% of the minimum required (see Table 0.2). This provides enough space in the most important FRSs to accommodate different types/sizes of fire engines and to store specialist equipment.

Table 0.2: Summary of FRS total floor area in the current situation and achieved from the four variants for modernisation programme

	Current situation	Variant 1	Variant 2	Variant 3	Variant 4
New build floor area, sq.m.		8,125	8,125	69,085	77,805
Expansion floor area, sq.m.		11,557	0	0	0
Total added floor area, sq.m.		**19,682**	**8,125**	**69,085**	**77,805**
Total floor area of the 56 FRSs sq.m.	**40424**	**58,326**	**46,769**	**77,570**	**77,805**
Area, % of the tolerable area	52%	75%	60%	100%	100%

Note:
1) The tolerable flor area is the minimum needed area for the FRS to meet the modern requirements and is based on 85% of the area specified in the current Russian design standard for fire stations [S7]. The tolerable area for the 56 FRSs is 77,805 sq.m.
2) The optimal floor area needed area for the FRS to meet the modern requirements and is based on 100% of the area specified in Russian design standard for fire stations [S7]. The optimal floor area for the 56 FRSs is estimated to be 91,484 sq.m.

Recommended Projects and/or Potential Modernization Programme

The bottom-up approach described above estimates the needed investments for different level of improvement (four variants) based on current needs and without applying any strategic considerations. Using the Fire Service Improvement Strategy, for reference see Section 7, a top-down approach is introduced to the decision making which leads to prioritisation of the needed investments based on strategic and contextual considerations. The readiness for implementation of the projects based on the availability/reliability of the data needed to take robust data-driven investment decisions was also a major consideration in selecting the six modernisation projects recommended below. In addition, the six modernisation projects below are developed with the aim to establish the core of a flexible and scalable modernisation programme which can be modified along the way and more importantly expanded/scaled by additional projects developed in parallel or after the completion of this modernisation programme. This will allow to MoES to integrate other projects with donor funding into this modernisation programme and scaling the outcome. The final outcome of this FSO study is the recommended below six specific project areas to form an 8 years long modernisation programme estimated to cost about $90M:

- **Project 1 - Modernising the Building Infrastructure ($45M):** This project area includes the construction of 5 new fire stations, refurbishment of 16 FRSs and major remodelling with area expansion of 35 FRSs together with seismic retrofit, energy efficiency measures, new building services, finishing works and new furniture for all stations with a total cost estimated at about $45M (range of $38M to $54M).
- **Project 2 - Modernising the Fleet of Specialised Vehicles ($16.5M):** This project area includes the procurement of 30 Brigade Response Vehicles (BRV), 20 Emergency Tenders (ET) and 8 Heavy Rescue Vehicles (HRV) with a total budget needed for this purpose estimated at about $16.5M (range of $12.2M to $21.4M).

- **Project 3 - Modernising the PPEs and the Specialised Equipment ($11.2M):** This project area includes the procurement of firefighting clothing, PPE, Self-Contained Breathing Apparatus (SCBA), light and heavy rescue equipment, laundering machines and storage racks with a total budget estimated at about $11.2M (range of $8.9M and $14.3M).
- **Project 4 - New ICT Equipment and Data Management System ($0.5M):** This project area includes procurement of 3 computers and communication equipment for the dispatch room of all FRSs with a total budget estimated at about $0.5M (range of $0.4M to $0.75M).
- **Project 5 - Install Emergency Diesel Generators (EDG) ($0.5M):** This project area includes the procurement and installation of 63 EDGs (all stations except that in Artashat) with a total budget estimated at about $0.5M (range of $0.3M to $0.75M).
- **Project 6 - Build New Multipurpose Regional Centres ($14M):** This project area includes the construction of four multipurpose regional centres that will provide training facilities, storage depos and maintenance and repair workshops with a total budget estimated at about $14M (range of $12M to $16M).

The six recommended projects form a modernisation programme that is closest to modernisation programme described as a Variant 1. The recommended investments in firefighting clothing and PPE, rescue equipment, ICT equipment and back-up power sources are practically identical with these in Variant 1 (see Table 0.3). This is because these interventions are critical for the stabilisation of the AFRS and do not need further data for justification. In addition, these interventions are “movable”, i.e., the procured goods can be moved to another building (if the building is replaced with new at a new site) or stored temporarily while the existing building is remodelled or demolished and replaced with new at the same site. While the deployment of these sets of equipment may delay in some stations, for example due to the lack of proper storage, it is still recommended to consider procurement for all stations at once as this is likely to lead to economic benefits due volume discounts.

The interventions for the building infrastructure improvements are practically the same as these in Variant 1 with a total cost estimated slightly higher (see Table 0.3) due to added provisions for energy efficiency, garage condition improvements, furniture and buildings services for the seven stations that were not visited and hence not included in the baseline assessment [P1] and in the estimate for the needed investments presented in this report.

The main difference between the recommended modernisation programme and the four variants is in the recommended upgrade of the fleet of specialised vehicles resulting almost twice lower investment in vehicles compared to the lowest cost variant of a modernisation programme (Variant 1) and five times lower investment compared with the “best-case scenario” – Variant 4. The selection of type and number of vehicles for the four variants of modernisation programmes is based on generic considerations. In particular it is in function of the average age of the current vehicles in the station, the shift size, the garage size and height in the FRS (with consideration of the potential upgrades) and some basic characteristics of the FRS serviced area like the overall terrain characteristics and the maximum height of the building stock. The main reason for that is that the selection of the most suitable vehicles and the optimal number of vehicles for each FRS is recommended to be based on further studies – detailed assessment of the current fleet and long-term fleet management strategy, see Section 7.2.5, and hazard, risk and vulnerability assessments of the FRS serviced area, Section 7.2.7. In addition, the procurement of vehicles is very flexible and scalable intervention, in contrast whit the interventions for improvement of the building infrastructure. However, based on the findings in the Baseline Assessment Report [P1] and the strategic considerations outlines in Section 7 of this report, the procurement of a fleet of (at least) 30 BRVs and adding 20 ETs as a direct replacement of 20 of the fire engines older than 25 years is considered a classical “no regret” investment. These are vehicles that are certainly needed, and the recommended numbers are certainly below the demand, i.e., there is a high confidence that these vehicles will be fit-for-purpose. Project 2 recommends also the procurement of 8 HRVs which are considered important if the MoES wants to build a more autonomous Urban Search and Rescue (USAR) capability.

Summary of the costs of the proposed projects and comparison with the needed investments as defined in Section 6 is provide in Table 0.3.

Table 0.3: Summary of costs of the potential modernisation projects

Modernisation Projects	Variant 1	Variant 2	Variant 3	Variant 4	Potential Programme
Building infrastructure	$41,700,000	$26,900,000	$95,300,000	$89,700,000	$45,000,000
Fleet of special vehicles	$41,500,000	$31,200,000	$73,100,000	$83,700,000	$16,500,000
PPE and specialised equipment	$12,100,000	$11,700,000	$12,500,000	$13,400,000	$11,200,000
ICT equipment	$500,000	$500,000	$500,000	$500,000	$500,000
EDG	$400,000	$400,000	$400,000	$400,000	$500,000
Specialised Training Facilities	$3,300,000	$2,100,000	$11,300,000	$22,900,000	$14,000,000
Total	$99,500,000	$72,800,000	$193,100,000	$210,600,000	$87,700,000

The recommended modernisation programme is phased in three phases with a spending profile estimated to be as follows:

- Phase 1 - Stabilise: Approximately $31M over 3 years period
- Phase 2 - Expand: Approximately $29M over 2 years period
- Phase 3 - Optimise: Approximately $28M over 3 years period

The project phasing proposed below is based on the following main considerations:

- Urgency and criticality:
  - Phase 1: should be considered as stabilizing the existing Armenian fire & rescue service with limited expansion of services.
  - Phase 2 and 3: build on the foundation of the implemented actions of Phase 1 and are transformational with either expansion of the services or improved efficiency.
- Availability of information for decision making:
  - Phase 1: considers actions for which 1) there is enough data available to support decision making; 2) the needed new/additional data is easy and quick to generate/collect or 3) there is no need for detailed information to take adequate decision and this can be done based on common sense or based on experience/analogy with other jurisdictions.

  - Phase 2 and 3: consider interventions that are based on further studies or design projects developed during Phase 1
- Sequence of activities

Table 0.4: Breakdown of project costs in each phase

Phase Project	Budget	Budget Range Min	Max	Comment
Phase 1	**$31M**	**$26M**	**$39M**	**Stabilise the existing fire service**
Brigade Response Vehicles (BRV)	$4.0M	$3.4M	$5.4M	
Personal Protective Equipment (PPE) and clothing	$6.3M	$5.0M	$8.8M	
Self-Contained Breathing Apparatus (SCBA)	$1.3M	$0.8M	$1.4M	
Computers	$0.1M	$0.1M	$0.1M	
Communication equipment	$0.4M	$0.3M	$0.6M	
Real time data management system	N/A	N/A	N/A	
Acquisition of privately owned area	N/A	N/A	N/A	
Construction of five new fire and rescue stations	$7.3M	$6.5M	$8.1M	
Emergency Diesel Generators (EDG)	$0.5M	$0.3M	$0.7M	
Rescue equipment	$2.9M	$2.5M	$3.3M	
Laundering equipment	$0.5M	$0.4M	$0.6M	
Storage racks	$0.3M	$0.25M	$0.4M	
Building infrastructure improvements	$7.6M	$6.3M	$9.2M	
Phase 2	**$29M**	**$24M**	**$36M**	**Expand the fire and rescue service**
Emergency Tenders (ET)	$6.1M	$5.6M	$8M	
Building infrastructure improvements	$22.8M	$18.8M	$27.6M	
Phase 3	**$28M**	**$22M**	**$33M**	**Optimise the fire and rescue service**
Heavy Rescue Vehicles (HRV)	$6.4M	$3.2M	$8.0M	
Building infrastructure improvements	$7.6M	$6.3M	$9.2M	
Regional Multipurpose Centres	$14M	$12M	$16M	
Total	**$88M**	**$72M**	**$107M**	

1 Introduction

The objective of the study is to support the World Bank and the Armenian Government in developing a service optimization plan for the fire/rescue and emergency response facilities in Armenia. This will be accomplished by performing a high-level structural and functionality assessments of all facilities, followed by a more detailed study of selected stations. Based on the detailed assessment, priority investment planning in terms of rehabilitation[6], retrofitting[7], reconstruction[8], or replacement[9] (new construction) for each facility will be identified. In addition, options for optimising the locations and functionality of the emergency facilities that could include new construction and relocation will be explored and suggested, if judged valuable.

The project has three stages with three main technical deliverables:

- **Desktop Baseline Assessment**: Perform a high-level assessment of all fire/rescue facilities in Armenia. The high-level assessment is achieved through analysis of data collected for 56 out of 63 stations in terms of functionality and response capacity, buildings adequacy, structural seismic vulnerability, and exposure to site hazards. Based on these analyses, the functionality of the fire stations is assessed for normal operation and disaster response scenarios. The prescribed scoring will facilitate prioritisation of the need for further studies and serve as an initial assessment of the need and the eligibility/potential for rehabilitation, retrofitting / reconstruction or replacement of each facility. This rating approach will also help understand the governing deficiencies and will identify facilities that do not satisfy even the basic requirements in terms of functionality, ambience conditions, and response capacity
- **Detailed Structural Assessment:** To select a representative list of facilities and to perform a more detailed structural assessment of these facilities and identify seismic retrofitting options at conceptual level and the relevant cost for each retrofit option. A study into these costs with respect to replacement cost will be performed, and a threshold for retrofit cost as compared to the replacement cost will be proposed. The results from the selected facilities will be extrapolated to all facilities identified in the Baseline Assessment study, and a list of facilities eligible for retrofit and rehabilitation will be developed.
- **Fire/Rescue Service Optimization Study (This report):** To perform a service optimization study based on the gathered information in the previous tasks. The aim is to provide recommendations to improve the fire/rescue services on a national level considering innovative approaches tailored to the context of Armenia in terms of capital and financial sustainability. A variety of interdisciplinary parameters will be considered to properly take into account functionality deficiencies and the potential for functional upgrades along with seismic resilience of current, upgraded and new fire stations.

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[6] Rehabilitation - the process of repairing an existing structure by replacing or strengthening damaged structural elements while preserving the original architectural look of the building

[7] Retrofit - the process of modification of existing structural systems of the fire/rescue service facilities to make them more resistant to hazards such as seismic activity induced hazards. Retrofitting can involve changes in the architectural look of the building

[8] Reconstruction - the process of repairing an existing structure by replacing or strengthening its structural elements so that the structure conforms with current building and seismic codes

[9] Replacement - relocating the fire/rescue service into a newly-built structure specifically designed to conform to current design requirements relevant to fire/rescue facilities

This report is the third and last technical deliverable for this project and summarises the approach used to identify suitable modernisation programmes at microlevel (individual Fire/Rescue Stations /FRS/) and macrolevel (regional and national programmes) and the main results.

2 Context

Armenia is classified as a developing country, an upper-middle income economy (ranked 127th and 104th in the world in terms of nominal GDP and nominal GDP per capita, respectively) with overall annual budget for public expenditures in the range of $3.5-4.0 Billion in the last years. The majority of approximately two-thirds of the Armenian population lives in urban settlements, but most of the 46 Armenian towns are relatively small. The sequence of the very damaging 1988 Spitak earthquake, the fall of the USSR and the following economic crisis in all ex-USSR countries which were the main trading partners of Armenia, and the wars with Azerbaijan led to a significant decline in the Armenian economy which currently relies on the agricultural sector for the generation of 17% of the GDP and 36% of the labour force. Due to demographic and emigration processes, the overall Armenian population is nowadays 20% less compared to the peak number during the Soviet time. The recent decades have also seen internal migration to Yerevan and the consequences are visible all over Armenia – abandoned industrial factories, degraded road infrastructure and empty houses are a common scene, especially in the countryside.

Due to the long period of underfinancing of the fire/rescue service operations, the current situation is that the physical infrastructure, the fire engines, and the specialised equipment of the Armenian fire/rescue stations are far from the international best practice. Overall, the building stock is degraded, many FRSs are located in buildings that were never intended to be fire stations, and those that were designed for fire stations had been designed to old standards. The site infrastructure provides essential services only on a basic level (e.g. no redundancy of electricity or water supply), proper back-up systems are rare, specialised training facilities are rare, too, and where present are often unusable. During the mission to Armenia in March 2020, for reference see Section 4 of [P1], it was observed that although the living conditions in most of the fire/rescue stations were inappropriate, some improvements were present as many of the visited fire/rescue stations have been recently refurbished. However, all repairs addressed only the living conditions which do not solve any of the fundamental key deficiencies found in the Armenian fire stations – small and inadequate plan layouts, lack of modern IT and communication equipment (especially in the dispatcher rooms), etc. A similar situation was observed for the fleet of the fire engines and the specialised equipment, but in many locations the fire engines fleet was significantly improved in the recent years mainly due to financial aid from Japan. However, the absence of a long-term strategy and synchronised interventions led to the fact that in many locations the new ISUZU fire engines were left outside of the FRS buildings or in makeshift shelters because they could not physically fit in the garages of the existing stations. The high average altitude and the continental climate with cold winters and hot summers provide additional challenges to both the FRS' building envelopes and the fire engines. Practically, all fire stations need heating for several months in the year, and most of them would benefit in having air conditioning during the summer.

Exception for the Yerevan region, the service area of the majority of the fire/rescue stations includes significant share of rural communities which are usually far from the main town (i.e. the fire station site) often in remote locations high in the mountain. The average and the maximum drive times in these regions were much above the international standards, especially where the FRS are equipped with old fire engines.

Another significant challenge for the Armenian fire stations is the regional seismicity. On one side this puts the FRS buildings at risk of damage and collapse, which in combination with potentially damaged equipment and fire engines may lead to significant financial impact for the Ministry of Emergency Situations /MoES/. On the other side the relatively high seismic hazard in Armenia with the combination of relatively vulnerable building stock is likely to lead to significant demand for fire-fighting services due to seismically induced fires and for Search and Rescue /SAR/ activities. The tragedy during the Spitak earthquake is a serious reminder for the potential consequences from a similar earthquake near Yerevan, whose population is about 3 times more compared to the aggregated population of the affected towns. High-level estimate presented in Section 3.3 of [P2] demonstrated that many large fires could be expected in Yerevan immediately after a major earthquake, which is also expected to be combined with reduced number of operational FRSs and available fire engines. The Seismic Structural Assessment study [P2] also demonstrated that investments in seismic resilience may prevent thousands of human casualties which converted in financial terms is equivalent to loss reduction in the range of several billion US dollars. On the contrary, keeping the status quo is expected to lead to severely damaged FRS physical infrastructure and equipment which will lead to incapacitated firefighting and SAR response, which for the case of Yerevan will lead to consequences much beyond the scale of the consequences after the Spitak earthquake.

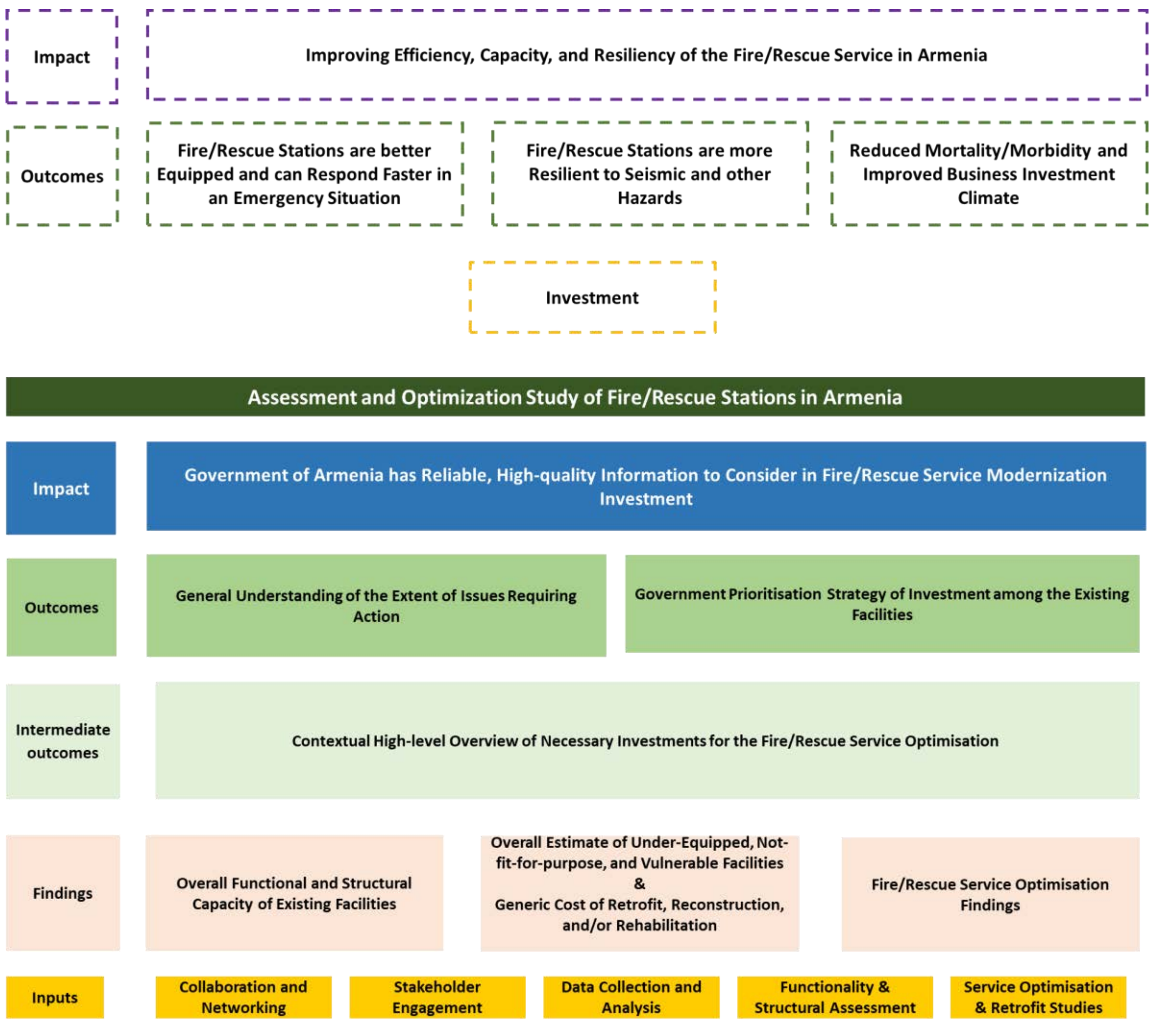
3 Objectives and Scope

3.1 Overall Objectives and Objectives of the Fire Service Optimisation Study

The objective of the study is to support the World Bank and the Armenian Government in developing a service optimization plan for the fire/rescue and emergency response facilities in Armenia. This will be accomplished by performing a high-level structural and functionality assessments of the FRS facilities followed by a more detailed study of selected stations. Based on the detailed assessment, priority investment planning in terms of rehabilitation, retrofitting, reconstruction, or replacement (new construction) for each facility will be identified. In addition, options for optimising the locations and functionality of the emergency facilities that may need reconstruction and/or relocation will be explored and suggested, if judged valuable.

A comprehensive illustration of the desired goals/impact and the underpinning findings, outcomes, and preconditions is presented in Figure 3.1.

Figure 3.1: Frame of the overall objectives



The main objectives of the fire service optimisation are:

- To highlight the key deficiencies in the Armenian FRSs that have direct impact on the fire service capacity.
- To develop specific, measurable, timebound investment recommendations that can address the key deficiencies in the Armenian FRSs and improve the fire service capacity and efficiency.

3.2 Scope of the Fire Service Optimisation Study

The scope of the fire service optimisation study is summarised below as follows:

- To review the information collected during the baseline assessment and structural/seismic assessment phases of this project and identify the key and most common deficiencies in the portfolio of FRSs in Armenia.
- To develop specific and measurable interventions that can address the identified deficiencies and can improve the fire service capacity.
- To identify required interventions and to estimate required investments for each FRS, for each province/Marz, and in total for Armenia.
- To develop a high-level fire service improvement strategy.
- To develop and apply an investment prioritisation procedure that will narrow the scope of the investment projects.
- To develop recommendations for modernisation projects compatible with the overall fire service strategy that can be integrated with parallel modernisation programmes and or scaled/expanded in the future.

3.3 Limitations

Although the title of the report is Fire Service Optimisation Study and the term fire service optimisation is often used within the report, the current report summarises a study and recommendations for improvement projects that can be classified rather as a modernisation programme/strategy than as an optimisation programme/strategy. Despite that, the implementation of theses modernisation projects will lead to an improved fire service across Armenia and to a certain level of optimisation of the fire service. In the same time this report cannot claim that the recommended modernisation projects are the most optimal investments for the needs of the Armenian fire service and that by implementing them the highest possible level of fire and rescue service capacity and efficiency for the devoted budget will be achieved. The main reason for this is the lack of specific data needed for taking informed decisions on what the real needs are and how these needs can be addressed in the most efficient manner. The missing studies and data are summarised below:

- Absence of up-to-date Hazard, Risk and Vulnerability assessments of each FRS serviced areas, which is the best source of information to guide decisions on the number of staff needed in each FRS, number and types of specialised vehicles, firefighting and rescue equipment, the most suitable location of the FRS within the serviced area, etc.
- Absence of a detailed inventory of the currently available specialised vehicles, firefighting and rescue equipment and PPEs, including protocols and records from their regular inspections and information about their current condition and remaining lifetime.
- Detailed statistics of the number and type of fire/rescue calls, response time, type of events, loss ratios, etc. over the past years.

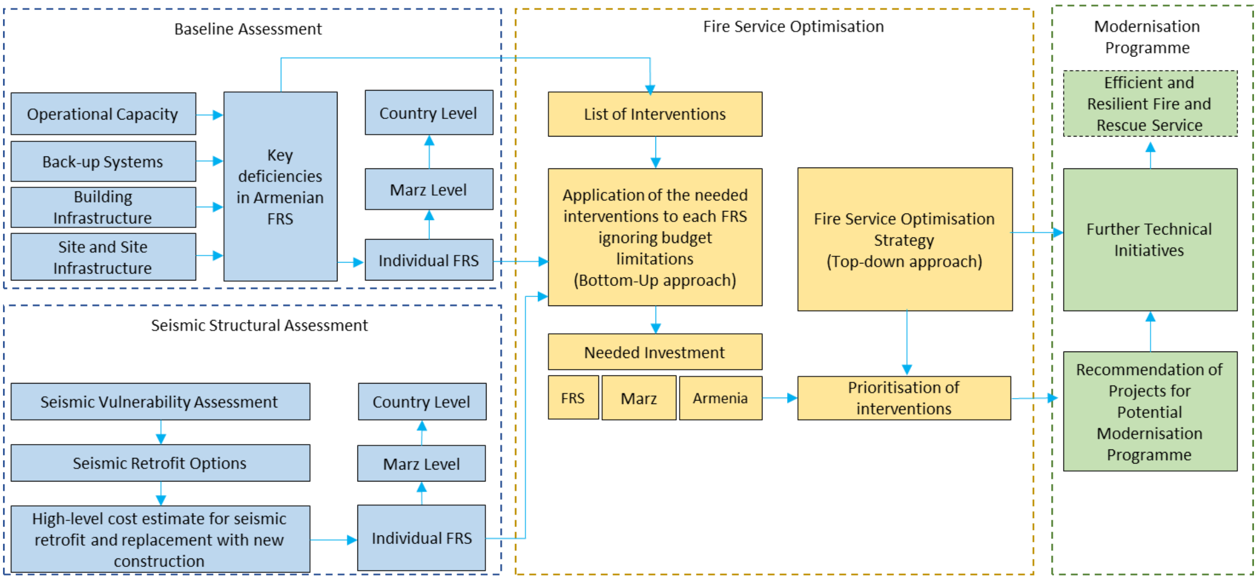
4 Methodology

4.1 Overall Approach

The fire service optimisation process is shown in Figure 4.1 and consists the following main stages:

- Identification of the key deficiencies in the Armenian FRSs based on the results from the Baseline Assessment [P1] and the Seismic Structural Assessment [P2] studies.
- Performing a fire service improvement study that includes the definition and application of different options for upgrading 56 FRS to provide some insights for the needed investments for improving the fire rescue services in Armenia.
- Development of a fire services improvement strategy implementing regional and national programmes to be implemented over different investment periods.
- Development of potential modernization programme.

Figure 4.1: Workflow of the fire service optimisation process



4.2 Identifying Key Deficiencies of Armenian FRSs

The process of fire & rescue service optimisation starts with the in-depth review of the baseline assessment and structural/seismic assessment studies and identification of the characteristic deficiencies in the portfolio of FRSs in Armenia.

The key deficiencies widely observed among the stations as identified in the Baseline report [P1] and the Seismic assessment report [P2] are summarised below and presented in detail in Section 5:

- Lack of information and communication technology and equipment. Lack of operational data collection records.

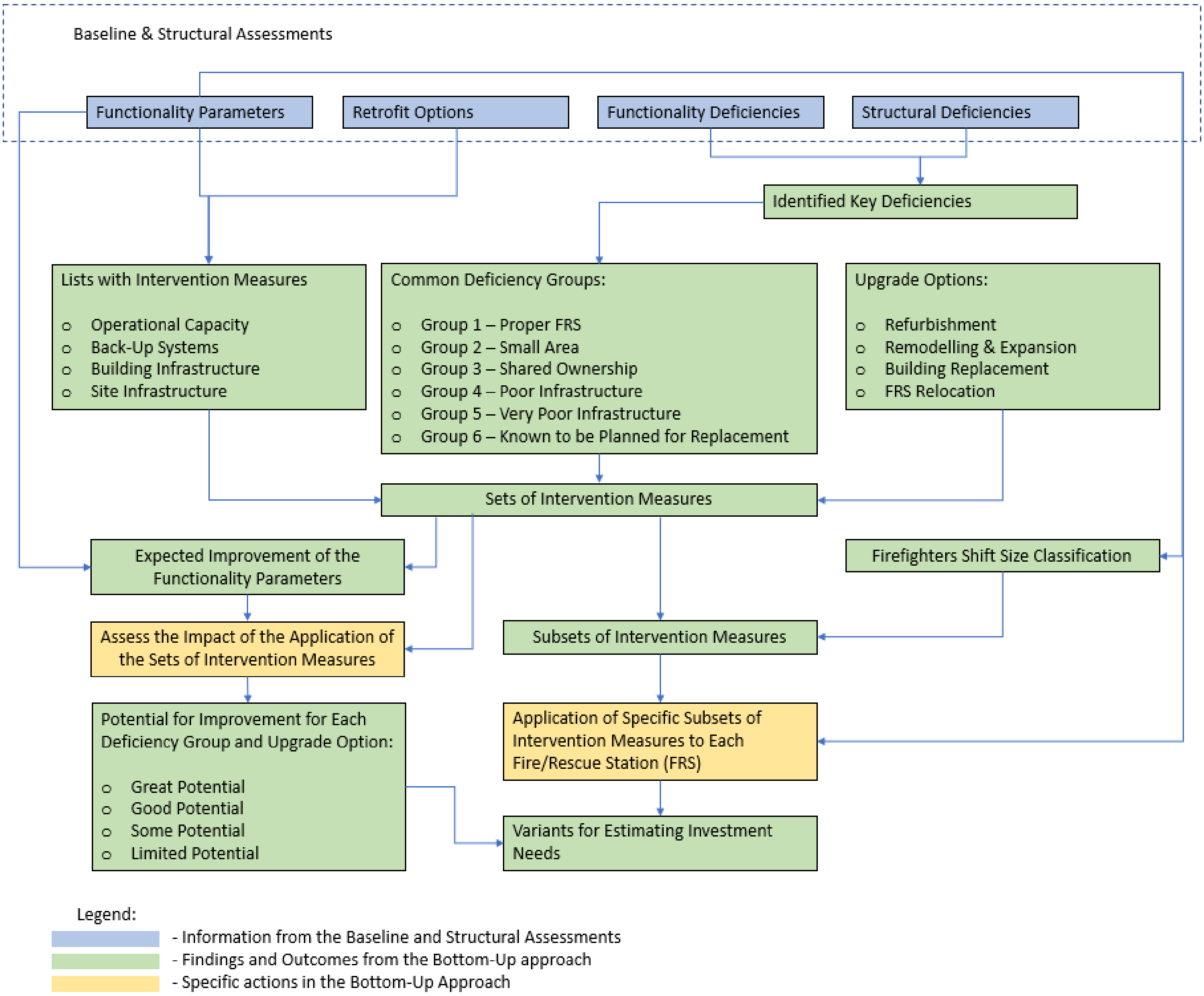
- Ageing fleet of fire fighter and rescue vehicles.
- Old personal protective equipment in poor state.
- No adequate storage and maintenance spaces.
- Lack of training facilities or training facilities in unusable state.
- Inadequate building infrastructure.
- Lack of back-up systems.
- Low seismic resilience of the buildings of the fire rescue services.

4.3 Assessment of Investment Needs

The estimation of the investment needs was performed on an individual FRS level and aggregated per Marz and total for Armenia in straightforward process of summing up the costs of all interventions prescribed to each FRS. The estimation of the investment needs can be summarised in the listed steps, and a diagram explaining the process of the Bottom-Up Approach as part of the workflow from Figure 4.1 is presented in Figure 4.2:

- Developing lists with intervention measures.
- Creating predefined specific sets of interventions.
- Application and estimation of the predefined sets with interventions for individual FRSs.
- Developing different scenarios (variants) for assessing the investment needs.

Figure 4.2: Bottom-Up approach flow



4.3.1 Developing Lists with Intervention Measures

The list of interventions is developed in a straightforward process in which the functionality parameters used for the relative qualitative scoring procedure in the baseline assessment are matched with specific interventions that can improve the scoring of the functionality parameters. The full lists with intervention measures, with the used assumptions and references are presented in Appendix A . Each intervention measure has the following attributes:

- Name
- Description
- Cost – based on a source, calculated with some assumptions
- Cost reliability – can be low, medium or high and is subjective based on the authors team judgment:

  - Low reliability was assigned to prices for complex measures (containing more than one measures), for measures not specified in detail, for measures with limited online presentation, or for prices based on expert's judgment.
  - Medium reliability was assigned to costs for measures specified in detail, based on a single source, or calculated with some simplistic assumptions.
  - High reliability would be to cost for a particular item for which an inquiry was made from a particular FRS, or a price for a particular item verified from different sources.

The presented in Appendix A costs are marked either with low or with medium reliability.

- Source – online sources and expert opinion from which was gathered the information
- Assumptions – on which is based the cost

Some interventions can improve only one functionality parameter, while others will have positive effect on several functionality parameters. Few examples are provided below:

- Adding new non-slippery epoxy surface and a drainage system will improve the score (and the condition) of the functionality parameter "Garage Surface", which will have a positive effect on the overall score of the functionality sub-category "Garage" and hence on the functionality category Building Infrastructure. Examples for interventions that address a single issue are also fume gases extraction system, automatic fire-suppression system, new automatic garage doors, emergency diesel generator, etc.
- Adding extra area by either building an additional floor or horizontal expansion of the existing building have a positive effect on several functionality parameters and hence a major effect on improving the total score of the FRS. This intervention improves about 10 functionality parameters for the Building Infrastructure functionality category, either directly, or by unlocking potential improvement through other interventions. In addition, this intervention unlocks the possibility for improvement of the score of the Operation Capacity due to the possibility to house new fire apparatus and firefighting equipment.

4.3.2 Developing Sets with Intervention Measures

To automate the process of selecting, quantifying and estimating intervention measures for each FRS, the stations were grouped into 6 groups by common deficiencies (described in Table 4.1), and 4 standardised upgrade options were developed to address these deficiencies (described in Table 4.2). The measures from the lists with interventions (Section 4.3.1) were logically distributed into sets with interventions, with each set including only measures applicable to one of the deficiency groups and in relation to one upgrade option. Further classification of the FRS within each group was also performed based on the number of firefighters within each station with 5 classes identified (described in Table 4.3). A diagram explaining the process of the Bottom-Up Approach is presented in Figure 4.2.

The definitions for the groups with common deficiencies are presented in Table 4.1. The criteria used aim at problems in the infrastructure that could hamper upgrade in the services. The identified key deficiencies listed in section 4.2 are expected for FRS categorised in all deficiency groups, although they are not listed in the criteria. The groups are ranked from 1 to 6, from the least to the most obstructive for any intervention / upgrade. Group 3 is not descriptive of a deficiency, but of a supplementary issue – the FRSs in this group are with shared ownership, which will presumably block most of the alternatives for improvement.

Table 4.1: Grouping of FRSs based on similar deficiencies

Group	Definition	Criteria
Group 1 proper FRS (6 FRS)	FRS with sufficient size of the infrastructure and no major* issues	The FRS is not known to be planned for replacement, no hazards (rockfall, mudflow, floods, soil settlements) were reported for the site of the FRS, it is not with shared ownership, the building area is more than 80% of the tolerable building area, the garage height is more than 4 m.
Group 2 Small sized (15 FRS)	FRS with insufficient size of the infrastructure and no major* issues	The FRS is not known to be planned for replacement, no hazards (rockfall, mudflow, floods, soil settlements) were reported for the site of the FRS, it is not with shared ownership, the building area is between 25% and 80% of the tolerable building area
Group 3 Shared ownership (11 FRS)	FRS with shared ownership	The FRS is with shared ownership
Group 4 Poor infrastructure (11 FRS)	FRS with insufficient size of the infrastructure, in bad state, and hazards expected on the site	The FRS is not known to be planned for replacement; it is not with shared ownership. Hazards from floods, mudflows or soil settlements can be expected, the building area is less than 25 % of the tolerable, or the Building Infrastructure Index /BII/ is Very poor. The site size allows building expansion and the site infrastructure index is at least Poor
Group 5 Very poor infrastructure (	FRS with insufficient size of the infrastructure, in bad state, expected hazards and additional problems on the site	The FRS is not planned for replacement, it is not with shared ownership. Hazards from floods, mudflows or soil settlements can be expected or the building area is less than 25% of the tolerable. The site size does not allow expansion, or the site infrastructure index is Very poor.
Group 6	FRS known to be planned for replacement	The FRS is known to be planned for relocation

*The definition of "major issues" is given in column "Criteria"

Further to this, 4 standard upgrade options are defined that address the identified key deficiencies. The definitions of the upgrade options are presented in Table 4.2.

Table 4.2: Predefined upgrade options

Intervention strategy	Definition	Criteria
Option 1 Refurbishment	Interventions in the existing building and site	Seismic strengthening, remodelling to separate the functional zones and to separate clean from contaminated areas, cosmetic renovation, new equipment and furniture, communication lines on site
Option 2 Remodelling and expansion	Expansion of the building area and interventions in the existing building and site	Building area enlargement or rebuying shared parts, seismic strengthening, remodelling to separate the functional zones and to separate clean from contaminated areas, cosmetic renovation, new equipment and furniture, communication lines on site.
Option 3 New building	Building replacement	New building on the same site
Option 4 Relocation	FRS relocation	Relocating the FRS in a new building on different location

Predefined sets with interventions that can be included in each of the 4 upgrade options and specified for each of the 6 deficiency groups were developed.

To automate the applications of interventions for each of the 56 FRS further division of the 22 sets was made, depending on the size of the FRS, measured by its shift size. The FRSs were categorised into 5 classes, depending on the number of people in one shift and each of the 22 sets has 5 subsets for each of the 5 classes. The criteria for categorising a FRS into the 5 classes is presented in Table 4.3. The classes are ranked from 0 – major FRS, to 4 - the smallest FRSs.

Table 4.3: Definition of FRS classes, depending on the number of firefighters in one shift

Number of firefighters in one shift	Class
FRS with 5 or less firefighters in one shift	Class 4
FRS with 6 or 7 firefighters in one shift	Class 3
FRS with 8, 9, 10 firefighters in one shift	Class 2
FRS with more than 10 firefighters in one shift	Class 1
FRS and ERC	Class 0

The total of 22 sets of interventions with listed intervention measures, each specified in 5 subsets are described in Appendix B.1.1 to B.1.4.

The expected improvement from the different upgrade options applied to different deficiency groups was logically assumed from the definition of the scoring criteria of the parameters and the tolerable and optimal limits defined in [P1] and the measures included into the 22 sets with intervention measures. The expected increase in the values of the parameters from the application of the different upgrade options on the 6 deficiency groups is described in B.2. It is summarised in Table 4.4.

The terms great, good, some, or limited potential used in Table 4.4 are described below:

- Great potential - the FRS can reach a level compatible with the international best practices.
- Good potential - the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirements for maintenance and storage can be met. All back-up systems can be implemented. At least four of the functional zones can be obtained (with less area than the tolerable defined in SP...) and clean and contaminated areas can be separated.
- Some potential - the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirements for maintenance and storage can be met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated.
- Limited potential - the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirements for maintenance and storage can be partially met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated.

Table 4.4: Potential for improvement for each deficiency Group depending on the selected upgrade option

	Improvement strategy	Upgrade Option 1	Upgrade Option 2	Upgrade Option 3	Upgrade Option 4
Description of the FRS	**Definitions**	**Intervention in the existing building and site,**	**Increasing the building area or rebuying shared parts and interventions in the existing building and site**	**New building on the same site**	**Relocating the FRS in a new building**
Group 1	**FRS with sufficient size of the infrastructure and no major issues**	Great potential	Great potential	Great potential	Great potential
Group 2	**FRS with insufficient size of the infrastructure and no major issues**	Some potential	Good potential	Great potential	Great potential
Group 3	**FRS with shared ownership**	Only minor partial interventions will be possible, until the FRS has full ownership on the building	Good potential	Not applicable	Great potential
Group 4	**FRS with insufficient size of the infrastructure, in bad state and hazards expected on the site**	Limited potential	Some potential	Great potential	Great potential
Group 5	**FRS with insufficient size of the infrastructure, in bad state and expected hazards and additional problems on the site**	Limited potential	Limited potential	Some potential	Great potential
Group 6	**FRS known to be planned for replacement**	No potential	Not applicable	Limited potential	Great potential

4.3.3 Application of Interventions for Each Individual FRS

To each individual FRS a specific predefined subset of interventions for the different upgrade options can be applied based on which deficiency group the FRS is assigned to and the class of the FRS. The process can be summarised in the following steps:

- The FRS in consideration is categorized into 1 of the 6 deficiency groups as per Table 4.1.
- The FRS is classified into one of the 5 classes as per Table 4.3 depending on the number of firefighters in one shift.
- 4 specific predefined subsets with interventions for the 4 different upgrade options (Table B.6) are assigned to each FRS based on its deficiency group and its class.
- The expected improvement from the 4 different upgrade options on the 56 FRS is qualified based on the scoring procedure described in [P1], and the assumed impact of the measures included in the set on the values of the parameters (Appendix B.2).

The results are presented in Figure 4.3 to Figure 4.6. The graphs provide staggered relative scoring from the baseline assessment and after each of the different upgrade options is applied:

- orange is the current state based on the Baseline assessment,
- blue colour presents the effect of Option 1 - refurbishment
- grey colour presents the effect of Option 2 - refurbishment with expansion
- yellow colour is option 3 – new building on the same site
- green colour is option 4 – relocation of the FRS in a new building on a new site

If some of the options are not applicable or are with no impact on the FRS based on the deficiency group (Table 4.4) they are not visible on the graphics

Figure 4.3: Potential for improvement of the Operational Capacity index depending on the selected upgrade option

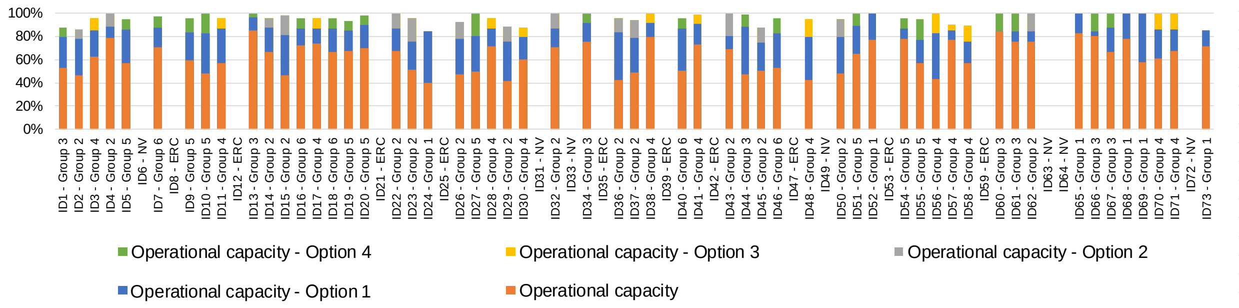


Figure 4.4: Potential for improvement of the Back-up Systems index depending on the selected upgrade option

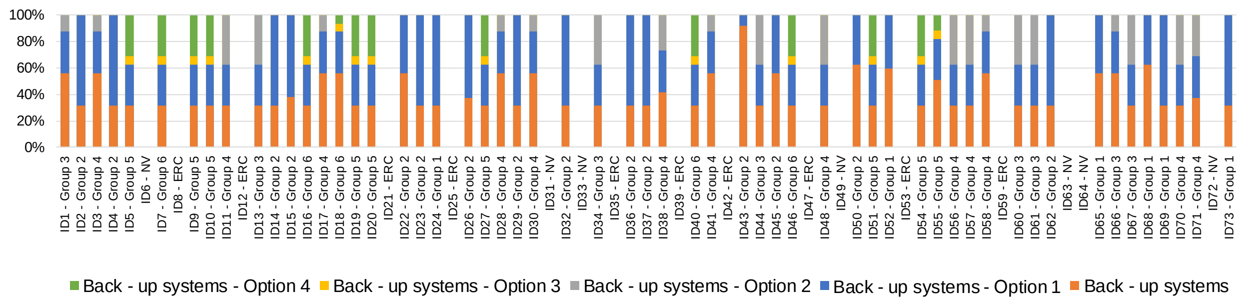


Figure 4.5: Potential for improvement of the Building Infrastructure index depending on the selected upgrade option

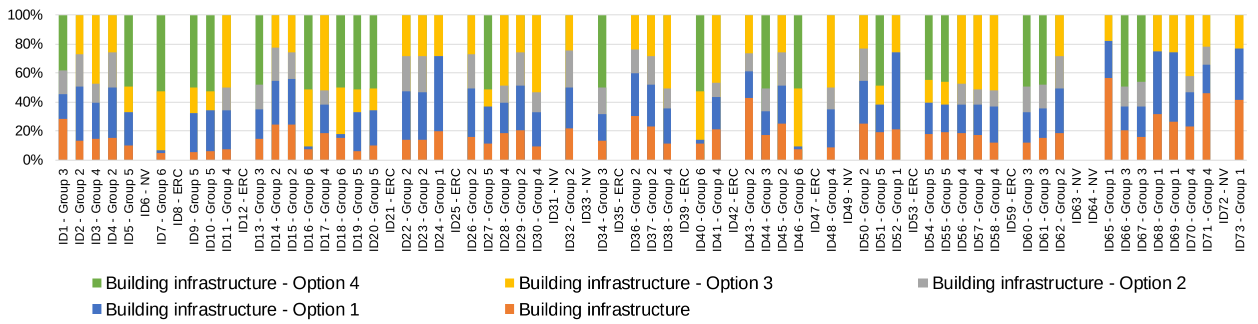
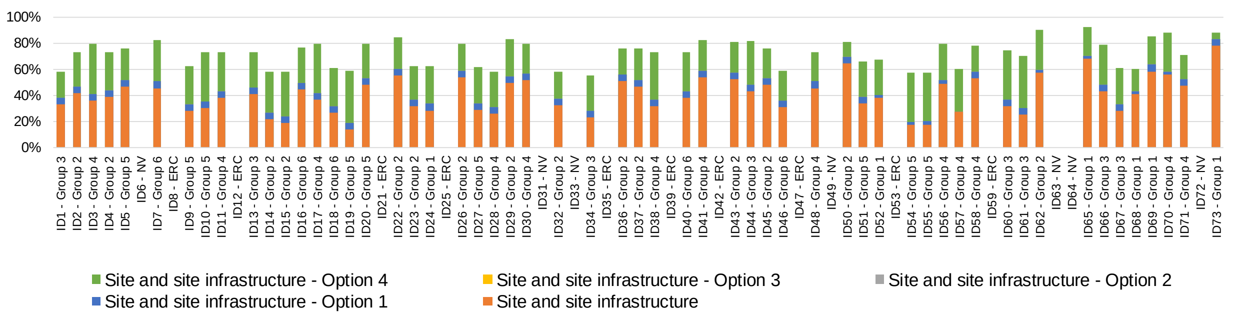


Figure 4.6: Potential for improvement of the Site and Site Infrastructure index depending on the selected upgrade option



- For each individual station the subsets of measures for the 4 upgrade options are quantified based on the following assumptions and a cost estimate is provided on FRS level
  - If the average age of the vehicles in a FRS is above 20 years new ones are prescribed
  - All firefighters are provided with new PPE – structural ensembles, SCBA are provided only for the firefighters on shift

- All FRS are provided new set of light rescue equipment.
- Only FRS in regional centres can receive heavy rescue equipment, if the upgraded state provides conditions for its storage and maintenance (great potential for improvement according to Table 4.4)
- All FRS receive PC and IT equipment
- All other interventions are quantified based on the difference between the values of the parameters from the baseline assessment and the assumed impact of the measures included in the subset

4.3.4 Developing Different Variants for Estimating the Investment Needs

Based on the described above deficiency groups and upgrade options 4 different upgrade variants were developed to provide insight of the investment needs of the Armenian Fire and Rescue Service (AFRS) by assigning different upgrade options from refurbishment to relocation to different FRS based on their deficiency groups and aggregating the results on regional and national levels

Based on the definitions for the groups and the options the variant with greater impact could be established from the expected improvement as presented on Table 4.4. However, the aim of this study is not to define the wanted level of improvement for the Armenian fire and rescue services, but only to provide guidance and information for the possible improvement strategies. For this reason, four different variants were developed to grasp a range of improvement strategies and needed budgets for all visited stations.

- Variant 1, presented on Table 4.5: all FRS classified in group 1 – without remarks are retrofitted, remodelled and renovated, vehicles and equipment are upgraded (Option1 - refurbishment), all FRS in group 6 – for relocation, are relocated on a proper site in a new building and the equipment and vehicles are upgraded (Option 4 - relocation), all other FRS are upgraded with option 2 – remodelling and expansion, vehicles and equipment are upgraded.

Table 4.5: Variant 1

	Option 1 Refurbishment	Option 2 Remodelling & Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 proper FRS	6 FRS Great potential			
Group 2 Small sized		15 FRS Good potential		
Group 3 Shared ownership		11 FRS Good potential		
Group 4 Poor infrastructure		11 FRS Some potential		
Group 5 Very poor infrastructure		8 FRS Limited potential		
Group 6 For relocation				5 FRS Great potential

- Variant 2, presented on Table 4.6: all FRS not planned for replacement are repaired and vehicles on more than 25 years are replaced and equipment is upgraded (Option1 -

repair), all FRS in group 6 – for replacement, are relocated on a proper site in a new building and the equipment and vehicles are upgraded (Option 4 - relocation). The potential for improvement between the stations is limited to great (Table B.25)

Table 4.6: Variant 2

	Option 1 Refurbishment	Option 2 Remodelling & Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 proper FRS	6 FRS Great potential			
Group 2 Small sized	15 FRS Some potential			
Group 3 Shared ownership	11 FRS Limited potential			
Group 4 Poor infrastructure	11 FRS Limited potential			
Group 5 Very poor infrastructure	8 FRS Limited potential			
Group 6 For relocation				5 FRS Great potential

- Variant 3, presented on Table 4.7 : all FRS not planned for replacement are repaired and vehicles on more than 25 years are replaced and equipment is upgraded (Option1 - repair), all FRS in group 6 – for replacement, are relocated on a proper site in a new building and the equipment and vehicles are upgraded (Option 4 - relocation). The potential for improvement between the stations is limited to great (Table B.25).

Table 4.7: Variant 3

	Option 1 Refurbishment	Option 2 Remodelling & Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 proper FRS	**6 FRS Great potential**			
Group 2 Small sized			15 FRS Great potential	
Group 3 Shared ownership				11 FRS Great potential
Group 4 Poor infrastructure			11 FRS Great potential	
Group 5 Very poor infrastructure			8 FRS Some potential	
Group 6 For relocation				5 FRS Great potential

- Variant 4, presented on Table 4.8 : all FRS not planned for replacement are repaired and vehicles on more than 25 years are replaced and equipment is upgraded (Option1 - repair), all FRS in group 6 – for replacement, are relocated on a proper site in a new building and the equipment and vehicles are upgraded (Option 4 - relocation). The potential for improvement between the stations is limited to great (Table B.25)

Table 4.8: Variant 4

	Option 1 Refurbishment	Option 2 Remodelling & Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 proper FRS			6 FRS Great potential	
Group 2 Small sized			15 FRS Great potential	
Group 3 Shared ownership				11 FRS Great potential
Group 4 Poor infrastructure				11 FRS Great potential
Group 5 Very poor infrastructure				8 FRS Great potential
Group 6 For relocation				**5 FRS Great potential**

4.4 Fire Service Optimisation Strategy

The Fire Service Optimisation /FSO/ strategy is based on a top-down approach that looks at the fire & rescue service in Armenia from a system perspective. While the bottom-up approach described in Section 4.3 works on a microlevel, the FSO strategy looks at macrolevel and recommends the needed interventions based on what should be the basic characteristics of an efficient national fire and rescue service.

The strategies include a simple logical approach striking a balance between action-oriented operational elements, data collection and planning that will ensure that the early steps taken will provide a solid foundation for ongoing system optimization. This holistic approach is considered most likely to achieve optimization results. Soft measures regarding information collection, legal and organization are needed to guide the optimisation process and ensure its continuity and tailor it to the needs of Armenia.

The recommendations were distributed into the three phases considering the following time period

- Phase 1 stabilizing the existing AFRS with limited expansion of services: first 3 years of the improvement program
- Phase 2 expansion of the AFRS: 3rd to 5th year of the improvement program
- Phase 3 optimisation of the AFRS: 5th to 8th year of the improvement program

The distribution of the recommendations into the phases is based on the following assumptions

- Phase 1 aims at stabilizing the existing AFRS and its focuses are the following:
  - Recommendations ensuring the current system can deploy safely, effectively, and efficiently.
  - Recommendations ensuring firefighter and resident safety
  - Critical infrastructure prioritization and stabilization

  - Recommendations ensuring fire apparatus is suitable, available, and operable in all stations.
  - Recommendations ensuring means for data collection to provide base for informed and accurate decision making in phases 2 and 3.

  In phase 1 should be considered only actions for which:

  - There is enough data available to support decision making,
  - Needed new/additional data is easy and quick to generate/collect
  - There is no need for detailed information to take adequate decision and this can be done based on common sense or based on experience/analogy with other jurisdictions.

- Phase 2 and 3 expansion and optimisation consider the following recommendations
  - Recommendations regarding the continuation of national staffing strategies and the facility and apparatus upgrade projects. The improved data collection, further studies, design projects and standards initiated in Phase 1 will guide the expansion and optimisation programs.
  - Recommendations considering business continuity planning processes and service delivery model changes. They will ensure that day-to-day systems can meet the community needs and that the more extensive system can activate and deploy when those day to day capacities are at risk of being overwhelmed.

4.5 Developing Potential Modernization programme

The development of the modernization programme is based on the estimate of the investment needs of the AFRS on FRS level, and on the recommendation from the fire service improvement strategy which provides system perspective. The modernization strategy is developed to result in simple recommendations.

Immediate and simultaneous implementation of all recommended interventions across all FRSs in Armenia is not a realistic scenario due to technological, programme, and financial constraints. Therefore, the recommendations are prioritised based on a two-step screening process based on:

- Importance:
  - Critical interventions – these are must have options that have a direct impact on the capacity of the FRS to serve its purpose and are directly related to the health and safety of the FRS personnel. Examples are replacement of old fire apparatus, adequate PPE, essential firefighting equipment, replacement or reconstruction of inadequate FRSs, investments in seismic resilience, etc.
  - Not critical – these are good to have options that can improve the efficiency of the fire/rescue service, improve the operational health conditions in the FRSs, reduce the maintenance costs related to the fleet of vehicles and the portfolio of FRS buildings, etc.
- Practicality:
  - No regret interventions – such interventions that are always useful when applied.
  - Does not block other interventions – such interventions that do not obstruct any other intervention when applied.
  - Can be updated, upgraded, continued – such interventions that can be applied only partially.

  - Can be moved within the FRS portfolio – such interventions that can be applied at one FRS, then moved seamlessly to another FRS if deemed reasonable.
  - Has enough data to support the justification for application or doesn't require data collection
  - Can be implemented with local / Armenian resources

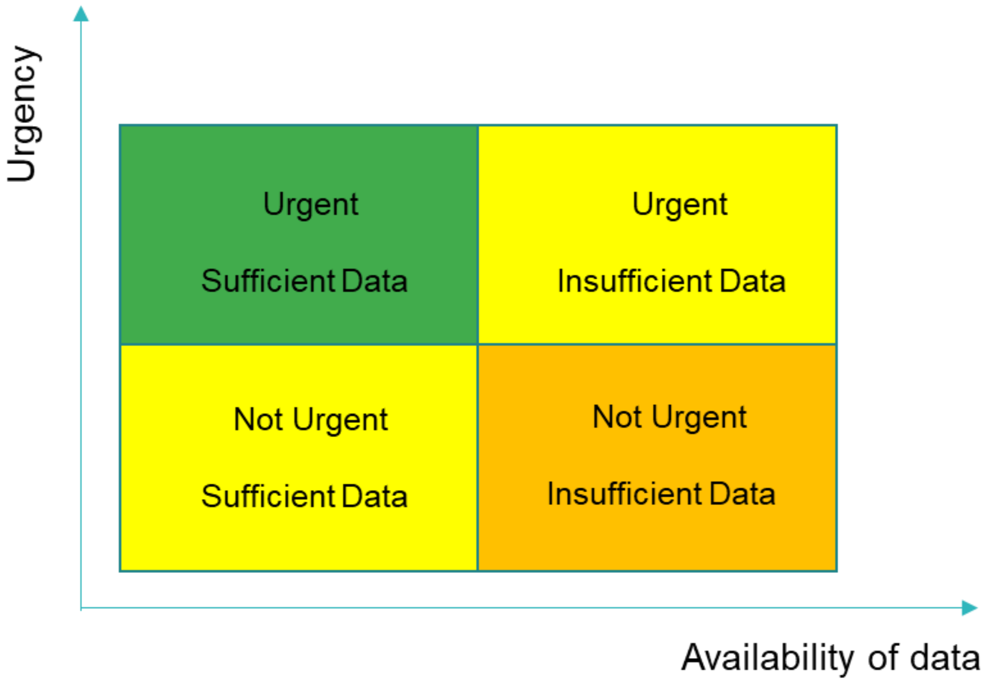
Timewise, the following time-bound phases of the investment programme are considered:

- Phase 1 – within 3 years
- Phase 2 – within 5 years
- Phase 3 – within 8 years

The prioritisation process of the interventions identified as a result of the studies as per 4.3.3 and 4.4 is performed based on the decision making criteria illustrated in Figure 4.7, summarised in the bullets below:

- Interventions that are urgent and supported by sufficient data (or do not need data to be justified) are implemented immediately – The early stages of Phase 1.
- Interventions that are urgent but not supported with sufficient data to take and informed decision are implemented in the later stages of Phase 1 based on additional studies.
- Interventions that are not urgent and supported by sufficient data (or do not need data to be justified) are moved for Phase 2 of the investment programme with considerations of the overall spending profile and the implementation of the urgent interventions which were delayed due to the lack of data.
- Interventions that are not urgent and not supported with sufficient data to take and informed decision are moved for Phase 3 based on additional studies implemented during Phase 2.

Figure 4.7: Prioritisation based on urgency of the measure and the availability of sufficient data to take informed decision



5 Key Deficiencies of the Armenian FRSs

This section summarises the key deficiencies of the fire and rescue service building stock identified in the in-depth review of the Baseline Assessment study [P1] and the Seismic Structural Assessment [P2]. A brief description of each key deficiency is presented along with photos taken during the mission to Armenia outlining the conditions on-site as of March 2020.

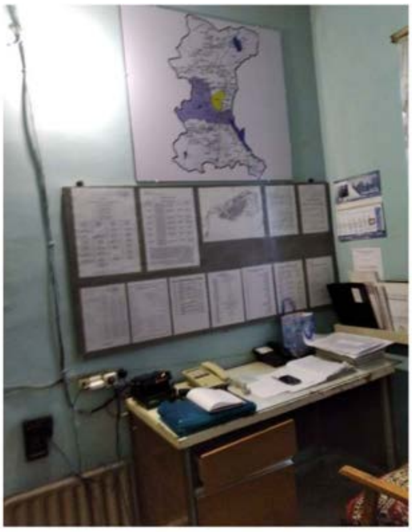
The information regarding deficiencies with the functionality of the Fire/Rescue stations is also provided in Section 6.1 of the Baseline Assessment report [P1], and more detailed information regarding the seismic structural deficiencies is given in Section 5 of the Seismic Structural Assessment [P2] report.

5.1 Information and Communications Technology /ICT/ Equipment and Operational Records

The state of the ICT equipment present in most of the visited FRS is shown in Figure 5.1 and Figure 5.2 below. As per Section 6.1 of the Baseline Assessment report [P1], the call processing communications system is old, the Fire/Rescue team internal communication is via radio stations (which do not have coverage over the whole service area for some stations), the operational records are populated by hand on hard copies only. The lack of digital equipment combined with the manual record keeping make the communication of operability parameters difficult and prone to errors, which in turn may impact negatively strategic decision making due to lack of comprehensive collected data liaising received calls to specific actions undertaken by the Fire/Rescue teams. In some stations the commanders had brought in their own personal computers and installed internet connection to facilitate the communication of information between the station and the control centres, however, that was neither commonplace, nor required by local regulations.

Figure 5.1: Examples of current ICT equipment in Armenian FRSs – Aparan and Gyumri/Akhuryan

Dispatcher room in FRS ID3 Aparan



Dispatcher room in FRS ID9 Gyumri, Akhuryan

Figure 5.2: Examples of current ICT equipment in Armenian FRSs – Yeghegnadzor and Jermuk

Dispatcher room in FRS ID 48 Yeghegnadzor

Dispatcher room and FRS commander office in FRS ID 50 Jermuk

5.2 Aging Fleet of Firefighting and Rescue Apparatus

Another key deficiency of the Fire/Rescue Service in Armenia is the aging fleet of apparatus. As per Section 6.1 of the Baseline Assessment report [P1], more than one third of all Fire/Rescue Stations are equipped with vehicles more than 25 years old. That leads to not only the higher possibility of having a specialised apparatus break down and be non-operational, but also that they are already technologically outdated. Several photos illustrating the available apparatus are shown in Figure 5.3.

Figure 5.3: Example of type of old specialised vehicles that are still in operation in the Armenian FRSs

5.3 Personal Protective Equipment (PPE) and Firefighting Equipment

The state of the specialised equipment in the Armenian Fire/Rescue Stations (FRS) is yet another key discrepancy. Despite the newly delivered PPE in some of the FRS, there seemed to be reduced space for its storage. For the majority of the FRS, more than 70%, the condition and number of the firefighting and rescue equipment was reported as insufficient and requiring improvement. The state of PPE and firefighting equipment typical for a FRS in Armenia is illustrated in Figure 5.4 and Figure 5.5 below.

Figure 5.4: Relatively new PPE stored inappropriately – FRS ID30 Sevan

Figure 5.5: Aged firefighting equipment is typical view in Armenian FRSs

5.4 Degraded Training Facilities

The lack of adequate training facilities for specialised training is a common deficiency across the portfolio of FRS in Armenia with almost 90% of the stations without any adequate training facilities. Even though there are existing training facilities in some of the stations, as shown in Figure 5.6 below, most of them are compromised or in inadequate condition. Within the FRSs where training facilities are available, only 3 FRSs have training facilities with adequate current condition.

Figure 5.6: Example of training facilities across the Armenian FRSs

Training facilities for confined spaces in FRS ID9 Gyumri, Akhuryan

Training facilities for work with toxic gases in FRS ID71 Yerevan

Training tower in FRS ID41 Vagharshapat

Training polygon for vehicle extrication in FRS ID57 Sisian

Training tower in FRS ID71 Yerevan

5.5 Inadequate Building Infrastructure

The current poor condition of the building infrastructure is a common deficiency of the portfolio of FRSs in Armenia. This is both in terms of adequacy of the building layout and size, and in terms of the current condition of the buildings due to inadequate maintenance during the years and the aged building stock (60% of the FRSs are older than 50 years).

As illustrated in Figure 5.7, the finishing plasters of the facades were deteriorated or entirely missing, which left the main structure exposed to weathering.

Figure 5.7: Many FRSs across Armenia have degraded building infrastructure (FRS 73 Yerevan pictured below)

5.5.1 Inadequate Space Size and Building Layout

The quality of the building stock in terms of adequacy of the building layout and size is also a major discrepancy. In terms of architectural layout, functional zoning and space, many of the FRSs are either situated in buildings that were never designed for a fire station or are based on outdated design concepts. In general, there is no clear separation of contaminated and clean zones and the available space is much below the modern standards for about 90% of the FRSs.

Regarding the garage areas, overall the condition of the garage areas is inadequate for the entire FRS buildings portfolio. None of the garages were equipped with a modern fume exhaust system, and only a few exceptions had any fume exhaust system. Most of the garages do not have proper floor surface cover and almost all FRSs have old steel manually operated garage doors. In many FRSs the height of the garage is too small to be able to accommodate modern fire engines. In some of the FRSs that have received new fire engines as a donation, the firefighters were either building external canopies or were digging the garage floor to lower its level to house the new fire engines. Some of the garages are not equipped with any heating, which could lead to freezing of the water within the tank during winter months.

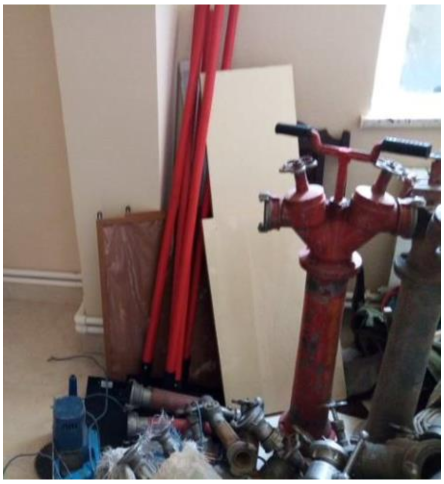
5.5.2 Inadequate Storage and Maintenance Space

Properly separated zones for maintenance of the specialised vehicles and equipment, decontamination of PPE and equipment, hose washing and drying, and organised storage equipment are generally missing or, where available, they are inadequate in terms of size, layout and current condition. Some examples of such conditions of these zones are illustrated in Figure 5.8 and Figure 5.9. The space is insufficient and the equipment is staggered, the furniture is old and the finishing surfaces of the rooms are in poor condition.

Figure 5.8: Example of type and quality of storage and maintenance workshop zones commonly seen in the Armenian FRSs – examples from Gyumri/Akhuryan, Amasia, Vagarshapat

ID9 Gyumri, Akhuryan

ID10 Amasia



ID41 Vagarshapat

Figure 5.9: Example of type and quality of storage and maintenance workshop zones commonly seen in the Armenian FRSs – examples from Masis, Vedi and Yerevan.

ID44 Masis

ID45 Vedi

ID67 Yerevan

5.5.3 Poor Occupational Health Conditions

Despite the recent attempts and investments in improving the interiors of the FRSs, the living conditions and health & safety conditions overall were rather poor. The furniture was old and seemingly not fit for purpose, the finishing surfaces were either missing or in deteriorated condition. A common sight in most of the visited station was the poor condition of the sleeping quarters furniture, as illustrated in Figure 5.10 and Figure 5.11.

Figure 5.10: Example of interiors commonly seen in the Armenian FRSs – examples from Masis, Vedi and Yerevan.

FRS ID7 Gyumri

ID 71 Yerevan

ID67 Yerevan

Figure 5.11: Example of interiors commonly seen in the Armenian FRSs – examples from Masis, Vedi and Yerevan.

ID36 Yeghvard

ID73

ID 73 Yerevan

5.5.4 Inadequate and Unequipped Training Facilities

Some of the FRS had dedicated areas for fitness, however, the equipment was scarce and old. It consisted of basic tools situated in spare rooms or outside the building in the open. An example of such training areas is shown in Figure 5.12 below.

Figure 5.12: Example of fitness training zones commonly seen in the Armenian FRSs when such zones are existent at all – examples from two fire stations in Yerevan.

ID66 Yerevan

ID73 Yerevan

5.6 Lack of Back-up Systems

Another major discrepancy among the Armenian FRS is the lack of back-up systems. In terms of power supply, only 5% of the FRS have some form of back-up power supply. As for back-up water supply, 37% of the fire stations have some form of back-up (independent/ on site) water supply. An example of semi-buried water tank is shown in Figure 5.13. The reported fuel back-up was provided by canisters stored in the garage area. The reported communication back-up was provided by personal mobile phones and radio stations, however, for some stations the range of the radio station was reported as not covering the whole serviced area.

In case of a strong earthquake, most of the FRSs in the affected area are likely to be in a total black-out without electricity (electricity supply is often lost in an earthquake), communication means (lost or overloaded communication lines), fuel supply (due to damaged gas stations or overdemand and chaos after the earthquake) and may lack the access to water (see "Seismic resilience" below).

Figure 5.13: Water tank as a water back-up system in ID22 Dilijan

5.7 Low Seismic Resilience

As reported in Section 10.1 of the Seismic Structural Assessment [P2], almost all FRSs in Armenia are expected to collapse (to be at Damage State 5) in a Very Rare (MRP 2475) earthquake, and many of them (83%) are expected to be non-operational (in Damage State 4 or5) in a Rare / Design Basis Earthquake (MRP 475 years, typically used as a code based demand for new designs in most parts in the World, including in Armenia). This is confirmed from the scenario earthquakes for Yerevan and Gyumri described in the report. An earthquake close to Yerevan along one of the two main faults surrounding the city with a magnitude of around M6.3 to M6.5 will generate shaking in Yerevan compatible with the prescribed demand (peak ground acceleration) in the current seismic code. In this credible scenario, it is expected that one FRS and 3 fire engines may be lost due to FRS structural damage.

5.8 Lack of Systematic Approach in Managing Capital Investments

A major discrepancy identified for the Fire/rescue Service in Armenia is the lack of systematic and sustainable approach in managing the capital investment projects. This is best illustrated by the following photos, each corresponding to specific example of inconsistencies:

- Allocating modern ISUZU apparatus in garage spaces of inadequate height. To make it possible to house the new apparatus in the garages, the floors or the beams above the door opening were partially removed as illustrated in Figure 5.14, Figure 5.15. In other cases, the new ISUZUs were left in the open as they did not fit in the garage at all, see Figure 5.17.
- Insufficient number of bays for the specialised equipment, see Figure 5.14.
- Inadequate storage of new PPE, for reference see Figure 5.16.
- Allocating aging apparatus in a modernised FRS, for reference see Figure 5.18.
- Lack of strategy on investing in modernising the shared FRS and Emergency Response Centre facility as illustrated in Figure 5.19 and Figure 5.20, where plenty of unused space is combined with degrading building conditions.

Figure 5.14: Two brand new mid-size ISUZU fire tenders housed in a degraded FRS building which floor needed to be lowered in order the be able to accommodate the new vehicles – example from FRS ID9 in Gyumri, Akhuryan.

Figure 5.15: Two brand new mid-size ISUZU fire tenders housed in a degraded FRS building which barely fit in the garage – example from FRS ID11 in Ashotsk.

Figure 5.16: New PPE with no space and adequate conditions for proper storage – example from FRS ID11 in Ashotsk.

Figure 5.17: Brand new mid-size fire tenders which cannot fit into the FRS garage and stay outside – example from FRS ID57 in Sisian.

Figure 5.18: Recently renovated FRS with improved conditions in the garage by installing modern automatic doors, drainage and fume gas extraction system equipped with aged fire engines – example from FRS ID43 in Artashat.

Figure 5.19: Lack of focus on regional centres - example of unused space and degraded building conditions in FRS ID52 in Kapan which share the building with the Regional ERC.

Figure 5.20: Lack of focus on regional centres - example of lack of investments in a regional FRS ID52 in Kapan which share the building with the Regional ERC.

5.9 Shared Ownership with Private Sector

Another discrepancy with around 20% of the FRSs is regarding the shared ownership with private owners, who typically occupy part of the building on the 2nd floor above the garages. This makes any reconstruction activities in these FRSs very difficult from administrative point of view, as well as in some cases they may increase the risk of fire in the FRS, as illustrated in Figure 5.23 where the gas pipe for the seemingly not engineered extension of the structure is passing mid-air. Examples from FRS with shared ownership are also given in Figure 5.21, Figure 5.22.

Figure 5.21: FRS sharing part of its first floor with a 3 storey high multifamily residential building – FRS ID44 in Masis.

Figure 5.22: FRS which is partially located on the 2nd floor of a 13 storeys high residential building connected to the apparatus bays via a bridge – FRS ID61 in Yerevan.

Figure 5.23: FRS which shares half of its 2nd floor with private residents – FRS ID70 in Yerevan. Note, the nonengineered extension of the floor area made by the residents and the gas pipelines attached to the extensions making the building even more risky in a seismic event.

5.10 Extreme Cases

Extreme cases of poor building infrastructure and site conditions is presented in Figure 5.24. The road infrastructure is in extremely bad state, the buildings lack finishing layers protecting the main structure, which is already deteriorated. Temporary measures of reinforcing the deteriorated structure that now seem to be permanent can be seen in Figure 5.25.

Figure 5.24: FRS in Myasnikyan - photographs speak for themselves.

Figure 5.25: FRS in Yeghegnadzor - photographs speak for themselves.

5.11 Good Examples

On the other hand, there are a few FRS which are modernised and have proper living conditions, back-up systems and sufficient space. Such is the FRS in Artashat, which is presented in Figure 5.26, Figure 5.27, and Figure 5.29. In a stark contrast with the majority of the FRS there are also non-slip epoxy coating on the garage floor, as well as a fume exhaust system, for reference see Figure 5.28.

Figure 5.26: FRS in Artashat – improved interiors, installation of an automatic EDG (the only one within the portfolio of FRSs in Armenia).

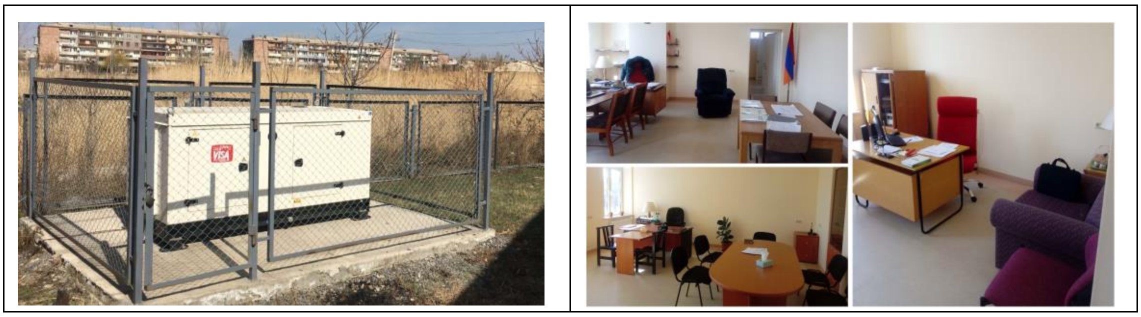


Figure 5.27: Improved conditions in FRS kitchen zones – examples from Artashat and Meghri.

Figure 5.28: Fume gasses exhaust system and epoxy non-slippage cover with a drainage in the garage – examples from Meghri.

Figure 5.29: Dedicated (clean and dry) space for storage and a clothes changing room with locking cabinets – examples from FRS ID68 in Yerevan.

6 Assessment of Investment Needs

This section summarises the works performed for the fire service optimisation study as per the methodology presented in Section 4.

6.1 List of Interventions

The full list of interventions grouped per functionality category is provided in Appendix A. The list includes 32 interventions related to the upgrade of the Operational Capacity, 10 interventions related to the upgrade of the Back-up Systems, 55 interventions related to the upgrade of the Building Infrastructure and 11 interventions related to the upgrade of the Site and Site Infrastructure. A screenshot from the developed spreadsheet is also provided in Figure 6.1 for the Fire/Rescue apparatus. Technical sheets for some of the vehicles are presented in Appendix E.

Figure 6.1: Exemplary list of interventions – partial list of interventions to improve Operational Capacity

Name	cost	(per sc	source	Description of the intervention	Realibility of the cost
OC1 - Brigade Response Vehicle	132000	$/unit	Rosenbauer proposal	These vehicles enable about 90 percent of coverage for fire and vehicular incident response and are typically used in areas with mixed urban and rural coverage. The capital cost for a fully equipped BRV is approximately US$ 112,000	medium
OC2 - Wildland Apparatus	112000	$/unit	unofficial conversation with experts	Small rapid attack vehicles with extended off-road capabilities	low
OC3 - Emergency Tender - Type 1	276500	$/unit	Rosenbauer proposal	small 4x4 water hauling vehicle; Water capacity up to 3.5t?	medium
OC4 - Emergency Tender - Type 2	306000	$/unit	Rosenbauer proposal	Large (4x4?) water hauling vehicle; Water capacity up to 7.0t?	medium
OC5 - Triple Combination Pumper	370000	$/unit	Rosenbauer proposal	urban style vehicle with water tank, pump, hoses and may carry limited rescue equipment, water capacity 5t	medium
OC6 - Aerial Truck	1001500	$/unit	Rosenbauer proposal	Vehicle equipped with a pump, ladder and waterway, 60m	medium
OC7 - Tanker Pumper Apparatus	396000	$/unit	Rosenbauer proposal	A vehicle that focuses primarily on hauling water and the ability to pump that water through an on-board hose onto the fire, without additional equipment such as ladders, blankets, and generators. Water capacity 12 t	medium
OC8 - Aerial Ladder	497000	$/unit	Rosenbauer proposal	Ladder truck with ladder capability up to 27 m	medium
OC9 - Aerial Platform	235000	$/unit	unofficial conversation with experts	Hydraulic platform, height 40m	low
OC10 - Small Rescue Vehicle	111500	$/unit	Rosenbauer proposal	Small 4x4 Modular vehicle that carries personnel and equipment for rescue purposes (Not a patient transport vehicle)	medium
OC11 - Heavy Rescue Vehicle	405000	$/unit	Rosenbauer proposal	Large 4x4 Modular vehicle that carries personnel and equipment for rescue purposes (Not a patient transport vehicle)	medium
OC12 - Snow Rescue Vehicle	40000	$/unit	unofficial conversation with experts	Snow cat modular rescue vehicle	low
OC13 - Swap body vehicles	829500	$/unit	Rosenbauer proposal	Swap body vehicles from Rosenbauer are the most efficient solution for the highest flexibility for the transport and storage of equipment that is only needed in certain situations	medium
OC14 - Command Vehicle	400000	$/unit	Rosenbauer proposal	A mobile command vehicle supports deployment crews in the management and coordination of tactical units for fighting fire and disaster operations. The command vehicle is an indispensable instrument for authorities and organizations for controlling and mastering difficult operational situations in a manageable and organized fashion.	medium

6.2 Application of Interventions to Each Individual FRS

The application of the interventions to individual FRS is performed as explained in Section 4.3. Example for the procedure applied to each FRS is provided in Figure 6.2 and Figure 6.3 below.

Figure 6.2: Application of interventions to individual FRS (pages 1 and 2) – example with FRS ID1 Talin

FRS	ID	1
City		Talin
Region		Aragatsotn
Population in the region		132925
Population density in the region		48
Number of FRS in the region		4
Facility type		FRS
Population in the FRS area		34449
Calls per year		NI
Staff		30
Staff per shift		7
Number of vehicles		3
Number of fire engines		2
Average response time		25
Maximum response time		55
Building ownership		shared
Expected site hazards		None
Known to be planned for replacement by MoES		No
Height of the buidlings in the region of the FRS (number of		5
Region type		Flat

Description of the infrastructure

FRS in one two-story building: administration is above garage

Building area	1215
Building area / tolerable area	1.04
Garage height	4
Site size	5390
Site size / footprint area	7

Results from baseline assessment

Functional category	Category	Index
Operational capacity (OC)	Poor	53%
Back - up systems (BS)	Poor	56%
Building infrastructure	Fair	28%
Garage		39%
Storage and maintenance		45%
Space and layout		26%
Living conditions		33%
Site and site infrastructure	Poor	38%

Link to presentation

FRS is initially assessed:	Group 3	Selected optimisation option:	Option 2
the FRS is with shared ownership		building area enlargement or rebuying shared parts, seismic strengthening, remodelling to separate the functional zones and separate clean from contaminated areas, cosmetic renovation, new equipment and furniture, communication lines on site	

Good potential for improvement

The FRS can meet basic requirements for the firemen health and safety , the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be met. All back-up systems can be implemented. At least four of the functional zones can be obtained (with less area than the tolerable defined in SP...) and clean and contaminated areas can be separated

Charts : possible optimisation

Figure 6.3: Application of interventions to individual FRS (pages 3 and 4) – example with FRS ID1 Talin

	Baseline Assessment Results	OC	BS	BI	SI
		Poor	Poor	Fair	Poor
Category	Title	Unit Cost $	Quantity		Cost $
OC	OC1 - Brigade Response Vehicle	$ 112,000	$/unit	1	$ 112,000
OC	OC5 - Triple Combination Pumper	$ 800,000	$/unit	1	$ 800,000
OC	OC7 - Tanker Pumper Apparatus	$ 400,000	$/unit	1	$ 400,000
OC	OC10 - Small Rescue Vehicle	$ 200,000	$/unit	0	$ -
OC	OC12 - Snow Rescue Vehicle	$ 40,000	$/unit	0	$ -
OC	OC14 - Command Vehicle	$ 100,000	$/unit	1	$ 100,000
OC	OC15 - Structural Firefighting Eq.	$ 5,000	$/unit	30	$ 150,000
OC	OC17 - Rescue equipment	$ 2,000	$/unit	2	$ 4,000
OC	OC20 - PPE	$ 5,000	$/unit	30	$ 150,000
OC	OC21 - Tower - Type 1	$ 1,000	$/unit	1	$ 1,000
BS	BS2 - EDG - 10kW	$ 7,150	$/unit	1	$ 7,150
BS	BS5 - UPS 1000V	$ 220	$/unit	1	$ 220
BS	BS10 - Back-up communication	$ 1,000	$/unit	1	$ 1,000
BI	BI3 - Area expansion	$ 900	$/m2	0	$ -
BI	BI4 - Vertical area expansion	$ 900	$/m2	0	$ -
BI	BI6 - Seismic retrofit - conventional	$ 135	$/m2	1213	$ 163,755
BI	BI12 - Walls - thermal insultaion	$ 10	$/m2	727.8	$ 7,278
BI	BI13 - Energy efficient windows	$ 80	$/m2	727.8	$ 58,224
BI	BI14 - Interior remodelling	$ 150	$/m2	1213	$ 181,950
BI	BI15 - Inside cosmetic renovation	$ 100	$/m2	1213	$ 121,300
BI	BI17 - Heating system - individual electric heaters	$ 5	$/m2	1213	$ 6,065
BI	BI20 - Garage heating devices	$ 5	$/m2	262	$ 1,310
BI	BI21 - El system replacement	$ 20	$/m2	1213	$ 24,260
BI	BI22 - Gas system replacement	$ 40	$/m2	1213	$ 48,520
BI	BI23 - Replacing water pipes	$ 40	$/m2	1213	$ 48,520
BI	BI24 - Remodelling sewage system (pipes)	$ 40	$/m2	0	$ -
BI	BI25 - Garage - surface	$ 10	$/m2	262	$ 2,620
BI	BI26 - Garage - non-slip epoxy surface	$ 10	$/m2	262	$ 2,620
BI	BI27 - Garage - drainage	$ 10	$/m2	262	$ 2,620
BI	BI29 - Garage - improving doors	$ 2,000	$/bay	3	$ 6,000
BI	BI30 - Fume exhaust system - source capture	$ 3,000	$/bay	3	$ 9,000
BI	BI31 - Fume exhaust system - ventilation system	$ 3,000	$/m2	3	$ 9,000
BI	BI32 - Fire extinguisher system	$ -	$/m2	1213	$ -
BI	BI33 - Fire detectors	$ 70	$/m2	1213	$ 84,910
BI	BI35 - Cleaning and decontamination room	$ 1,500	$/unit	1	$ 1,500
BI	BI36 - Hose wash cleaning machine	$ 785	$/unit	1	$ 785
BI	BI37 - Cl. & decont. equipm. for PPE	$ 5,000	$/unit	1	$ 5,000
BI	BI38 - Bathroom (finishing materials, sinks, showers, etc)	$ 175	$/unit	1	$ 175
BI	BI39 - Office furniture - desks , chairs, shelves	$ 205	$/cabinet	0.6	$ 123
BI	BI40 - Kitchen & dayroom - furniture	$ 1,580	$/kitchen	0.8	$ 1,264
BI	BI41 - Dormitory - furniture	$ 2,975	$/bedroom	0	$ -
BI	BI42 - Meeting/training room - furniture & equipment	$ 805	$/room	0	$ -
BI	BI43 - Communication room - furniture	$ 370	$/room	1	$ 370
BI	BI44 - Communication room - ITC equipment	$ 5,000	$/room	1	$ 5,000
BI	BI45 - Passive lightning protection	$ 5	$/m2	1213	$ 6,065
BI	BI46 - Storage racks	$ 50	$/unit	2	$ 100
BI	BI48 - Electrical boiler	$ 250	$/unit	0	$ -
BI	BI51 - Fitness equipment	$ 890	$/unit	1	$ 890
BI	BI52 - Outside fitness area	$ 200	$/unit	1	$ 200
BI	BI53 - Roof repair	$ 35	$/m2	485.2	$ 16,982
SI	SI1 - Yard pavement	$ 20	$/m2	300	$ 6,000
SI	SI2 - Yard asphalt	$ 50	$/m2	300	$ 15,000
SI	SI8 - Surveilance system	$ 400	$/unit	1	$ 400
SI	SI9 - Cable Internet access	$ 20	$/month	1	$ 20
SI	SI10 - Back-up cable Internet access	$ 20	$/month	1	$ 20
SI	SI11 - Rebuying shared parts	$ 900	$/m2	200	$ 180,000
		$ -	-	0	$ -
		$ -	-	0	$ -
		$ -	-	0	$ -
		$ -	-	0	$ -
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Functional category	Total	OC	BS	BI	SI
Expected upgrade level		Good	Very good	Good	Poor
Cost for upgrade	$ 2,743,216	$ 1,717,000	$ 8,370	$ 816,406	$ 201,440
Available budget	$ 340,000	$ -	$ -	$ -	$ -

6.3 Needed Investments

Once each FRS is categorised (Group 1 to 6) and the improvement strategy is selected (Option 1 to 4) a specific list of interventions is applied to each FRS and the total investment costs per FRS and the costs needed to improve each functionality category are calculated. Tables summarising the estimated investment in Variant 1, 2, 3 and 4 for each FRS provided in Appendix C.

The identified investment needs were estimated to be between $75M and $210M depending on the selected modernisation programmes. Each variant of a modernisation programme aims a holistic approach with improvement of all physical components of the fire and rescue service – buildings, communication system, specialised equipment and vehicles. However, the scale of improvement varies and hence the needed investment differs significantly. While the most expansive variant (Variant 4) leads to complete transformation of the AFRS, the lowest cost option (Varian 2) achieve mainly stabilisation of the AFRS with some aspects of expansion of the capacity. The four modernisation programmes variants are summarised below and in Table 6.1:

- **Variant 1 Stabilisation with Expansion and elements of Optimisation of the AFRS ($100M):**
  - Refurbishment of 16 FRSs keeping their original size, major remodelling with area expansion for another 35 FRSs and construction of 5 new FRSs at a new site with a total cost of the building infrastructure improvements of $41.7M;
  - Acquiring of 167 new vehicles, of which 26 Brigade Response Vehicles (BRVs), 18 Wildland Apparatus, 25 Emergency Tenders (ET) of different types/sizes, 26 tanker pumpers (to pair each BRV), 7 Heavy Rescue Vehicles (HRV) and 65 specialised

vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of about $41.5M;
  - Buying of 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 12 sets of heavy rescue equipment with a total expected cost of $12.1M;
  - Buying and installing 3 computers per FRS and modern communication equipment to equip the dispatcher rooms of all FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new or retrofit of the existing technical training facilities in 42 of the FRSs with a total expected cost of $3.3M;

- **Variant 2 Stabilisation with Expansion of the AFRS ($75M):**
  - Refurbishment of 40 FRSs keeping their original size, partial renovation and refurbishment of the 11 FRS with shared ownership and construction of 5 new FRSs at a new site with a total cost of the building infrastructure improvements of $26.9M;
  - Acquiring of 140 new vehicles, of which 21 BRVs, 17 wildland apparatus, 25 ETs of different types/sizes, 21 tanker pumpers, 4 HRVs and 52 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $31.2M;
  - Buying 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 4 sets of heavy rescue equipment with a total expected cost of $11.7M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new or retrofit of the existing technical training facilities in 21 of the FRSs with a total expected cost of $2.1M;

- **Variant 3 Expansion and Optimisation with elements of Transformation of the AFRS ($195M):**
  - Refurbishment of 6 FRSs keeping their original size, construction of 34 new FRSs at their current site and construction of 16 new FRSs at a new site with a total cost of the building infrastructure improvements of $95.3M;
  - Acquiring of 251 new vehicles of which 34 BRVs, 18 wildland apparatus, 63 ETs of different types/sizes, 34 tanker pumpers and 14 HRVs and 88 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $73.1M;
  - Buying of 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 20 sets of heavy rescue equipment with a total expected cost of $12.5M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;

- Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
- Developing new or retrofit of the existing technical training facilities in 43 of the FRSs with a total expected cost of $11.3M;

- **Variant 4 Expansion and Optimisation with Transformation of the AFRS ($210M):**
  - Construction of 21 new FRSs at their current site and construction of 35 new FRSs at a new site with a total cost of the building infrastructure improvements of $89.7M;
  - Acquiring of 282 new vehicles, of which 34 BRVs, 18 wildland apparatus, 63 ETs of different types/sizes, 34 tanker pumpers, 14 HRVs and 119 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $83.7M;
  - Buying 1937 sets of firefighting clothes and 441 sets of SCBA, 56 specialised/rescue equipment and 38 sets of heavy rescue equipment, 2 sets of water rescue equipment with a total expected cost of $13.4M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new technical training facilities in 51 of the FRSs with a total expected cost of $22.9M;

Table 6.1: Summary of interventions and costs for the four variants of modernisation programme

Modernisation Projects	Variant 1	Variant 2	Variant 3	Variant 4
Building infrastructure				
- New construction	- 5	- 5	- 50	- 56
- Remodelling w/ expansion	- 35	- 0	- 0	- 0
- Refurbishment	- 16	- 51	- 6	- 0
- **Estimated Total Cost**	- **$41,7M**	- **$26,9M**	- **$95,3M**	- **$89,7M**
Fleet of special vehicles				
- BRVs	- 26	- 21	- 34	- 34
- ETs	- 25	- 25	- 63	- 63
- HRVs	- 7	- 4	- 14	- 14
- Other Vehicles	- 109	- 90	- 140	- 171
- **Estimated Total cost**	- **$41,5M**	- **$31,2M**	- **$73,1M**	- **$83,7M**
PPE and specialised equipment				
- Firefighting clothing sets	- 1937	- 1937	- 1937	- 1937
- SCBA sets	- 441	- 441	- 441	- 441
- Light rescue equipment	- 56	- 56	- 56	- 56
- Heavy rescue equipment	- 12	- 4	- 20	- 38 + 2*
- **Estimated Total Cost**	- **$12,1M**	- **$11,7M**	- **$12,5M**	- **$13,4M**
ICT equipment				
- Computers	- 168	- 168	- 168	- 168
- Communication equipment	- 56	- 56	- 56	- 56
- **Estimated Total Cost**	- **$500,000**	- **$500,000**	- **$500,000**	- **$500,000**
EDG				
- Number	- 55	- 55	- 55	- 55
- Stations	- 55	- 55	- 55	- 55
- **Estimated Total Cost**	- **$400,000**	- **$400,000**	- **$400,000**	- **$400,000**
Technical Training Facilities	- 42 - **$3,3M**	- 21 - **$2,1M**	- 43 - **$11,3M**	- 51 - **$22,9M**

Modernisation Projects	Variant 1	Variant 2	Variant 3	Variant 4
- Stations - **Estimated Total Cost**				
Total	**$99,5M**	**$72,8M**	**$193,1M**	**$210,6M**

While all variants achieve great improvement of the Operational Capacity, each variant achieves very different level of improvement of the Building Infrastructure and the other two functionality scores. The results of the functionality scores for the current situation and after implementing the interventions for the four variants are summarised in Appendix D. It is the MoES to decide what is the target functionality level that they want to achieve across their portfolio of fire stations.

Variant 4 and to large extend Variant 3 will lead to transformational change in the Armenian Fire and Rescue Service (AFRS) but is associated with an investment cost in the range of $200M. In addition, Variant 3 and 4 are scalable and provide great flexibility for modification and reorganisation (in the timeline) of the interventions. This is because the most static/inertial element of the AFRS, namely the building stock, is fully replaced (almost fully replaced for Variant 3) with new modern buildings and the floor area is doubled compared to current figures (see Table 6.2) Having modern spacious FRSs provide the mentioned above flexibility and scalability of the modernisation programme, e.g., changing type/size of vehicles, staff number, etc.

At the other extreme, is Variant 2 which will achieve mainly stabilisation of the current AFRS by improving the building infrastructure, strengthening the communication system, adding back-up power capacity and technical training facilities. It will, however, lead also to some expansion of the capacity due to the acquisition of new vehicles and new specialised equipment. The cost of Variant 2 could be reduced even further to about $50M by reducing the number of procured vehicles. The main disadvantage of Variant 2 is that this is not a scalable modernisation programme. The FRS total floor area will be increased just slightly and will be still only 60% of the minimum needed (see Table 6.2). This means that the FRSs will be still too small to meet the needs of modern fire and rescue station and this will restrict the number and type of vehicles that can be assigned to the FRS, the equipment that can be safely stored and maintained, the staff number, etc.

Variant 1 describes a more balanced modernisation programme which for 50% of the cost of “best case” options and for 25% more than Variant 1 is likely to achieve stabilisation and expansion of the AFRS with some elements of optimisation of the service. The main difference and advantage of Variant 2 compared to Variant 1 is that it is scalable modernisation programme and provides greater flexibility to modify the type of interventions. Variant 1 leads to 50% increase of the total floor area compared to current situation and achieves total floor area at about 75% of the minimum required (Table 6.2). This provides enough space in the most important FRSs to accommodate different types/sizes of fire engines and to store specialist equipment.

Table 6.2: Summary of FRS total floor area in the current situation and achieved from the four variants for modernisation programme

	Current situation	Variant 1	Variant 2	Variant 3	Variant 4
New build floor area, sq.m.		8,125	8,125	69,085	77,805
Expansion floor area, sq.m.		11,557	0	0	0
Total added floor area, sq.m.		**19,682**	**8,125**	**69,085**	**77,805**
Total floor area of the 56 FRSs sq.m.	**40424**	**58,326**	**46,769**	**77,570**	**77,805**
Area, % of the tolerable area	52%	75%	60%	100%	100%

Note:

3) The tolerable flor area is the minimum needed area for the FRS to meet the modern requirements and is based on 85% of the area specified in the current Russian design standard for fire stations [S7]. The tolerable area for the 56 FRSs is 77,805 sq.m.

4) The optimal floor area needed area for the FRS to meet the modern requirements and is based on 100% of the area specified in Russian design standard for fire stations [S7]. The optimal floor area for the 56 FRSs is estimated to be 91,484 sq.m.

As mentioned above, Variant 1 is considered to be a well-balanced modernisation programme that will manage to stabilise, expand and to some extent, optimise the AFRS at a more affordable cost compared to the ideal cases (Varian 3 and/or 4). Therefore, Variant 1 is used as a basis for the recommended modernisation programme outlined in Section 8. The total investments for each FRS based on Variant 1 are illustrated in Figure 6.4. Maps illustrating the needed investments for each functionality category across the entire portfolio of FRSs are provided in Appendix C. The estimated investments in the Armenian FRSs aggregated on a Marz level is provided in Table 6.3. The distribution of the estimated total investments within the Armenian provinces/marzer is illustrated on Figure 6.5 to Figure 6.8 for the four variants.

Summary of the investment needs per investment type for all four variants is provided in Table 6.2.

Table 6.3: Variant 1: Estimated investments per functionality category and total, for each Marz and total for Armenia

Region	Investments for the visited FRS in a region (3)				Total investment for the visited stations in the region, million US $	Likely total investment for all stations in the region (1), million US $	Average total investment per firefighters for the region, US $	Average total investment per FRS, for the region, million US $	Total investment per resident (2), US $
	OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Aragatsotn	$ 3.12	$ 0.03	$ 2.21	$ 0.1	$ 5.46	$ 5.46	$ 47,100	$ 1.37	$ 40
Shirak	$ 4.44	$ 0.06	$ 4.07	$ 0.3	$ 8.87	$ 10.64	$ 45,200	$ 1.77	$ 40
Lori	$ 4.56	$ 0.08	$ 6.02	$ 0.37	$ 11.03	$ 11.03	$ 46,500	$ 1.38	$ 45
Tavush	$ 5.41	$ 0.05	$ 3.13	$ 0.25	$ 8.84	$ 8.84	$ 62,200	$ 2.21	$ 70
Gegharkunik	$ 5.56	$ 0.05	$ 3.28	$ 0.28	$ 9.17	$ 12.83	$ 53,600	$ 1.83	$ 55
Kotayk	$ 4.32	$ 0.06	$ 2.05	$ 0.25	$ 6.68	$ 8.34	$ 52,600	$ 1.67	$ 35
Armavir	$ 4.18	$ 0.04	$ 2.13	$ 0.24	$ 6.59	$ 6.59	$ 67,200	$ 2.2	$ 25
Ararat	$ 6.46	$ 0.05	$ 2.95	$ 0.12	$ 9.58	$ 9.58	$ 76,000	$ 2.39	$ 35
Vayots Dzor	$ 3.4	$ 0.03	$ 2.4	$ 0.18	$ 6	$ 8	$ 58,800	$ 2	$ 150
Syunik	$ 4.38	$ 0.06	$ 4.44	$ 0.43	$ 9.31	$ 9.31	$ 52,600	$ 1.55	$ 65
Yerevan	$ 9.96	$ 0.16	$ 7.33	$ 0.64	$ 18.08	$ 23.5	$ 40,600	$ 1.81	$ 20
Total for Armenia	$ 55.79	$ 0.65	$ 40.01	$ 3.13	$ 99.57	$ 113.79	$ 51,400	$ 1.78	$ 35

Notes:

(1) Likely total investments for all FRS stations in the region - based on the assumption that the stations which were not visited in the region would need investments equal to the average per FRS for the region

(2) Total investments per resident – estimated with the population data from Census 2011 and with the likely total investments for all FRS

(3) OC, BS, BI, and SI stand for Operational Capacity, Back-Up Systems, Building Infrastructure, and Site Infrastructure

Figure 6.4: Variant 1: Estimated investment for each FRS

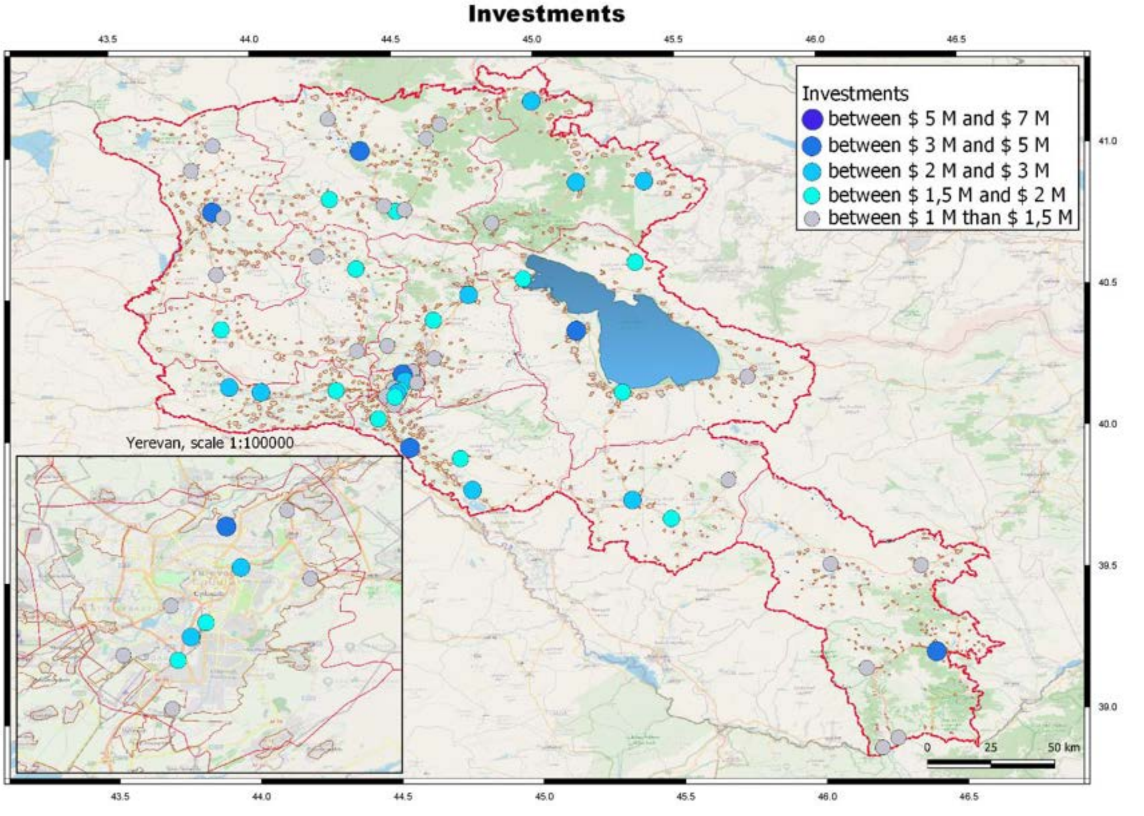


Figure 6.5: Variant 1: Estimated investment for each Marz

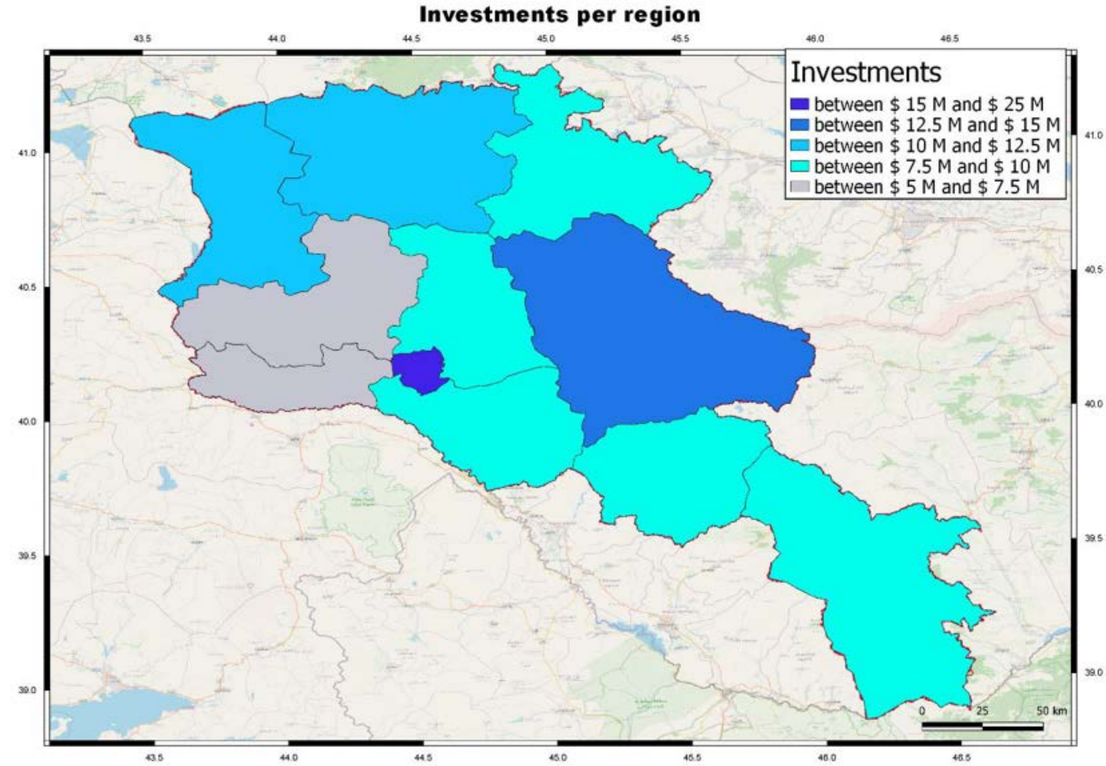


Figure 6.6: Variant 2: Estimated investment for each Marz

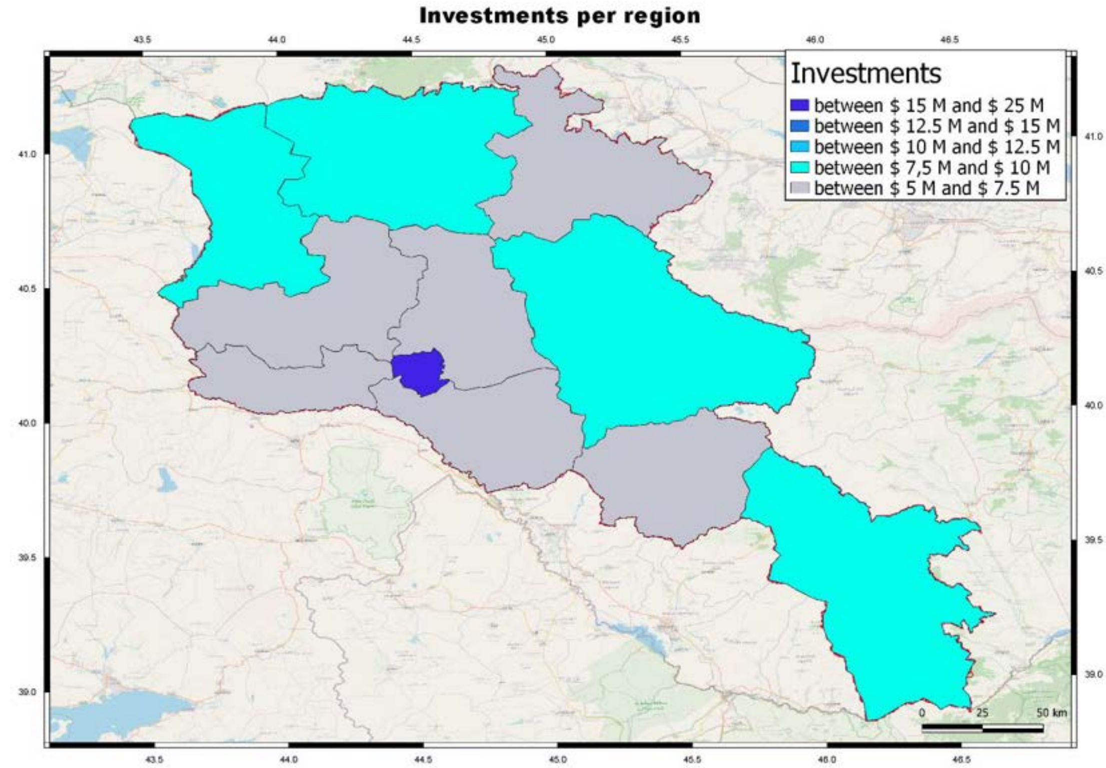


Figure 6.7: Variant 3: Estimated investment for each Marz

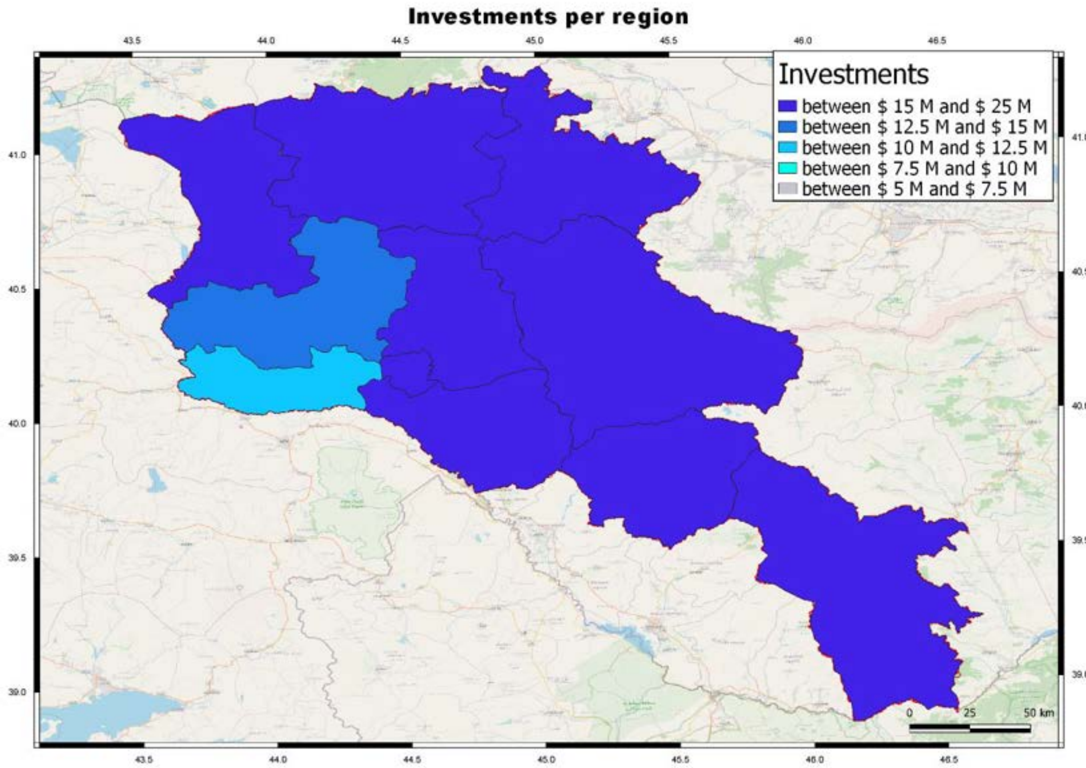
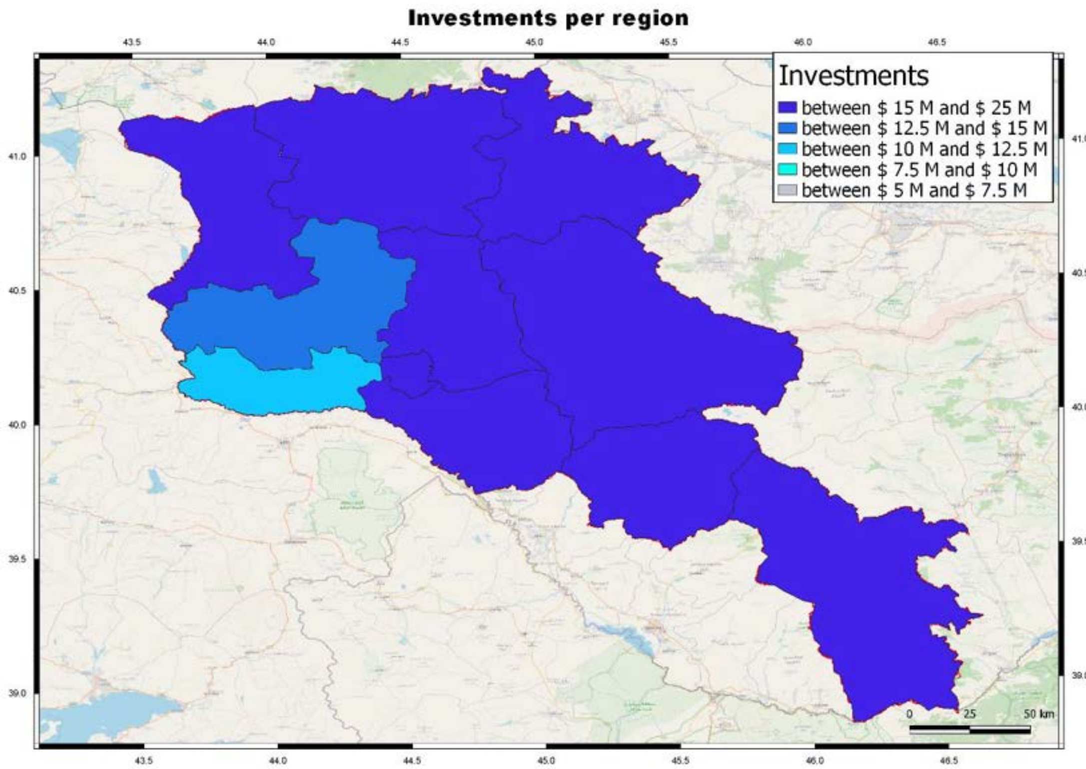


Figure 6.8: Variant 4: Estimated investment for each Marz



7 Fire Service Improvement Strategy

7.1 Background Considerations

The purpose of the Armenian Fire and Rescue Service (AFRS) improvement strategy is to identify opportunities for short and medium-term projects that will result in an optimized fire and rescue service. Funding that would solely focus on replacing existing infrastructure may not provide an optimal solution to the fire and rescue services. A more comprehensive approach that links early investments in public safety infrastructure like protective equipment, vehicles, and buildings to improved data collection and analysis will offer more refined actions in Phase 2 and Phase 3 of the investment programme as described in Section 7.2. The improvement strategies contained in this section represent this integrated approach.

The improvement strategy that has been made are based on careful consideration of information obtained from several sources:

- The analysis of buildings and vehicles in the Baseline Assessment Report [P1] is extensive and provides considerable insights into the status of the overall system.
- The Ministry of Emergency Situations publishes call data and other information related to the system, deployments, and activities on its public website, for reference see Figure 7.1.
- The report information sources were rounded out with monitoring of various Armenian media feeds, including Armenpress [A14], for current events.

The consolidation of the information provided from these varied sources supports a high level of confidence in the Phase 1 recommendations and a firm foundation for Phases 2 and 3. Implementation of some or all of the Phase 1 data collection and reporting elements will help refine the later stage recommendations.

Figure 7.1: Ministry of Emergency Situations in Armenia, public site http://mes.am/en/

While overall the data related to fire stations provided in the Baseline Assessment Report [P1] is comprehensive and provides a clear picture of the state of all Armenia fire stations and vehicles, there is some opportunity to further refine the information for some functional parameters such as:

- Differentiation of the response time data between rural and urban deployments or incident types. To address this the public reports by the Crisis Management National Centre on the nature and number of incidents that the system handles on the Ministry of Emergency Situations public website[A1] can be used.
- Regarding the effectiveness ratio there is limited information to differentiate between excellent fire department performance, inadequate reporting systems, or failure of the

public to call. Data on call types, response, and minimum practical muster (the time it takes for a full deployment of staff required to deal with the emergency safely) were not made available.

- Training facilities appear as lacking in Armenia. There is a central Crisis Management State Academy that provides advanced training for emergency management and fire-rescue personnel. No data was collected about how the national competency management and training program for fire rescue personnel is delivered across the country. A lack of locally available facilities would hamper practical skills management training.
- Published data shows that Fire Rescue Services deploy on a complex range of incident types from building explosions to injured and ill people. Motor vehicle rescue, emergency medical and false alarms represent the largest segment of the services incident volume (based on tracking weekly response data published by the Ministry). Facility, equipment, and apparatus discussions need to reflect the diverse nature of the calls that the service responds to and the variances between stations.

A homogeneous approach to the provision of services across all fire stations is not likely sustainable. Small and remote communities may not require the same availability of services that large and more populated centres will need. A small centre will not maintain a complex system, and the costs to try to do so may be prohibitive. In most jurisdictions, small communities focus on providing essential services that represent more than 95% of the daily activity of emergency responses and use mutual aid or other service agreements to cover the less frequent and more complex events. Larger centres will demand a higher service level due to their concentration of risks and the life safety risk these larger centres represent. Simultaneously, those larger centres with their higher level of resources can contribute to those infrequent severe events in the smaller communities and larger-scale regional or national emergencies. This approach is sustainable and supports the progression or sharing of resources as required, recognizing the infrequency of a large-scale emergency occurrence in smaller communities and remote areas of the country. Service levels based on an analysis of all risks, call history, and local fire service capacity needs to be developed to help guide future system investments.

Starting the process of improving the service and making recommendations for optimizing the Armenian Fire Services should be viewed on two levels. Immediate to medium-term projects geared to improving the functionality and conditions in fire stations. These systemic improvements should build on existing Ministry and staff efforts to enhance the safety and efficiency of the services being provided. New equipment, vehicles and facility improvement should see parallel enhancements in data collection and reporting to measure the effectiveness of the selected solutions, report on their impacts and guide future phases of the optimization project.

There are several recommendations that would benefit from an “All of Government” or national approach or the development of partnerships with the private sector or non-governmental agencies. Communications, information technology and public education efforts will benefit from a broader approach. These efforts should be linked to other Armenian government priorities to ensure all agencies can communicate as required during routine and serious emergency events. A reliable communication and information system will assist in improving organizational cohesion and interoperability when significant emergency incidents require a multi-station or national government response. These additional projects will provide an opportunity to link resources, ensure effective deployment and command practices and will generate the data required to support future decision making.

7.1.1 Data Analysis

This report has relied on several sources of information to inform the recommendations contained in this report. Sources included:

- The Baseline Assessment Report [P1] and the accompanying presentations and photographs provided insights into the facilities that currently house Armenian Fire and Rescue Service (AFRS), provided an opportunity to evaluate some of the vehicles and equipment in service and give some understanding of the service area the various stations provide fire rescue services.
- The Ministry of Emergency Situations and the Crisis Management Centre publish various materials in English that provided critical insights into daily pressures faced by AFRS as well as an understanding of the breakdown and nature of the calls on a routine basis, for reference see Figure 7.2.
- Various media outlets, including Armenian news reporting, feeds provided daily updates on activities in Armenia, and, those on fire and rescue responses.
- Wikipedia, the World Bank and World Health Organization websites provided supporting information.
- Specific standards or industry best practices were used to fill in gaps in available data, recognizing that Armenia will establish its standards, developed, and implemented locally.

The strategies listed in Section 7.2 offer an opportunity to build on existing processes already adopted by the Ministry related to data collection and stakeholder engagement processes. Large amounts of data are already collected but may require additional detail and publishing.

The report provides a high-level framework focussing on the development of programs based on industry practices applicable to Armenia.

Figure 7.2: Weekly fire report from the Crisis Management Centre for the week of September 6, 2020. [A1]

INFORMATION
About emergency cases and accidents registered in the Rescue Service of the MES of RA during the period from August 31 o September 6 in 2020

N		*Amount of the registered cases*	*Victims*	*Casualties*	*Rescued*	*Removed to a safe area*		*Responded by the authorized body*
						Means of transport	*People*	
1	Fire	195	0	2	0	0	0	195
1.1	Fake Fire Calls	22	0	0	0	0	0	22
1.2	Treat of Fire	38	0	0	0	0	0	38
2	RTA	66	6	84	1	0	0	22
3	Collapse	3	0	0	0	0	0	2
4	Explosion	2	2	4	0	0	0	1
5	Wild Animal Attack	3	0	0	0	0	0	0
6	Poisoning	11	12	22	0	0	0	0
7	Corpses	2	2	0	0	0	0	2
8	Detection of Ammunition	1	0	0	0	0	0	0
9	Search and Rescue Operation	1	0	0	0	0	1	1
10	Suicide (attempt)	10	0	1	0	0	3	5
11	Household Cases	133	0	0	0	0	3	133
12	Accident	37	0	0	0	0	0	37
12.1	Snake Detection	18	0	0	0	0	0	18
13	Including found	26	0	4	3	7	9	25
13.1	Other Cases	7	0	0	0	7	9	7
14	Including Means of Transport Blockage	4	0	0	0	0	0	4
Total		**554**	**22**	**117**	**4**	**7**	**16**	**487**
Total Emergent		**283**	**20**	**112**	**1**	**0**	**0**	**222**

Note: RTA stands for Road Traffic Accident (RTA)

7.1.2 COVID-19

The authors of the report recognize the impact that COVID-19 is having on virtually every jurisdiction in the world. The pandemic has demonstrated the critical importance of strategic investments in fire and rescue services. AFRS confirms the essential nature of their support roles to the community, beyond primary firefighting duties. These services and the fire and rescue professionals who staff them are faced with the challenge of delivering emergency programs and responses to communities who need them most and are least able to access them. This essential service role has forced Fire Services, in general, to change deployment and operational models to reflect the pandemic risks. It has expanded to provide critical care to those afflicted by the virus, where health agencies are overwhelmed. The change to operational and deployment delivery models has required investments in personal protective equipment and improved operating procedures related to hygiene and managing the numbers of staff exposed to medical and other low acuity events.

COVID-19 is forcing change and is driving the modernization of response agencies into more nimble and agile response systems. A more responsive fire services model makes better use of resources and is better able to cope and manage through the pandemic. Departments are using smaller apparatus to deploy smaller crews to these emergency calls recognizing that the nature of most medical emergency incidents requires fewer than four personnel to mitigate. Improved technologies allow the safe and effective deployment of these smaller units, limiting the exposure of staff to just those needed, utilizing smaller crew sizes of two or three.

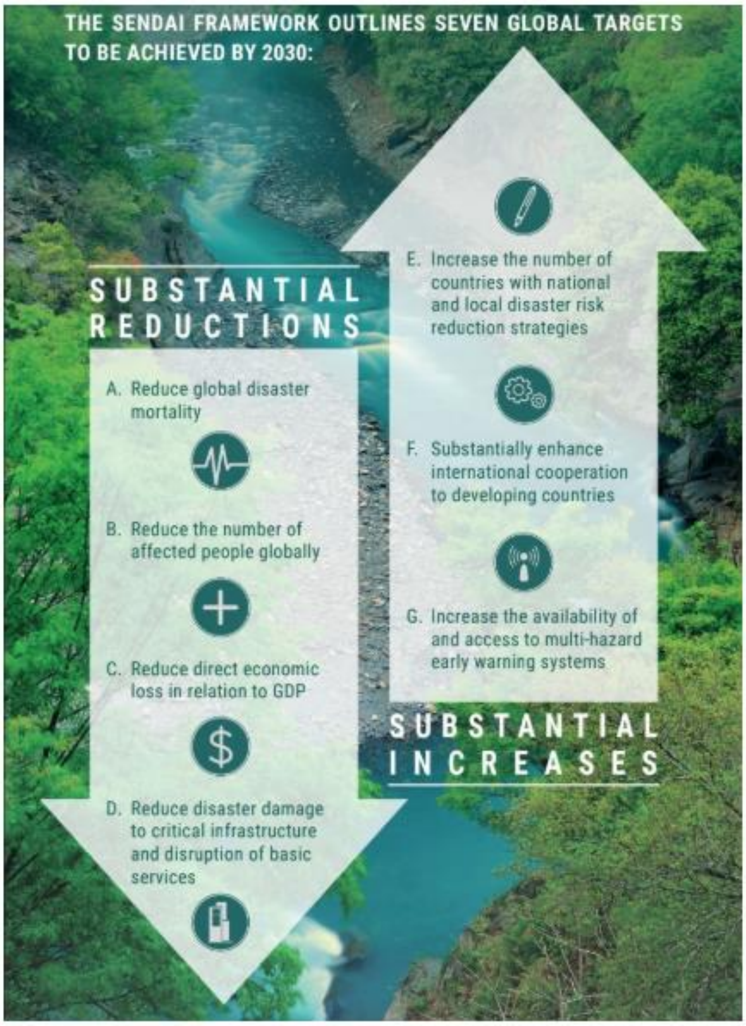
The smaller response units are well equipped for firefighting and rescue operations and are backed up by various vehicles that can escalate the response as required. Better protective equipment and clothing make decontamination easier and do a better job of protecting exposed staff. These modernized systems rely on advanced radio communications systems to link first responders to each other and other agencies and support agencies as required.

7.1.3 Economic Arguments for Fire and Rescue Services Investments

Finding funds to invest in government programs are challenging anytime but is exceptionally difficult during a national crisis like a pandemic or economic downturn. Climate change, urbanization and people living closer to risks and, most recently, the COVID-19 pandemic are increasingly demonstrating that extensive investments in emergency response and disaster management programs are necessary to ensure the preservation of life and the protection of people, business, communities and country. Effective disaster planning plays an essential role in encouraging the development of business and society, protecting critical infrastructure, including those businesses and industries that create employment, generate incomes and contribute to technologies and capabilities that will allow a rapid return to “normal.” Enterprises with money to invest consider the resilience of the jurisdictions vying for their attention and factor that resiliency in when making investment decisions.

A resilient jurisdiction with a professionally managed and efficient emergency response capability will be more attractive to an investment partner. A successful investment project depends on a stable workforce and a community with the capacity to provide critical services. Risk managers will analyse the ability of a local jurisdiction to provide essential safety and security services. Their community analysis will look at prevention and mitigation measures for critical infrastructure. Also considered will be response capabilities for local and regional emergency response services and recovery plans. The analysis will include systems that will be available following a major emergency like an earthquake. Most industries will recognize that their processes may require developing corporate emergency response capabilities for their site. There is an expectation, however, that local, regional, and national governments can provide public safety services to a community.

Figure 7.3:Seven global targets for disaster risk reduction Sendai framework



International collaborations like the 2015 - 2030 Sendai Framework for Disaster Risk Reduction [A4] have recently been enacted. The results of these Disaster Risk Reduction and recovery efforts guide governments in developing comprehensive programs to prevent new and reduce the effects of identified disaster risks, as they impact persons, businesses, communities, and the environment. The Sendai Framework recognizes the vital link between a prepared country with sustainable and competent emergency planning and response systems in place, and its ability to attract and retain critical investments in business and social support systems. The Framework has four core priorities for action:

- Understanding disaster risk.
- Strengthening disaster risk governance to manage disaster risk.
- Investing in disaster reduction for resilience.
- Enhancing disaster preparedness for effective response and “Build Back Better” in recovery, rehabilitation, and reconstruction.

The recommendations in this report address the four Sendai priorities for action directly. Taken in their entirety, they will help the Armenian government meet requirements for safer communities, build on existing successes for a stronger emergency response system in a manner that is sustainable and responsive. At the same time the proposed approach will improve the economic competitiveness of Armenia as a place to invest and do business.

7.1.4 Cancer in the Fire Services

Cancer and cancer-related deaths and illness are identified as the single most serious health threat to firefighters. The risk to firefighters of developing certain types of cancers is elevated significantly compared to other social groups. These findings have been the impetus of improved fire station designs that reduce transmission of contaminants into administrative areas, better personal protective equipment, improved decontamination and cleaning practices, and health and wellness focussed operations lessening exposures and mitigating impacts.

All fire events will result in the generation or release of a wide array of toxic materials and compounds. Modern building contents have changed dramatically in terms of the types of materials that may be found. The heavy reliance on synthetics, plastics and other modern materials, and a move away from natural woods and fibres have increased the density and relative toxicity of smoke. There are many chemicals and compounds produced. Table 7.1 identifies some of the more common carcinogens found in smoke. These are based on studies completed by the International Agency for Research on Cancer (IARC), an agency of the World Health Organization [P3].

Table 7.1: Common carcinogens found in smoke

IARC Group 1 Agents (known to cause cancer in humans)	IARC Group 2A Agents (probable human carcinogens)
Arsenic	Creosote
Asbestos	Polychlorinated biphenyls
Benzene	
Benzo(a)pyrene	
1,3-butadiene	
Diesel engine exhaust	
Formaldehyde	
Soot	
Dioxin	

It is important to note that the exposure of firefighters to diesel exhaust is almost exclusively a result of the contamination of quarters from the exhaust emissions of their vehicles. Older fire stations lack adequate controls on the management of their diesel engine exhausts. The development of mitigation strategies is essential in managing this risk of cancer source.

Consistent and regular medical monitoring of firefighters should form part of the exposure management plan for the department. Early identification of exposures, cumulative or acute, is essential to successful outcomes. NFPA 1500 [S5] guides medical practitioners on the criteria that should form part of a routine medical evaluation for firefighters. AFRS should consider making mandatory medicals for firefighters, at least once every two years, part of their exposure management plan.

7.1.4.1 Exposure Routes

Chemical and biological exposure routes include ingestions, inhalation, and absorption. Understanding the exposure risk is vital in terms of planning for both PPE and decontamination procedures. While ingestion may be an exposure route, the risk is reduced through well-applied exposure protection and hygiene control plan.

Priority concerns for the fire service are inhalation, absorption, and secondary exposures.

7.1.4.2 Inhalation

Inhalation hazards are well understood by the Fire Service. Significant advances in respiratory protection devices, both supplied air and filtration systems, have effectively managed inhalation injuries. Inhalation exposures are generally restricted to a failure to utilize the appropriate respiratory protection, frequently during the overhaul phases of an event or in outdoor areas where periodic contamination is present. A strict respiratory protection policy must be developed, implemented, and enforced. Codes of practice are required for all respiratory protective equipment to ensure it is appropriately used, cleaned, maintained, repaired, and replaced as necessary.

7.1.4.3 Absorption

Firefighter protective clothing does little to protect against chemical infiltration of the protective ensemble. Many of the carcinogenic materials contained in smoke are easily absorbed through the skin, and skin absorption rates increase with the ambient air temperature. Recent studies indicate that a temperature increase inside the protective clothing of as little as 5 degrees will increase the absorption of toxic chemicals by 400%. This temperature increase requires a reassessment of fire suppression tactics and the development of effective decontamination procedures. Decontamination must start the incident scene and continue back at the fire station with careful cleaning of equipment, clothing, and personnel.

Exposure reduction strategies should be considered that include tactical decisions to reduce exposures of firefighters to the hazards. Implementation of command considerations that include the evaluation of potential contamination by-products such as asbestos should also be implemented. Many factories and almost all buildings constructed before 2000 should be assumed to contain asbestos products. When asbestos is found, decontamination practices should reflect that on-site, with both the contaminated crew and the decontamination personnel being properly protected from contamination. Industry best practices dictate that cleaning and decontamination begin at the scene and that contaminated gear does not get transported inside the apparatus.

7.1.4.4 Effects of Heat

As previously mentioned, elevated heat exposure has shown to increase the absorption of chemicals by as much as 400% for every 5 degrees increase in temperature inside the firefighter protective clothing. Strategies to reduce the combined exposure of firefighters to toxic smoke and chemicals and high heat require consideration. Modern firefighter protective clothing is designed to help moderate internal temperatures using specific materials and designs.

7.1.4.5 Transitional Fire Attack

The transitional fire attack strategy is one that sees the controlled application of water before entry to lower the temperature of the fire compartment and begin fire control. This transitional attack strategy has been evaluated by Underwriters Laboratories (UL) in the United States and has shown to provide a host of positive outcomes, including the reduction in flashover risk, faster management of the fire, significant cooling of the fire compartment for both potential victims and firefighters plus a reduction in the overall time spent in overhaul and extinguishment. When utilizing an effective exhaust removal and ventilation system in fire stations, firefighter exposure to toxic chemicals and smoke is significantly reduced.

This transitional attack works very well when using rapid attack vehicles and smaller crews. The initial application of a relatively small amount of water, especially with foam, contains the expansion of fire, increases survivability for victims inside the building and will provide time for larger apparatus and additional crews to deploy.

7.1.4.6 Secondary Contamination

Secondary contamination is an ongoing and profound concern for all fire services. Contamination from fire and rescue sites is transported back to quarters and, in some cases, home through soiled clothing, equipment, and in the vehicles are leading causes of secondary contamination. Contaminated gear and equipment inside the passenger compartments of firefighting vehicles are manageable. So is thoroughly cleaning PPE gear and equipment. The COVID-19 sanitizing protocols demonstrate how effective equipment and personal hygiene and decontamination protocols can be made routine.

Various internationally recognized standards guide methods to reduce the potential for cross-contamination. As a matter of practice, no dirty gear should be worn or transported inside the passenger compartment of vehicles. It should be isolated in something as simple garbage bags and placed in separate compartments on a vehicle. Contaminated gear and equipment should be secured and transported in cargo areas directly to the fire station for laundering and decontamination at the station. Strict controls on in-station handling, including the use of personal protective equipment, should be in place and followed to ensure the hazards are contained and eliminated.

7.1.4.7 Exhaust Contamination of Fire Station

Vehicle exhaust fumes should be vented directly to the outdoors to prevent contamination of personnel, the facility and equipment by gas and diesel exhaust gases. Where it is not possible to do so, proper maintenance of engines to minimize exhaust emissions and indoor air monitoring should be provided to ensure that worker exposures do not exceed safe exposure thresholds.

The negative impacts of diesel exhaust contamination can be managed by having administrative and operational guidelines. Engines should only be operated for the minimum time required to pull out of the station. The engine should be run at the minimum throttle level necessary to move it and, the garage doors opened before starting the engine. Simple procedures such as hoses over exhaust pipes that extend to the outside could be implemented to reduce the toxic effects of diesel exhaust.

7.1.4.8 Personal Protective Equipment

Personal protective equipment (PPE) provides an essential layer of protection from the effects of fire and its products of combustion. In terms of protection, research has demonstrated that personal protective gear in and of itself is not sufficient to fully protect firefighters from exposures to chemicals, including those entrained in smoke.

Section 7.1.3 of NFPA 1500 [S5] stipulates that "Structural fire-fighting and proximity fire-fighting protective ensembles and ensemble elements shall be cleaned as specified in NFPA 1851, Standard on Selection, Care, and Maintenance of Structural Fire Fighting Protective Ensembles" [S6]. Most manufacturers provide detailed cleaning and maintenance schedules that reflect these requirements. In all cases, these manufacturers' directives should be followed.

NFPA 1851 [S6] provides detailed guidance on the safe storage, cleaning, maintenance, and replacement of firefighter protective clothing. These requirements are also specified by manufacturers in their use and care instructions. Consideration of a separate space or enclosed, vented storage units that protect the gear from secondary contamination from station sources as well as protecting it from ultraviolet degradation should be implemented in the current and any future facility designs.

Specific PPE should be provided to protect the personnel assigned to clean up and decontamination processes. Specific PPE includes respiratory, eye and skin protection measures.

Contaminated protective clothing should not be permitted inside crew compartments of vehicles or fire apparatus. It should be given a preliminary cleaning at the incident scene and bagged for transport to the station for proper cleaning and maintenance. Where this becomes unavoidable due to rehabilitation needs, the vehicle should be taken out of service and properly decontaminated before returning to active duty.

Civilian tours of the operational areas should be considered carefully regarding their potential exposure to toxic chemicals. If PPE gear and helmets are to be placed on civilians, these should be non-operational gear that has been decontaminated.

7.1.5 Standards

Standards should support the optimization efforts of the AFRS and reference recognized international standards that are developed internally to reflect the operational and governance realities of Armenia. Care should be taken to carefully assess the implications of standards, particularly those that address response or service delivery standards. Many jurisdictions find an emergency response and operational standards to be financially and operationally impractical to achieve consistently.

International standards that address the selection, design, use and maintenance of equipment, clothing and vehicles should be referenced. These standards reflect decades of improved processes, materials, and approaches to other international standards. Other standards guiding the engineering, construction, maintenance, and repair of vehicles or personal protective equipment may be considered as written. These standards address risks and issues that are common to all jurisdictions. These standards should be identified and considered for all future vehicle and equipment purchases to ensure that what is being ordered is safe, well designed, constructed properly and built to last for its intended service life.

Emergency response system performance standards should be defined internally by the Ministry of Emergency Situations and reflect the expectations of the country and its residents. The adoption of internally developed standards can be phased in over several years and at a pace that can be supported both operationally and administratively. The Ministry should focus on system outcomes and allow AFRS to define their approach to delivering the services they are mandated to provide. Expected results can be articulated through operating guidelines and procedures which are developed internally. The Ministry and the AFRS understand their complex operational environment best. Reporting processes with Key Performance Indicators (KPI’s) should be included in standards making to track the performance of the systems being measured and guide changes as required. Using KPIs will allow for continuous improvement as more data becomes available.

Some international standards are worth consideration as written. Those pertaining to the design, manufacture and operation of machinery and equipment may require processes more complex than the local jurisdiction can support. In these cases, international standards may offer a safe alternative. Standards related the following should be considered for adoption in Phase 1 or the Optimization project:

- **Equipment**: all fire-fighting equipment and particularly personal protective equipment should be specified to comply with an appropriate international standard. There are numerous standards that may make sense for the Armenian government to adopt. North America, Europe, Russia, and other countries have developed comprehensive standards that can guide Armenian efforts and improve safety, consistency and ensure the best possible value for taxpayers.
- **Vehicles**: All firefighting vehicles should be designed and built in accordance with an appropriate international standard. Again, this ensures these complex vehicles are constructed correctly and, if maintained in top form, will operate throughout their anticipated life cycle.
- **Training**: Standards for the basic training of firefighters related to new equipment, vehicles and processes should be evaluated and adopted.
- **Fire Station Design Standards**: These standards should be developed in consultation with building design professionals competent in fire station design. They may reflect some elements of international standards but should focus on sound engineering and architectural design principles related to operations, administration, and post-disaster construction.

7.1.6 Armenian Specific Criteria

The Armenian Fire Rescue Service is a unique entity operating in a challenging response environment. The department currently responds to emergencies of all types affecting the health and safety of residents and businesses. Fire Rescue personnel have a deep understanding of their communities, their needs and expectations and the challenges each represents. The collective wisdom that the Ministry, the AFRS and its personnel must be captured and used to guide the Fire Service Optimisation Project. Efforts to engage personnel at all levels of the organization should be formalized and form part of the Project implementation strategies.

The use of standards to provide baseline guidance on equipment, vehicles and training should be enhanced with the operational insights of those who will use the tools and resources. Additional requirements that reflect the local reality should be added to the international standards so that the solutions reflect a "Made in Armenia" perspective. Ideally, solutions that are being considered should be piloted in selected areas of the country to ensure the solution fits the perceived problems and performs as anticipated.

7.1.7 Procurement Considerations

Deciding on the level of equipment and vehicle technology appropriate to the needs of the organization is a challenging process. Frequently these processes are entirely focussed on the most modern and high-tech solution available. Little consideration is given to the life cycle costs of the item or the availability of technical and service support to keep this equipment functional and in use. It is essential that procurement processes carefully consider the ongoing operational costs and availability of testing and maintenance services of the more complex equipment that may be considered by fire and rescue services. These vehicles and pieces of equipment will require very technical and specific maintenance processes, and the costs can exceed the initial purchase price in some cases.

As an example, modern self-contained breathing apparatus (SCBA) may require periodic battery changes to power onboard heads up displays and integrated alarm systems. These batteries can be alkaline or rechargeable, but either way, it represents costs to operate the equipment. All

SCBA require at least annual testing of masks, regulators, tanks, and other elements. Tanks have hydrostatic pressure testing requirements and specific replacement requirements that should be factored into the program costs. SCBA are extraordinarily complex pieces of equipment and require qualified service technicians to keep them in service. Procurement decisions should consider access to the required technical skills and ensure skills are available within the jurisdiction. Taking equipment out of service to ship out of the country for repairs and maintenance is not likely a sustainable model. The failure to provide the budget to provide for maintenance ensures an early loss of essential equipment.

The tracking, maintenance, and service testing of various equipment will require competent personnel to manage the program administration and delivery. Daily operational checks can be done on most equipment by station personnel with appropriate training. The more advanced testing, service and repairs will need to be done by trained technicians who will likely be responsible for the development and delivery of training programs. These costs should be considered by management when explaining and justifying requests for equipment and fire apparatus.

In 2002 - 2003, the Canadian government, in consultation with fire departments, determined that there was a need for hazardous materials equipment. Included in this process were special suppression systems, protective clothing and chemical-biological detection and testing equipment to address a perceived threat of Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) events. The complex mitigation equipment was procured and distributed to medium-sized fire departments to improve their response abilities. Unfortunately, there was little conversation and no funding considerations related to testing, maintenance, and life cycling. Expensive maintenance and short operational lifecycles for the PPE were not budget considerations by anyone. Some equipment required expensive maintenance programs that required the tools to be returned to the factory for sensor and software updates or repairs. The sampling and detection equipment were beyond the capability of the departments for staff to operate, and limited training was provided. Regrettably, most of this equipment never made it into an operational role within these departments, and the critical investments did not achieve the desired outcome resulting in a significant financial investment loss.

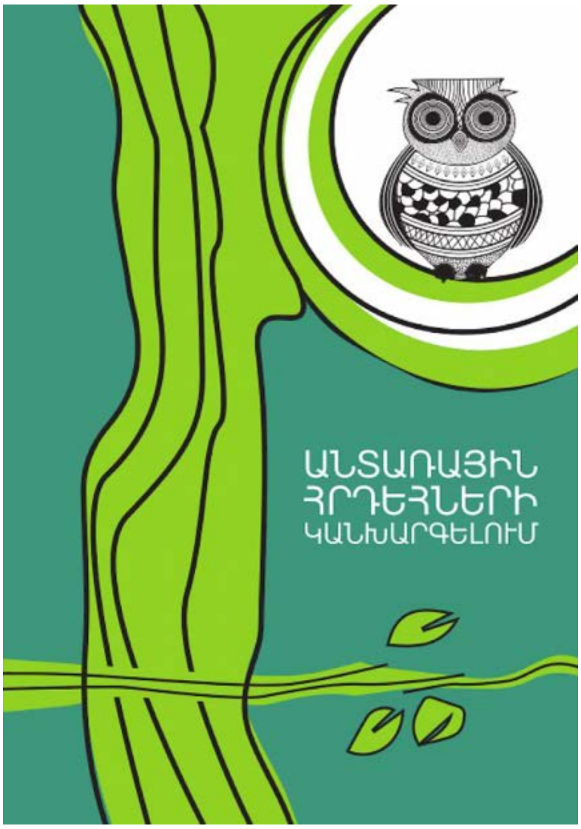
There should be no regrets after the purchase of necessary fire and rescue equipment. Procurement processes should reflect a clear purchase decision that begins with defining the problem and finding a solution. Among other decision factors, the process must include anticipated operating costs, technical maintenance requirements, availability of qualified servicing capacity for preventive maintenance and emergency repair services within the country or region.

7.1.8 Assumptions for the Proposed Project Phasing

Phase 1 should be considered as stabilizing the existing AAFRS with limited expansion of services. This phase is focussed principally on ensuring the current system can deploy safely, effectively, and efficiently. Phase 1 is concerned about firefighter and resident safety, critical infrastructure prioritization and stabilization, and ensuring fire apparatus is suitable, available, and operable in all stations. Phase 1 priorities build on current systems and practices. They include the provision of internet and computer systems for all fire stations, optimization of basic data reporting systems and the evaluation of opportunities to integrate some of the communications systems currently in use by the Fire and Rescue Services.

Phase 1 considerations also include harm reduction strategies that start with prevention and education programs that can empower citizens and communities to take more responsibility for their safety. Excellent examples exist of efforts in the area of personal safety that can be leveraged, see the extract shown in Figure 7.4.

Figure 7.4: Example of Armenian fire prevention materials [A13]



Phases 2 and 3 recommendations build on the foundation of the implemented actions of Phase 1. These recommendations reflect the reality that some of the changes required for an optimized AAFRS will be transformational and demand planning, time, and space to occur. These recommendations consider business continuity planning processes and service delivery model changes. They will ensure that day-to-day systems can meet the community needs and that the more extensive system can activate and deploy when those day to day capacities are at risk of being overwhelmed. These phases also see the continuation of national staffing strategies and the facility and apparatus upgrade projects.

Data will form an essential part of these Phases 2 & 3. The improved data collection and reporting processes initiated in Phase 1 will assist in refining the recommendations, ensuring they fit the needs of Armenians.

7.2 Strategies

The following strategies, when taken in their entirety, form a strategic plan that could guide the ongoing optimization of the Armenia Fire Rescue Service. The strategies in this section include a simple logical approach striking a balance between action-oriented operational elements, data collection and planning that will ensure that the early steps taken will provide a solid foundation for ongoing system optimization. The recommendations cover the continuum of the Ready to Respond (R2R) Framework, including Information, Facilities, Legal and Organization, Equipment and Facilities. This holistic approach is considered most likely to achieve the optimization results envisioned in the project charter.

- Provide Effective Fire Rescue Facilities: Phase 1 through Phase 3
- Improve Community Fire Protection Water Supplies: Phase 1 through Phase 3

- Update Firefighter Protective Clothing: Phase 1
- Evaluate Personal Protective and Fire Rescue Equipment: Phase 1
- Develop an Effective Fleet Management Program: Phase 1 through Phase 3
- Provide Computer and Information Technology Systems: Phase 1 through Phase 2
- Develop Business Continuity Plans and systems: Phase 1 through Phase 3
- Conduct a Hazard, Risk and Vulnerability Analysis (HRVA): Phase 1
- Establish Service Levels Based on HRVA Outcomes: Phase 2 through Phase 3
- Develop and Implement a Communications System Strategy: Phase 1 through Phase 3
- Expand Training, Health and Wellness Strategies and Facilities: Phase 1 through Phase 3
- Formalize Marzer and Town Roles in Fire Protection, Including Volunteer, and Inspection Programs: Phase 1 through Phase 3
- Develop a National Staffing Strategy: Phase 1 through Phase 3
- Develop a Fire Prevention and Public Education Strategy: Phases 1 through 3
- Considerations for Adding Community Value: Phase 1 through Phase 3

7.2.1 Facilities: Phase 1 through Phase 3

The design of fire stations has advanced dramatically over the last several decades. The role of a fire station has evolved from being a building just housing some equipment and personnel for response into fires to a critical community resource providing a variety of services essential to community health. The modern fire station needs to address heightened community expectations for use across all foreseeable emergency events, including post-disaster response and coordination. International fire station design guides are readily available and can help develop facility design guides that can flexibly address large and small facility requirements [S1]

The need for fire rescue facilities to withstand unpredictable natural events has led to a focus on post-disaster construction and upgrades. Building code revisions in other jurisdictions reflect a better understanding of the use of space, operationally critical areas and functions, and the challenges of keeping occupants safe from occupational health risks. Decontamination processes for personnel and operational equipment and the requirements detailing how the isolation of operations from crew quarters and administrative areas of the building are achieved are understood. Modern fire station design has incorporated improved utilization into their design and functionality. The new fire station designs contribute to aiding fire service leaders and their communities to provide a safe, sustainable and effective local fire service. Specialized support spaces that include training, wellness and fitness, communications and briefing spaces are all elements that should be considered when designing a new facility or considering upgrades to existing ones.

Due to the critical nature of the public safety functions AFRS is expected to provide, these buildings should be constructed to “post-disaster” standards. A post-disaster structure is defined as one that is essential to the provision of services during a natural disaster. Included are buildings such as emergency response facilities, hospitals, power generating stations, communications facilities, and transportation control centres. Post-disaster buildings mean that critical infrastructure, including people, vehicles, and facilities, need to survive disaster events, so essential services are available to their communities during these natural disasters. While generally referring to seismic risk, the idea of post-disaster design standards is also applicable to flooding, wildland and other significant natural disaster events and weather-related hazards. Professional design is essential in all aspects of fire station siting, design, and construction.

The decision on where a fire station should be built is a complex one. First, the site must be of sufficient size to be able to accommodate the building and enough outdoor areas for the safe movement of large equipment. Training spaces may be a factor where access to larger regional training spaces is not possible. The site should be located outside of known flooding zones and away from high-risk industrial facilities. Ideally, the site will be found with good access to major roadways that will support rapid deployment into the community being served, supporting a fast response time to emergency events. A formal assessment and analysis of site options and their suitability should form a starting point for any project related to upgrading, expanding or fire station construction projects.

An analysis of AFRS stations has been completed. This analysis has identified the need for significant investments in the fire stations occupied by the AFRS. The issues identified vary by building but most commonly reflect limited space, small site size, low seismic performance ratings and limited facility services like water, sewer, backup systems and other building infrastructure. Several fire rescue stations are not well located in relation to optimal response times. Several fire stations are co-located with other occupancies. This approach is practical and used in other countries where the building meets the operational and post-disaster construction standards required of a fire station. Other concerns identified include fire stations too small for the fire fighting vehicles assigned to them.

Due to the scope of concerns identified in the facility review assessment, a phased approach will need to be considered. Stations will need to be prioritized for upgrades, which is an exercise that will require careful consideration by Armenian authorities.

- Use Fire Station Facility Assessment to guide the development of a facility update and replacement program. Phase 1:
  - The fire station condition report and data should be used as the foundation for a multi-phase facility upgrading strategy that will run through all phases of the Optimization Project. A capital plan that identifies the total cost of upgrades and schedules the expenditures accordingly may be of value to this process. Priorities should be set for each building related to the expected role it will fulfil in a post-disaster situation. Priority facilities may include:
    - Regional headquarters buildings
    - Fire stations serving large population centres
    - Fire stations housing specialized services or functions,
    - Fire stations serving remote areas or that are difficult to access, and
    - Fire stations which, are relatively inexpensive to upgrade or replace.
  - Upgrades or replacement plans for Phase 1 buildings should include full backup power plus emergency firefighting water storage capacity.
  - Those facilities that are identified for future phases of the process should receive basic updates that may include limited structural repairs, provision of basic power generators suitable to sustain basic operations during power interruptions and where required, installation of emergency firefighting water storage capacity.
  - Fire station design standards should be developed that address optimal facilities to accommodate fire and rescue stations. These standards should reflect industry practices for spaces, functions and engineering and be scalable to apply to large and small stations. These standards should be applied to all renovations and new construction of fire stations.

  - Refer to the Business Continuity planning recommendations for planning considerations to support those facilities waiting for upgrades in case of a significant emergency event.
  - Temporary facilities may be required to safely store fire apparatus deemed necessary for a fire station but is either too large or the apparatus bays are functionally or structurally inadequate.
- Implement a facility replacement program. Phase 2 through 3:
  - Capital project planning to support the ongoing implementation of Phase 1 prioritization and capital plans should continue through the balance of the project phases. Priority listings will require annual reviews and updates to ensure that they reflect changes in circumstances and conditions.
  - Begin site selection and procurement processes for new sites for stations that will need to be moved to new locations.
  - Develop agreements for building upgrades with property owners where fire stations are in a shared facility and where the location and relationship are deemed beneficial for the provision of fire and rescue services.
  - Identify gaps in the system where additional facilities may be required. Work should start early to identify and secure potential sites for new fire rescue stations.
  - Develop long term capital plans that include life cycle strategies for new and newly updated facilities to ensure that they remain appropriately maintained and able to meet the response objectives of the system.

7.2.2 Improve Community Fire Protection Water Supplies and Utilization Practices: Phase 1 through Phase 3

Water conservation and the provision of adequate water for fire-fighting and associated activities is a worldwide challenge. Fire protection systems are under increasing pressure to find adequate and dependable water sources that can supply appropriate quality and quantities of water to protect the increasingly complex risks found in the communities [A5]. Threats like climate change, desertification of formerly agricultural lands and the movement of people into interface areas are challenging fire services. Even large and modern cities are forced to evaluate supplemental water storage, distribution, and utilization practices.

Access to adequate water supplies is an essential requirement for the delivery of effective fire suppression services. The facility assessment identified the lack of access to dependable water supplies as a critical gap in many areas of Armenia, including developed areas, rural and wildland areas as well. Open reservoirs provide some limited water storage, but fire service personnel noted water availability as a severe concern. The inclusion of water resource planning as part of the Fire Service Optimization project should be a critical element for attention.

Managing water resources can follow either of two streams. First, departments can plan to make more efficient use of the water they are able to carry on their trucks and tanker vehicles using various technology solutions. The other option is to develop infrastructure to transport, store, or access water in strategic locations to support fire department operations. Many fire departments in arid areas or areas with limited piped water infrastructure make extensive use of both strategies to deliver high-quality services in their jurisdiction.

7.2.2.1 Making Better Use of Water

Use of Class A or Multi-agent Foam Concentrates.

Many fire departments use various foam and wetting agents to enhance the wetting properties and extinguishing capacity of the limited water they carry. The agent increases the penetration ability of the water, and the foaming action allows it to stick to surfaces longer. While the fire flows required to deliver the extinguishing agent remains the same as non-foam applications, the foam offers a more effective extinguishing medium and should reduce the overall amounts of water used.

The technologies for applying the foam are mature and are relatively straight forward in operations and in terms of maintenance. It is likely that some of the equipment necessary for this application is already in service with the Fire Rescue Service, requiring minor modifications and some changes in training and operational guidelines or policies.

Compressed Air Foam Systems (CAFS)

Compressed air foam systems are a technology designed originally for structural protection operations during wildland-urban interface fires. The premise of the system is the application of a viscous mixture of foam concentrate and high-pressure air to create a slurry that is ejected from a nozzle at the end of a hose line. The system was created for areas requiring rapid interventions to extreme fire conditions that were frequently lacking in water supplies. CAFS such as those manufactured by HNE Technologies from Augsburg, Germany [A6] are seeing increased use in all aspects of structural firefighting operations and continue to be of great value in structure protection roles.

CAFS system uses small amounts of water when compared to standard fire-fighting operations. This enables smaller vehicle types (Figure 7.5) with limited water supplies to be highly effective fire suppression platforms. The manoeuvring of hose lines is much easier as the hose is filled with foam instead of water, making them much lighter and more manoeuvrable.

Figure 7.5: Fire bike with CAFS system, [A6]

CAFS systems come in varying sizes and can be installed as part of the original build or as an after-market addition to existing fleet vehicles. The equipment for the CAFS system is complex and does require maintenance and servicing for it to remain operational and effective. An example of CAFS system is presented on Figure 7.6

Figure 7.6: Examples of CAFS systems: retrofit unit on the left and integrated system for new apparatus

Water use with CAFS systems is considerably less than standard firefighting methods or standard Class A foam systems. Examples of the application of class Application of foam Class A and CAFS in firefighting is presented on Figure 7.7

Figure 7.7: Application of Class A foam on a structure during a wildfire (on the left picture) and application of foam using CAFS system in a structure protection configuration (on the right picture)

7.2.2.2 Alternative Water Supplies

Firefighters in Armenia identified the availability of adequate water supplies as a significant challenge to suppressing fires. Firefighting requires large volumes of reasonably clean water free from sand, grit, and other contaminants to extinguish a fire. There is limited availability of piped water supply systems and fire hydrants available to firefighting operations capable of supporting fire suppression. Water sources that are accessible for drafting purposes are limited as well. Photos of human-made water storage facilities used for firefighting suggest that they are rudimentary and do not meet the needs of current fire services and equipment.

The term “alternative water supply” describes a system of vehicles, water access or storage facilities and operational equipment that can provide adequate volumes of water for fire suppression operations in rural areas or areas with limited access to piped water systems. The first responding apparatus should be equipped with a limited supply of water that will let them start operations. They may have a water tanker that will deploy to the scene of the fire and supply water to the fire truck. In many cases, this will be sufficient to manage the situation. More massive fires require substantially more water to support rescue and suppression activities and will need a more robust system of vehicles and resources.

For these large fire events, several tank equipped vehicles will be deployed to the nearest water source, which can be human-made or natural, and will load and move water as required. Water is unloaded into portable tanks at the scene, and the tanker returns for additional loads. Generally, sourcing the required tankers to support the fire suppression operations depends on multi-station deployments or mutual aid activation, where available. Many jurisdictions also have arrangements with commercial water haulers to provide some or all this water supply and transport capacity. While mostly used in rural areas, there are increasingly large numbers of urban areas with ageing or limited infrastructure that is not able to support modern firefighting equipment. Alternative water sources and associated water storage systems are utilized to provide water for firefighting efforts.

The alternative water supply document referenced in this report was prepared by insurance companies to guide fire departments in the development of their mobile and alternative water supply. It is only important in terms of this report because it pertains to the elements of the system and the operating metrics used to determine its effectiveness. The actual numbers used to measure the effectiveness of the system should be developed using Armenian data.

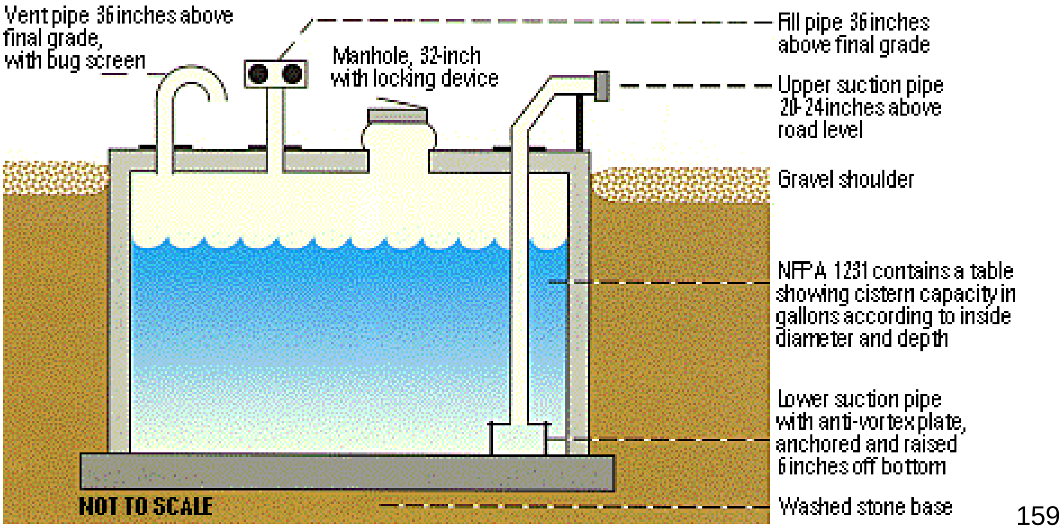
Cisterns

Many agencies utilize cisterns as a planned storage device for fire protection water in areas not served by piped water systems and where there is limited access to standing bodies of water suitable for drafting operations. Large cities in seismically active areas or in areas with limited piped water infrastructure have installed large cisterns under parks and other public developments. Cisterns help to ensure an adequate fire flow during normal events and serve as an emergency backup system in case of a severe seismic event.

The design and construction of cisterns are varied and can include concrete, steel or fibreglass structures that may sit on the ground or be buried below ground. The decision to bury the cistern may reflect a need to protect the water from freezing or because it is needed in an urban or built-up area. These cisterns can be secured to prevent contamination or unauthorized use of the resource. If a cistern is only required during summer and fall fire seasons or is in an area that does not have below-freezing temperatures, above-ground applications will suffice. Many jurisdictions repurpose existing tanks from industrial or other applications. Re-purposing tanks is a cost-effective practice as long as the tank is cleaned thoroughly of possible contaminants.

Water must be supplied to these cisterns. This may be through harvesting runoff water, hauling water or by connections to limited capacity piped water systems.

Figure 7.8: Example of an underground fire water cistern [P3].



Dry Hydrants

Dry hydrants can be used to provide a secure and safe connection point to a standing water source like a lake, stream, or reservoir. They are a relatively simple assembly consisting of a pipe in the ground that runs into the water source. If freezing is a concern, there will be a valve that will restrict water from entering the pipe until required. The top of the pipe has a suction connection permitting the fire apparatus to connect and draft water safely. These are commonly used in both rural and urban operations around the world.

Figure 7.9: A typical dry hydrant installation near a lake [P3].

Water Tankers- Commercial

Many fire departments have contracts with commercial water tanker companies to provide emergency water transport for emergency operations. These vehicles can bring large amounts of water quickly and efficiently. Typically, most will not have fire department connections, but the tankers can rapidly dump their loads into portable tanks from which the fire department can draft water.

Agricultural operations may be a consideration. Generally, they have the capacity and water sources to provide support to water tankers and shuttle operations.

Figure 7.10 Commercial water tankers [P3].

7.2.2.3 Summary of the recommendation

A summary of the recommendations for improving the community fire protection water supplies can be summarised as follows:

- Develop a national water supply strategy that includes improved water utilization practices and strategic water supply facilities. Phase 1
  - The national strategy should address the addition of new technologies like compressed air foam systems (CAFS) to future fire fleet purchases.
  - Water storage facilities appropriate to the various regions and locations should be established in consultation with Fire Rescue personnel and other local agencies. They should reflect various options, including seasonal storage for wildland and agricultural fires, permanent storage for urban installations and structure protection with access to reservoirs, rivers and other alternate water sources.
  - Maps detailing the locations of these sites should be available across the system to support the sharing of these water supply resources during regional or national emergency responses.
  - Cisterns and other strategic water storage should be considered for large urban areas to augment existing piped water systems and to provide strategic fire protection reserves for post-disaster operations.
- Develop water delivery strategies for fire suppression. Phase 1
  - Evaluate the placement and location of water tankers or tender vehicles to support fire suppression and rescue operations. The strategy should consider first response supplies and where additional water will be accessed to support ongoing operations.
  - Develop a water shuttle program that can be amended and implemented in all jurisdictions to support fire suppression operations where piped water systems are unavailable. Local realities will require different approaches to achieve reasonable performance objectives.
  - Evaluate opportunities to work with private industry and other government agencies for access to water hauling vehicles that can be engaged for emergency operations. Where the capability exists, enter into agreements that include deployment parameters and instructions for those services.

7.2.3 Update Firefighters Protective Clothing: Phase 1

Firefighter protective clothing or PPE is a multi-purpose protective envelope that is required to protect them from heat and cold. Well-designed protective clothing will limit dangerous heat build-up inside the gear due to exertion and heat exposure. It will also protect against chemical and biological contaminants and provide varying degrees of puncture and impact protection. Well-designed protective gear is constructed of various materials that are layered to give a range of protection from breathability and cooling to fire and heat resistance. Most now provide reasonable barriers against blood and body fluid borne pathogens as well. Due to this complex construction and the multiple materials involved, firefighter personal protective gear has specific storage, cleaning, testing, maintenance, and replacement requirements to ensure that all the elements retain their specific functions. These cleaning and repair processes ensure that the equipment continues to perform as designed over its expected service life. If well maintained, it should remain durable, and the need for replacement can be planned well before the product fails.

Firefighter protective clothing that includes jacket, pants, gloves, boots, helmet, protective hood, and coveralls are the crucial protection for firefighters during all types of emergency operations. While the primary function of this clothing is for protection from fire and heat, it also plays a critical role in protecting firefighters from the hazards at rescue scenes, medical emergencies, and many of the other emergencies they mitigate. For the gear to adequately protect the firefighters, it must be carefully selected, cleaned, maintained, and tested. Each element of the protective PPE ensemble is provided with the manufacturer’s recommended instructions on these processes.

Structural firefighting gear has operational limitations. For example, it is heavily insulated as part of its thermal protection requirements for structural firefighting. The PPE gear can be dangerously warm during summer operations, especially in sustained physical activities like wildland fire fighting during high seasonal temperatures. Ideally, specific protective clothing should be provided for firefighters designed for the type of incident. In the absence of this, sufficient hydration and rehabilitation programs are necessary.

The purchase of new firefighter protective clothing is only part of the recommendation. As noted, this equipment has specific requirements for testing, cleaning, storage, and repair. The recommendation will require investment in maintenance systems and procedures to maintain the gear maximizing its life cycle and ensure it will protect the firefighters.

The development of locally appropriate standards and policies should be a priority. The policies and procedures should be based on the manufacturer's requirements and may reference international standards, as necessary. These documents should also reference applicable legislation and regulations, including local occupational health and safety requirements [S2].

- Update all front-line firefighter structural firefighter protective clothing. Phase 1
  - Issue all firefighters one set of protective clothing consisting of boots, jacket, pants, coveralls, protective hood, gloves, and goggles. All new gear should be inventoried on arrival so that all maintenance and testing can be tracked over the life of the gear. This will help inform life cycle planning.
  - Unless current firefighter protective clothing meets appropriate standards, it should be phased out and removed from the fire stations as new protective clothing becomes available. The existing equipment that is in the best condition should be retained, cleaned, and kept as a strategic reserve for national-level responses to a seismic or other significant events that may require the deployment of civilian volunteers or personnel from other government Ministries. While not suitable for front line firefighters, this protective clothing could serve to protect workers in non-fire related assignments.
  - Order sufficient protective pants, gloves, and jackets so that there is a cache of clothing that permits frontline gear to be rotated out of service for maintenance and repair. The cache of spare protective clothing will require a selection of the most common sizes as well as some outlier sizing to ensure that all equipment can be rotated out of service and not limit staffing levels. A limited cache of spare helmets and boots should be maintained to ensure replacement and available supplies for recruits or in case of damage.

Figure 7.11: Examples for structural firefighters' protective equipment [P3]

- Provide proper storage facilities for in-service and spare protective clothing. Phase 1
  - Storage racks that permit the storage and protection of firefighter protective clothing should be installed at the same time as new gear arrives.
  - The racks should be vented to permit drying and airing out of the clothing and provide protection from ultra-violet radiation, as necessary.
- Provide appropriate cleaning and maintenance facilities and equipment for firefighter protective clothing. Phase 1
  - Cleaning facilities will be required that comply with the recommendations of the clothing manufacturer.
  - Evaluate and implement options to conduct cleaning, testing and maintenance that may include contracted services, creation of internal capacity or a public-private partnership or a combination of approaches.
  - Develop and implement required training and performance management processes for these functions.
- Develop life cycle and replacement policies for firefighter protective clothing. Phase 1
  - Policies governing the life cycle replacement of protective clothing are necessary. Replacement of protective clothing should be based on its condition as determined through appropriate maintenance and testing as recommended by the manufacturers.

7.2.4 Evaluate Personal Protective, Fire and Rescue Equipment: Phase 1

AFRS relies on a wide array of equipment, tools, and protective equipment to deliver fire and rescue services. Those tools and equipment have specific storage, inspection, maintenance, operational and life cycle requirements. It is essential that proper equipment is purchased. Once it has been purchased and placed in service, it must be maintained in a safe and functional operating condition for use throughout its life cycle. It is a best practice to have occupational health and safety policies that direct AFRS on their maintenance program. Governments frequently have legislation requiring the development of codes of practice covering all aspects of the equipment program for complex systems. These may include ladders, respiratory protective equipment, hydraulic tools and lifting devices. In most cases, manufacturers supply the framework necessary to set up an appropriate program.

The enclosed link to the Operating and Maintenance program for Scott X-3 Pro self-contained breathing apparatus is provided as an example [A7]

This recommendation suggests preforming a comprehensive inventory of all equipment employed by the Fire Rescue Service that will see use in emergency operations. The recommendation includes but is not restricted to hydraulic rescue equipment, hoses and ancillary equipment, respiratory protective equipment, generators, and ladders. Maintenance programs based on manufacturers' requirements should be reviewed, and where they do not exist or are not compliant with recommendations, these practices should be revised or developed for implementation. Where the manufacturer does not suggest a maintenance and testing program, procedures should reflect the accepted training curriculum or industry best practices.

- Develop an inventory of existing respiratory protective and other firefighting and rescue equipment issued to each station. Phase 1
  - The analysis should include:
    - Type, manufacturer.
    - Age.
    - Condition.
    - Status of maintenance, testing and operability.
    - Deployability factors like storage and mounting.
    - Criteria for issuance to specific Fire Rescue Service stations.
    - Training levels of personnel required to use it.
  - Equipment that should be considered in the initial inventory should include:
    - Fire hose, nozzles and associated appliances.
    - Respiratory protective equipment (self-contained breathing apparatus, etc.).
    - Hydraulic rescue tools.
    - Motorized equipment including pumps, generators, fans, etc.
    - Radio equipment including hand-held, mobile, and base stations.
    - Motorized off road vehicles including snowmobiles, all-terrain vehicles, etc.
- Develop comprehensive operating processes for specialized and protective equipment. Phase 1 to 3:
  - Develop codes of practice for all personal protective equipment, fire and rescue tools and equipment as it is added or replaces existing materials. The code of practice should be a comprehensive use, training, maintenance, and replacement schedule for each type.
  - Develop a maintenance program following the manufacturer's requirements and industry best practices for each type of personal protective, fire or rescue equipment.

7.2.5 Develop an Effective Fleet Management Program: Phase 1 through Phase 3

Optimizing a fire services fleet of vehicles depends on creating an effective fleet management plan. The plan can be simply summarized by the following points [A8]:

- Buy Right: Purchasing programs are developed that represent the careful analysis of the actual use and application of the specific elements of the fleet, assessments of supply chain factors including after-sales support capabilities and ongoing revision of specifications to reflect improved fleet understandings and new technologies.
- Repair Right: This element depends on proactive preventive maintenance programs and accurate analytics that track life cycle trends of the fleet elements. Fleet management processes that produce accurate and robust data that can prevent unscheduled downtime can save large amounts of money and keep vehicles on the job.
- Replace Right: Overall costs, including operating costs, should be factored into purchasing decisions. More robust expenditures in the purchase may be offset by lower operating and maintenance costs over the lifetime of the vehicle. Vehicles that have a flexible design may permit rotation from high use areas to lower use areas, extending the functional life cycle and reduce operating and maintenance costs. Rotation of vehicles will have an additional benefit of speeding the integration of technological improvements into the fleet and into areas requiring improved capabilities.
- Drive Right: Fleet operating policies need to be developed that provide clear guidance to operators and managers to make sure the right people with the right training get are operating the vehicles. Incident and damage investigations should be routine to determine whether an accident or damage to a vehicle requires additional training for the operator or improved design for the vehicle.

Fire apparatus includes all the road vehicles employed by a fire rescue service to move equipment and personnel from their station to the location of the fire event. These vehicles vary in terms of their jobs, from simply transporting personnel to complex aerial apparatus equipped with ladders and water systems. The initial analysis of call data and deployment modelling suggests there is an opportunity to add small, rapid intervention vehicles to support daily operations supported by small pumper tankers deploying water and additional staffing resources. Data collection measures being suggested in Phase 1 will help clarify where specialized apparatus such as large fire engines, heavy rescue and aerial vehicles for severe but infrequent events, large structure or technical rescues will best be placed for optimal distribution of resources and capacity.

Community design should be a significant influencing factor in the choices of vehicles supporting AFRS responses. Narrow streets, heavy traffic, rough and mountainous roads, and the need to enter wildland or agricultural areas should be considered in the design of vehicles. Large traditional apparatus may not work well in many of these circumstances and may demand the use of smaller, lighter, and all-wheel drive units.

Armenia represents a hard service area for modern fire apparatus due to its relatively remote location, limited access to factory service facilities and challenging road conditions. These challenges have resulted in difficulties integrating new fire department vehicles into the fire rescue response system and keeping them there. On-site collected reports during the mission to Armenia in March 2020 suggest that newer apparatus suffer breakdowns and can remain out of service for long periods due to limited access to parts and repairs. Older vehicles are retained and used due to their more robust and simple designs. Managing equipment downtime can be achieved through the development of spare parts caches, mobile repair services and an improved understanding of why damage or breakage is occurring. New apparatus specifications should include the lessons learned with a more robust design and ensuring the right vehicles are assigned to specific locations.

Figure 7.12: Fire apparatus undergoing routine preventative maintenance and servicing [P3].

Maintenance and repair programs for fire rescue vehicles can be simplified by consistency in specifications for new vehicles without limiting competitive procurement programs. Many chassis builders use third party materials in the drive train and suspension of their vehicles. Engines, suspension, transmissions, fire pumps and other items are frequently available from multiple builders as per the customer's preference. The use of commercial chassis instead of custom chassis can assist with this as well.

A close relationship between those who purchase the vehicles, including those who donate them, and those tasked with maintaining and repairing them is necessary. Maintenance records and customer experiences related to the fire apparatus should be part of all procurement processes. Builders should be accountable for training, parts availability, repair downtime rates and other metrics. Maintenance personnel are well suited to track and report on these matters providing good maintenance records are kept.

- Prepare an inventory of all fire apparatus. Phase 1
  – Any apparatus deemed front line and required to respond to incidents that are more than 25 years old should be scheduled for replacement in Phase 1.
  – Only those vehicles that are required for day to day operations should be retained in fire stations. Apparatus that are being kept as mechanical backups should be taken out of these stations and removed from replacement programs. The best of these units *may* be retained in a central location to permit the backfilling of fire stations while primary equipment is out of service. Backfilling practices should be treated as an interim measure as the fleet is modernized. Backup equipment should be of equivalent quality and dependability as front-line vehicles.
  – Analysis should be undertaken to explore opportunities to reassign existing vehicles that have remaining functional life from high use stations to low use stations. Moving apparatus from high use facilities to lower use facilities, where the fire apparatus is appropriate for the local risks, can extend the effective life span of the vehicle. Reduced maintenance costs and downtime resulting from breakdowns, enhanced capabilities in low call volume areas and accelerate fleet modernization in the higher use and higher risk areas are all benefits from this recommendation.

- Integrate smaller rapid response vehicles into the Fire Rescue Fleet: Phase 1 through Phase 2
  – Emerging trends in fire vehicle design are moving to smaller, nimble, but well-equipped rapid response vehicles. These vehicles operate with smaller crews, carry equipment including medical, firefighting and rescue equipment related to their day to day tasking and can manoeuvre through narrow streets, crowded roadways and are able to manage remote and difficult rural responses. These vehicles are considerably less expensive to purchase than traditional fire apparatus allowing more of them to be purchased and assigned to a distributed deployment model in smaller stations and communities. These vehicles reflect trends in responses that see fewer structure fires and more focus on rapidly increasing numbers of medical and rescue calls. These smaller units started in response to wildland-urban interface fire responses but have are seeing strong adoption from small, rural communities to very large cities [A9].

Figure 7.13: Example of BRV with sample equipment [P3]

Figure 7.14: Rapid Intervention Vehicle in a 6x6 configuration [P3].

  - Any community provided with a Battalion Response Vehicle (BRV) type vehicle should receive a small pumper-tanker unit to ensure that adequate personnel and water arrive on-site to support all necessary operations.
  - Evaluate placement, dispatch and availability of large fire pumpers, aerial apparatus, and specialist response vehicles to ensure availability to support the small vehicle deployments to more severe incidents.

Figure 7.15: Rosenbauer multi-purpose all-wheel drive fire apparatus [P3].

- Establish a life cycle plan for existing and new fire apparatus. Phase 1
  - Develop operational guidelines and operating parameters for deployment and assignment of new apparatus to guide placement and fleet management processes.
  - Establish procedures to move fire apparatus from high volume stations to low usage stations to maximize vehicle life cycles and reduce repair and maintenance costs allowing modernization to occur at a faster pace where the risk and utilization rates support this.
  - Establish life cycle rules and replacement schedules for each vehicle type.
  - Establish a maintenance tracking system to track service times and costs and ensure that high maintenance vehicles are identified and moved out of service earlier.
- Define Deployment Model: Phase 1 to Phase 3 Project:

A deployment model should be considered as part of the vehicle optimization plans. The deployment model will change as the system evolves and is understood, and as community needs and expectations change. This project should become an ongoing review and updating process, forming part of the strategic direction of the AFRS.

  - A formal deployment model that includes local, regional, and national consolidation of resources to manage events is necessary. The deployment model should focus on the local station's capability to meet regular “daily” events and use the broader deployment of other stations and resources to resource those events with higher relative seriousness that dictates more capacity requirements.
  - The severity of an event may require additional resources, which is referred to as an incident upgrade. An upgrade calling for more resources should be automatic and

initiated by dispatch on the original deployment notification. Parameters supporting the Incident Commander for initiating an upgrade to the response based on their perspective on the event are also required.

– Multi-station deployment modelling should be undertaken to determine the optimum location of specialized apparatus and equipment. Analysis should include incident types, frequency of significant events, travel times, community need and expectations plus other factors
– Deployment plans should include the creation and maintenance of national and regional caches of critical supplies and equipment. These caches should form parts of a national stockpile and must be available when and where required.

- Develop Capability-Based Vehicle Specifications: Phase 1 through 3
  – The development of specifications for all AFRS vehicle types that would apply to vehicles proposed for fire and rescue operations should be considered during Phase 1. These specifications should consider the desired capabilities of each unit and should be applied to the acquisition of all vehicles, including those obtained through donations or other sources. Compatibility-based vehicle specifications assure compliance with fleet management objectives of the Armenian government.
    - Specifications should reflect local realities and lessons learned from previous procurement processes and vehicles acquired.
    - Specifications should be capability-based and consider the usage and assignments the vehicles will be required to support.
    - Specifications should consider service, maintenance, and repair elements.
    - All specifications to provide AFRS fleet vehicles should include a requirement for warranty and qualified fleet maintenance in Armenia.
  – Evaluate the practicality of multifunctional vehicles using modules, trailers and skid units that can be loaded or changed to reflect seasonal or other needs.

Figure 7.16: Examples for livestock rescue trailers, side by side all terrain unit with small skid tank and pump for remote wildland operations, wildland light truck skid unit (from left to right) [P3]

- Assess current newer vehicle fleet for repair and parts history. Phase 1

  - An assessment of breakdown, repair and parts histories for the new vehicle fleet should be undertaken to better understand the nature of breakdowns, commonalities between servicing issues and quantify the parts availability challenges.
  - Based on the outcome of the assessment, discussions with the chassis and fire truck manufacturers should be undertaken to develop a resolution. This may include contracting with a third-party servicing company to provide emergency and routine maintenance of critical systems.
- Implement a maintenance and repair tracking system. Phase 1 through Phase 2
  - All repair and maintenance records for fire department vehicles should be consolidated into a central maintenance program. This program should track all fire rescue vehicles, their repairs and downtime and should be able to analyse trends and common problems.
  - The maintenance tracking system should utilize the manufacturer's recommended programs for each vehicle type as the basis for the maintenance and deployment tracking system.
  - The system should be able to produce reports that identify common breakdowns and repairs, specific parts required, and overall downtime for each vehicle being tracked.
- Develop a critical parts inventory in Armenia. Phase 1 through Phase 2
  - Based on the maintenance program and tracking reports, consideration should be given to retaining a central store of commonly used or damaged parts for fire department vehicles. Only those parts widely used or where there has been a documented history of delay in procurement processes should be considered. If possible, the inventory of those parts should be outsourced to a dealer or qualified truck repair company.
  - Future vehicle acquisitions should stipulate that the successful truck and chassis builders will be responsible for ensuring parts are readily available in Armenia.

7.2.6 Provide Computer and Internet Access and Systems: Phase 1 through Phase 2

Connection of fire and rescue stations to a dependable, and preferably a high-speed internet connection should be a critical service requirement. Using a high-speed internet connection, particularly with the remote location of several AAFRS stations, is a method of maintaining daily contact with the rest of the organization. The communication network is essential for managing administrative functions and achieving a reasonable level of situational awareness of AAFRS and the communities the fire stations service. The internet is increasingly vital for the delivery of many training programs. Computer-based training will allow for on-shift learning without the need for a firefighter position to be backfilled or for the required to leave their community.

- Install Computers in all Fire Rescue Stations. Phase 1
  - Issue at least one computer for installation in each of the AAFRS stations for communication, record management and reporting.
  - Investigate and, where possible, a hard-wired internet connection into each fire station with WIFI capability inside the station.
  - Implement mandatory incident reporting standards, including a standardized format of the data collected.
- Connect all Fire Stations to the Internet. Phase 1 through Phase 2
  - Internet Connections: Explore providing additional internet connections to all AAFRS stations that are identified as having a regional coordination capacity and could

support the delivery of training and other programs supporting the development of the AAFRS capacity and capabilities.

– Online Services: Develop online services to support training, operations, and administrative services in the fire stations.
– Radio, Dispatch and Event Monitoring: Evaluate opportunities to integrate existing radio systems through internet connections to a central dispatch centre. This integration could support enhanced operational capabilities, situational awareness across the network and support improved deployment practices between AAFRS stations.

7.2.7 Develop Business Continuity Plans and Systems: Phase 1 through 3

Fire and rescue services have developed, forming an essential part of the business continuity and resumption planning processes for government, business, and residents in the nation. The core mandate of fire services is to mitigate damage and threats to public safety occurring in the community. The AFRS is in place to return things to a state of public safety, permitting people and organizations to return to a relatively normal state. While the bulk of the fire services focus is developing skills to resolve other emergencies, the reality is that many situations can impact the ability of AFRS to deliver those essential services to the community. Service interruptions can occur either through an internal emergency or because of a shared community disaster. Business continuity planning supports identifying those potential interruptions and guides the development of plans to minimize their impacts.

Business continuity planning can also help develop resource movement models that will support the deployment of public safety resources from one part of the organization or region to another. Most deployment models see fire station response capacities linked to anticipated call volumes. Anticipated emergency incidents mean that certain event types will be beyond the immediate ability of the station to mitigate on their own. Deployment plans that include modelling, initial response priorities and movement of additional resources to support local operations are an effective use of business continuity planning processes and can provide the actual application of the efforts and outputs of the planning process.

Business continuity planning is an evaluation and planning process that describes how the business of an organization will continue through a severe disruption or emergency event [A10]. Business continuity considerations for business are no different than those of emergency response systems. They depend on a clear understanding of critical functions, threats that could negatively impact those services and the development and exercising of strategies to either prevent the interruption or move into alternate service delivery strategies. The process depends on a planning team representing the experts on the business model and may include some of those who receive services. Plans should recognize the reality that people are involved in both the emergency and the response to it. In many communities, the firefighters are residents of the community, and their families and friends will be part of the group receiving services. Plans should consider this reality.

Business continuity planning will need to consider a wide range of possible service interruption threats. While a lot of focus is placed on large scale disasters, the effective delivery of services can be because of comparatively smaller events. Business continuity plans should consider small and large interruptions that may include:

- Staff absences due to illness or injury.
- Vehicle breakdown or maintenance.
- Power or other type of service outage.

- A serious incident resulting in multiple injuries or deaths in the community.
- Severe injury or death of a staff member.
- Loss of a fire station.
- Escalation of an event beyond local capacities requiring additional resources regionally or nationally.
- Major natural disaster event including seismic, hazardous materials and other.
- Service delivery during a conflict.

An effective process can have positive impacts on staff morale by considering the issues that affect them as both professionals and as caring compassionate people.

Wildland firefighting is an area that would benefit from a cross-government multi-agency response. Most jurisdictions utilize aerial operations with aircraft and helicopters for containment and suppression in high value or inaccessible terrain. This capability does not exist in Armenia. There may be value in having a discussion with the military to evaluate the opportunity to provide automated buckets (Bambi buckets) that would enable the military to assist civilian efforts in this area.

Figure 7.17: Military helicopter using a Bambi bucket on a fire [P3]

It is evident that operational plans exist in both unwritten and written formats used to guide operation and administrative practices. These processes should be identified, documented, and guide this ongoing process. The following recommendations represent a graduated approach to the development of a business continuity program.

- Develop a plan to address business continuity for current and proposed facilities operated by Fire and Rescue Services. Phase 1 through 3
  – Operational plans are required that describe how services will be delivered into communities struck by major disasters, recognizing that most of the critical infrastructure serving them is likely to be damaged or destroyed in the event. Plans should consider the deployment of regional and national resources, occupation of other facilities to deliver emergency and other services, as well as a national command and control systems able to guide response and resources.
  – Business continuity plans should reflect a “Whole government” approach to planning. The loss of critical infrastructure in a community, no matter the cause, is a serious event and likely beyond the capability of local and regional agencies to manage.

Early development of and clearly understood plans that start moving resources to assist is the best way to ensure continuity of critical services, including fire and rescue services in remote or damaged communities.

- Prioritize Facility Seismic Refits: Phase 1
  - Seismic retrofits should be prioritized to those facilities identified as necessary to support a regional or national response. The balance of facilities should be Phase 2 or 3 projects. As facilities are retrofitted, they should be equipped with backup power systems, including generators. The following describes prioritization elements:
    - Priority 1: Regional fire stations and those protecting high population density locations or areas of specific importance to the country.
    - Priority 2: Local fire rescue stations that are extremely remote from assistance
    - Priority 3: All other AAFRS stations.
  - Business continuity planning referenced in other sections of this strategy reflects the need for planning to replace capabilities, including vehicles and equipment, in the event of a significant disaster that renders a particular fire station unusable.
- Prioritize the AAFRS facilities requiring backup power systems.
  - Only those facilities with sewer and water should be considered for significant investments in backup power. Those without sewer and water are not able to support sustained operations in an emergency event, even if supplied with backup power. Those facilities deemed ineligible for major upgrades should receive portable generators that can be used in emergency operations and to support limited services in the fire station during short-duration power interruptions.
  - Phase 3 projects may include the identification of facility(ies) within the community that could serve as a coordination centre for emergency operations that would benefit from backup power. Partnership opportunities might see arrangements with schools, health centres or other public facilities.
- Establish a Business Continuity Planning Process. Phase 1 through Phase 3
  - Establish a business continuity planning committee made up of stakeholders from across Government to create a business continuity framework.
    - A steering committee should be assigned to guide the development of this initiative and to provide a definition of key objectives.
    - Subcommittees representing the various Ministries should be established as required to provide inputs to the overall process and lead the internal processes for their various agencies.
  - This plan should capitalize on the strengths of all government departments to support operations, planning, finance, administration, and logistics needs of a major response.
  - Examples could include:
    - Evaluate opportunities for air support operations to wildland fires using military rotary-wing aircraft with dump bucket retrofits.
    - Cross-training with proposed National Militia for fire, rescue, and emergency management roles,
  - Communications system development should be led centrally as part of this planning process.
- Develop caches of deployable equipment for serious events. Phase 1 through Phase 3

  - Develop cache(s) of equipment and materials that can be deployed quickly by land or air to remote areas to augment local resources during serious events. This permits the development of appropriate service levels and capacity in remote or small communities and ensures rapid support can be delivered as required while more robust support moves by ground from regional and national sources. This model ensures that caches of equipment are used periodically and remain in a high state of readiness in case of a national emergency. It also spreads out the assets so that a disaster cannot take all this critical infrastructure out at once.
  - Equipment caches should be developed to support immediate operations and likely needs like hand tools, generators, hydraulics, ropes, airbags, and shovels. Additional specialty resources like pumps, hoses, nozzles, and protective clothing should be considered and added to the package as required.
  - A large cache of equipment and materials should be developed in conjunction with the Armenian USAR team.

7.2.8 Conduct a Hazard, Risk and Vulnerability Assessment: Phase 1

A hazard, risk, and vulnerability analysis (HRVA) is an essential part of any risk management program. The HRVA offers an opportunity to evaluate current and historical conditions and provide a planning focus for the organization's risk management, response, prevention, and mitigation plans. The HRVA provides guidance to the development of plans that will guide building a more resilient and safer organization, prevent emergency events, and help staff respond effectively to those that cannot be avoided. It also identifies areas of vulnerability that may require additional contingency planning to ensure the continued operation and viability of critical services and systems.

- Conduct a Hazard Risk and Vulnerability Assessment: Phase 1
  - A standardized baseline understanding of the risks, hazards, and vulnerabilities (HRVA) facing Armenia's Fire Rescue Service is required to ensure a "made in Armenia" solution for the delivery of fire, rescue, and emergency management systems. The HRVA should produce a detailed analysis of the local, regional, and national level issues and report on the effectiveness of current and proposed mitigation measures.
  - The HRVA should look at:
    - External Risks: Evaluate those risks that the community, environment, and industry pose to the delivery of fire and rescue services.
    - Internal Risks: These are the organizational risks, including training, capacity, deployment model, equipment, and facilities.
  - The HRVA should inform the refinement of a strategic plan for fire and rescue services in the country.

The HRVA should also include future-focused studies with consideration of demographic characteristics such as growth and decline, economics characteristics, and demand of services.

7.2.9 Establish Service Level Descriptions Based on HRVA: Phase 2 through Phase 3

Service level policies are a government's way of describing the nature and extent of services that will be available to citizens. It is essential that the services and levels being provided to a community are articulated to all stakeholders. Clear and simple communication of the service level desired will aid in managing expectations of those expecting service. Clear communication will provide direction to service providers related to budget, equipment and training and sets up discussions on how out of scope events will be managed, however often or infrequent they may occur [S3].

These service levels are influenced by many factors, including:

- Hazards, risks, and vulnerabilities related to the community and region.
- Community expectations.
- The capacity of the community to provide required services.
- Cost to provide services.
- Availability of services from other service providers or locations.
- Demographic and economic status and projects.

Service level policies frequently identify different service levels for various areas of the jurisdiction. It is simply not practical nor cost-effective to try and provide all services all the time everywhere in the country. Service levels should focus on how routine business is going to be delivered. Ideally, service levels should be discussed with local stakeholders as they are being developed and include change management processes that can be implemented as the system evolves.

As referenced in sections of this report pertaining to significant emergencies and business continuity planning, all emergency events will require a response. Major event plans will identify how these emergencies will be actioned and by whom.

Service levels are required to describe the services that would be provided and will be delivered by a specific fire rescue station. The service level policy will lay out those services and describe the level to which they are provided. The services provided are based on need, risks, the capacity of the community and other factors. Services not delivered by the local station may be provided by other stations or through partner or contract agencies. Service level policies give assurance to residents, providing comfort to them, so they understand how emergency services will be provided in their community.

- Develop a Service Catalogue for Fire Rescue Services. Phase 2
  - The service catalogue should detail those services currently required in Armenia, the level of availability, who is providing them and the level of training, equipment, and personnel to deliver the service.
  - The service catalogue should offer guidance to the AAFRS station and their communities on the equipment, training, competency management processes and staffing levels that will be required to provide specific services.
  - Preliminary service level policies should be developed that describe these services as they currently exist and inform training, equipment, and response planning in Phase 1 planning processes.
- Develop a Comprehensive National Service Level Policy. Phase 2 through Phase 3
  - The national service level policy should clearly describe all fire and rescue services required or available in Armenia and be linked to funding, training, staffing requirements and reporting requirements.
  - A change management model should be included in the policy that guides how Fire Rescue Services will add or remove certain services. The change management tool should be linked to reporting systems.

7.2.10 Develop and Implement a Communication System Strategy: Phase 1 through Phase 3

Effective communications between responders, dispatch systems and other agencies are critical to the effective management of any emergency event [S4] Command and control systems depend on the ability of the Incident Commander to communicate with resources under their control as well as reach out for other resources or provide instructions to incoming assisting agencies. Most effective systems depend on a combination of radios, repeaters and, in modern designs, Voice Over Internet Provider (VOIP) connections to central dispatch.

Information gathered on-site during the site visits suggests that the Armenian system is a patchwork of radios and cell phones with inadequate coverage in some areas of the country. Communications are made more difficult due to the mountainous geography of the country. It is not clear what role the Crisis Management National Centre has in supporting the incident commander, activating mutual aid, or accessing additional resources. An optimized Fire Rescue system will rely heavily on effective communications systems that allow a much more integrated effort between Incident Command, Dispatch, and other agencies.

- Develop a comprehensive communications strategy that integrates internet, radio and telephone communications supporting an effective and robust communications system. Phase 1 through Phase 3
  - Communications equipment should be assessed, and new equipment like mobile repeaters be considered for areas with rugged terrain or inadequate radio coverage.
  - While maintaining a national approach, integration of communications on a regional level using commercially available interface equipment should be explored as a first step in creating a national communications architecture. Voice over IP systems are commonly available and can be the connection between a central dispatch and operational forces. There is off the shelf technologies that are well proven and can link digital, analog, and other communications systems together in a cohesive structure. It can also connect other agencies into the system as required.
- Increase the coordination capacity of the Crisis Management National Centre (CMNC). Phase 1 through Phase 2
  - Systems should be evaluated that will support the real-time communication between Fire Rescue Services and the CMNC and improve their ability to forecast the need for additional resources and provide improved support for Incident Commanders on serious incidents.
  - Data, including response times for the various elements of the response system, should be automatically reported as resources are deployed and respond. Data collection that may be considered is vehicle location and availability tracking, crew makeup and numbers, departure, arrival and on-scene times, benchmarking information on the status of severe incident types. Technological solutions should be considered and added to the procurement of new vehicles to assist and automate in some of these functions.
- Evaluate interoperability between AAFRS, police, ambulance, and other first response agencies. Phase 1 through 3
  - Communication systems should be linked to police and other agencies that will be tasked with deployment on major disasters, including seismic events. A national working group representing all identified interests, including industry and NGO agencies (e.g. International Red Cross), should be included in the project working group.

7.2.11 Expand Training, Health and Wellness Strategies and Facilities: Phase 1 through Phase 3

For this report, the training recommendations for Phase 1 centre around delivering training for new equipment and processes. It also considers the consolidation of knowledge-based curriculum and high-level development, coordination, and distribution of the practical training to the Crisis Management State Academy. Consistency of training is essential to the development of a cohesive national response capability able to respond effectively. These new practices can be added to existing competency management and training programs used by the AAFRS.

Observations suggest there is a lack of effective and safe training facilities in most areas of Armenia for firefighters and rescue professionals. This lack of accessible facilities hampers the effective delivery of training and competency management programs for staff. Early analysis suggests there are opportunities to develop local and regional training facilities that can support the efforts of the Crisis Management State Academy and its efforts to provide a national fire rescue training program. These facilities can support practical skills development critical to firefighting and rescue services. Proper facilities play an important role in allowing new and existing firefighters the opportunity to practice existing skills, learn new ones and to do so in a safe and controlled environment.

Figure 7.18: Fire training structure built from used shipping containers. An example of an inexpensive practical training prop [P3].

It is not practical for firefighters to attend a central college for all their training requirements. Regional and local facilities are required, and this can be done effectively but inexpensively. Regional facilities can be positioned to support complex training like outreach certification programs and courses from the Crisis Management State Academy. Modular facilities are available in varying levels of complexity to support the development of a facility based on current needs and scalable to meet future requirements.

Training should be a daily activity in the local fire stations. Best practices see the station commit time each day or at least blocks of time during each shift for skills refresher training. Some of that time should be spent on skills maintenance and on high risk, low-frequency incidents with severe consequences when things go wrong. Putting on and taking off various elements of their PPE, effective operation of the multiple tools, advancing and using hose lines, interior search and rescue and other activities. These drills can be supported with locally built “props” that provide realistic training experiences and are very inexpensive to put together. These props can be made inside available bay space and are generally constructed in a manner that they can be disassembled and put away when not in use.

Figure 7.19: Examples for training facilities [P3]

Moveable walls for interior search and rescue operations; walls can be reconfigured to create different spaces and challenges

Roof venting prop

Entanglement prop – for self-rescue

Armenia is served well by the Crisis Management State Academy. The AFRS should leverage its success and leadership in developing specialized training programs.

Frequently, physical, health and wellness programs are included in a firefighter training mandate. Firefighters are at increased risk of numerous job-related health risks that are related to the physical and mental stresses of the job. While firefighter’s job sites are potentially very hazardous, it is health and wellness deficits that contribute to the highest percentage of a firefighter on and off duty deaths. Coronary disease, cancers and suicide are leading causes of death in fire services and can all be managed through effective health and wellness programs. The implementation of health and wellness programs that are part of traditional training programs can have significant benefits to the overall health of the fire department. Much of the training being done has a specific fitness and health requirement so, building these into these programs encourages participation and helps to create a healthy culture in the organization. Supports that include confidential medical monitoring, provision of fitness program supports including equipment and effective medical surveillance programs for staff are all elements of an effective health and wellness program.

- Integrate new equipment and apparatus training into the existing national training program. Phase 1
  - Coordinate all training for new equipment and fire apparatus through the Crisis Management State Academy.
  - Training programs should include the introduction of the new equipment and vehicles to response personnel, maintenance and repair agencies and others who may have a role in their operation, training or routine maintenance.
  - Specific driver-operator training programs should be updated to reflect the requirements of the new vehicles and vehicle types.
- Develop Health and Wellness Program under the direction and leadership of the Crisis Management State Academy: Phase 1 through Phase 3
  - Begin development of a firefighter medical and physical program that encourages healthy lifestyles, risk reduction strategies and minimum acceptable benchmarks for new firefighters.
  - This program should be developed in consultation with medical professionals in the government. It should form the basis for future recruit screening processes, return to work processes and periodic staff evaluations.
- Evaluate requirements for local, regional, and national practical training facilities and simulators. Phase 1
  - Encourage the development of training props in local Fire Rescue Stations to support specific training. Evaluate options for sharing the training props between stations to maximize value for investment.
  - Develop a plan for a national campus with regional and local facilities that make training available to all firefighters as well as future volunteer or part-time personnel that may be engaged. Inclusion of other government agencies and non-governmental organizations should be a consideration.
  - Begin development of regional training facilities based on the analysis.
- Update national training programs to reflect potential changes in operational models, including alternate water supply operations: Phase 1 through Phase 3
  - Evaluate training programs required for the Armenian fire rescue services and training delivery models that fit the needs of a regional fire rescue service. These should enhance consistency of practice between stations, communications and command consistency and role clarity.
  - Determine service levels and competency requirements that can be applied to community fire-rescue services. These service levels recognize the capacity of communities to meet and support operational, staffing, training, and administrative requirements.
- Expand National training program to support volunteer and citizen emergency response training: Phase 3
  - Implement a national certification program for firefighters that includes specific guidelines for community volunteers.
  - Implement a system of skills maintenance to maintain a high level of operational readiness that can include roles for volunteer firefighters and civilian trainees.

7.2.12 Formalise Marzer and Town Roles including Volunteer and Prevention Programs: Phase 1 through Phase 3

The AAFRS is under the direction and control of the Ministry of Emergency Situations. The chain of command is clear; however, it is less clear what role the regional and local governments have in service level decisions, and what responsibilities they have or could have in terms of alternative staffing and prevention program leadership. Things like recruitment of volunteers, promotion of fire prevention and safety programs or prioritizing inspection programs can be positively influenced and supported by the local government.

- Evaluate regional and local authority (Marzer and towns) involvement in the delivery of fire and emergency services. As the system further evaluates the implementation of volunteer or citizen responders, local leadership in recruitment and retention will be critical for the success of these programs.
- It is critical to share the planning and administrative load across all levels of Government in a carefully considered way. Each level of government should understand its roles in keeping citizens safe.
  - National Interests:
    - Significant events- national level emergencies, hazardous materials events (dangerous), industrial accidents, conflagrations, landslides with loss of life, any event dealing with critical infrastructure
    - Standards
    - Legislative direction
    - System performance and accountability
    - Dispatch, communications, and data systems
  - Marzer:
    - Organization of regional service priorities
    - Coordination of fire station efforts and performance
    - Prioritization of service locations, capabilities
    - Compliance with national directives
  - Town:
    - Prevention, Public education
    - Recruiting for volunteer or emergency assistance
    - Citizen engagement and empowerment

7.2.13 Develop a National Staffing Strategy: Phase 1 through Phase 3

Early assessments of the capacity of the Armenian Fire Rescue Service indicate that additional resources may be required to provide acceptable levels of protection in all areas of the country. Information gathered on-site during the mission shows extended response times to some emergency calls for assistance, but there was limited information available to quantify the issues involved. Some areas may be underserved due to their remote location and small populations, while others may not have enough stations and firefighters. Most jurisdictions have developed either a part-time or volunteer service to support career services in these instances and to create a trained community resource for significant emergency events. Additional data is required to determine the Phase 2 and 3 actions that will meet Armenian expectations and needs.

Developing the community infrastructure to recruit, train and equip a new volunteer or part-time service is a complex and resource-intensive process. It would likely see the requirement to develop additional capacity and full-time staff to implement. Realistic planning for an additional fire rescue force would take years to develop and implement and a significant financial commitment.

Ideally, opportunities to partner with other agencies who may have similar needs and constraints should be considered. For example, the Ministry of Defence (MOD) [A11] has recently called for the development of a national militia that would be formed on a regional level in the towns and villages around the country. While the primary mandate of the militia is to augment the military in times of conflict, many other countries also utilize trained personnel of this type in varying emergency management roles in support of emergency response, search and rescue, technical support to operations and other functions as needed. There are many transferrable skills that would benefit both mandates. Recognizing the limited pool of people who would be available for these roles in many communities, it may be worthwhile evaluating the development of a shared resource that can be deployed on defence or emergency response missions.

Figure 7.20: Canadian soldiers and reservists serving civilian firefighting roles [P3]

- Consider the establishment of a national staffing strategy for fire services, rescue and other emergency management functions as necessary. The staffing strategy includes full time, part-time and volunteer staffing. The staffing strategy would flow from data in the Baseline Report. A comprehensive HRVA would help define the need.
- Evaluate the development of a part-time fire and rescue capability that can infill remote areas, support career stations and improve initial responder response times. Planning considerations should include exploration of shared staffing resources with other agencies, including the Military.
- The staffing strategy should include a resident empowerment plan to develop citizen capabilities that can provide some degree of assistance and support while professional responders deploy.

7.2.14 Develop a Fire Prevention and Public Education Strategy: Phase 1 through 3

Fire Prevention is the most cost-effective strategy for keeping people and communities safe. Fire prevention programs are the most inexpensive programs to develop and implement and can have the most significant impact on broad community harm reduction strategies. Fire prevention activities are centred on improving the behaviours of people, whether its through a fire prevention inspection program or teaching children fire safety in schools. The exchange of information, and in some cases, the enforcement of that information sharing, will change behaviours and improve the safety of everyone.

Wildland areas are increasingly at risk from agricultural activities, increased recreational use and climate change. Armenia has relatively few forests that represent an important national resource.

The bulk of fires occurring in or around the forests of Armenia are because of human activity. Prevention programs would be of great benefit if they include education, prevention, and enforcement processes.

North America has mature programs including FireSmart that have been developed to improve protection of forests and forest interface areas through a variety of mitigation, preparedness, response, and recovery processes. FireSmart [A12] is successful in many communities because it is implemented at the land owner and local government level, with support funding from senior orders of government. Fuel modification projects help to reduce the risk from wildfire going into settled areas but can also be a tool for the protection of at risk forested areas from neighbouring agricultural areas.

Fire prevention follows several streams, and all should be evaluated to see how they fit into the Armenian context.

- Inspections: Phase 1
  - A limited inspection program should be considered for the urban areas of the country. It is not possible to inspect all buildings. A listing of high hazard, high-risk facilities and critical infrastructure should be developed, with an inspection program established based on the life safety risk profile the buildings represent. Inspection frequency should be related to the risk and the capacity of the Prevention Branch.
  - Inspector positions should be filled in each Marzer and in Yerevan. The inspection personnel should be linked to the regional headquarters station and be provided with a computer and internet access to keep good records so data collected can be analysed.
  - Data should be consolidated at a national level to ensure that long term planning for fire protection can benefit from the intelligence gathered by the inspectors.
- Development Planning: Phase 1
  - Fire Rescue Services should be included in all aspects of new construction and development planning. Adequate fire protection systems should begin with community design ensuring that these new communities or buildings are more resilient, less dependent on fire response services, but are accessible in an emergency. While fire emergencies are front of mind, rescue, evacuation of sick or injured building occupants, water supplies are all areas of interest for Fire Rescue Services.
- Public Education: Phase 1
  - Public education priorities are driven by the risks the community faces and should be anchored to statistics or an HRVA. Public education should take an “all-hazards” approach and could be more of a Ministry priority than simply the jurisdiction of the AAFRS. This ensures that there is proper coordination of effort and resources, reduction in duplication and likely makes it easier to find program partners.
  - Wherever possible, partnerships should be made with other agencies to develop and deliver programs. Limited resources should not be wasted competing. For example, if there is an agency already providing support to elderly residents, it may make sense to work with them and use their expertise in messaging elderly people on fire and other safety messaging.
  - Firefighters can and should be trained in basic fire prevention and inspection procedures. This will allow firefighters to be assigned responsibility to do low-risk occupancy inspections or maintenance inspections of those facilities that have

already been evaluated by a dedicated fire inspector or deliver life-saving information to residents and businesses.

- Wildland Fire Prevention and Protection:
  - A program for the protection of forest and other wildland areas should be developed and linked to improved fire prevention practices on agricultural lands. The program should emulate best practices from other jurisdictions to reduce development time and costs.
  - Program contents should include assessments of at-risk forest and other ecologically sensitive areas that may be at risk for fires and the development of strategies to protect them, which may include fuel modification or other processes to increase resilience.
  - Public education efforts should include the development of regulatory controls related to open and agricultural fires.

7.2.15 Considerations for Adding Community Value: Phase 1 through Phase 3

The report recommends the implementation and acquisition of equipment and materials that will enhance the performance and capabilities of the Armenian Fire Rescue Service. While few will argue about the need to improve the ability and safety of those who are providing these essential services, many will ask about the net value to the community and those businesses and individuals that will ultimately pay the bills. These reasonable questions deserve attention, as many of the materials and processes exist in Armenia or could easily be created.

The following are some considerations related to supporting existing or creating new capacity within the country.

- **Facility Construction**: Consistency in materials and results has been identified as a concern related to construction in small and remote communities in Armenia.
  - Pre-fabrication of Structural Wall Panels and Roof Elements:
    - The creation of standard construction elements at a central facility that can then be transported and erected on site is a common practice around the world. It permits the development of expert crews who create the elements in a highly controlled environment, ensuring consistency of product and compliance with good engineering practices.
    - These elements can be standardized and will permit multiple layouts based on need and function. These panels can be designed with chases for building services, allowing easy on-site completion by skilled tradespeople.
    - The approach allows for rapid erection on site, again using trained and expert crews.
    - The final finishing of the facilities can use local tradespeople to ensure that the community benefits from this important development project.
    - This approach could establish an Armenian centre of excellence that might be used in response to a disaster where broad reconstruction is required in a community. These facilities can rapidly turn out prefabbed wall and roof segments that can speed the replacement of critical infrastructure and homes with safe and high-quality buildings.
- Development of Training Facilities for Fire and Rescue Personnel:
  - Many agencies are using retrofitted metal shipping containers as the building blocks for highly effective simulators for fire service training. These modules can be easily

modified with windows, hatches, doors, and other elements to accommodate safe and effective training. The plans for these modules are readily accessible as freeware on the internet.

- – The technology and skilled workforce currently exist in Armenia to develop this opportunity.

- Fire Fighter Protective Clothing Storage, Maintenance, Cleaning and Repair:
  - Storage:
    - The racks used to store firefighter clothing ready for deployment are generally a steel and metal mesh cubicle with hooks to hang helmets, masks, and jackets. Depending on the deployment model of the station, some have wheels under them, making it possible to roll out one and replace it with another at shift change. These can easily be manufactured locally by a competent welding shop.
    - Vented storage lockers for spare gear can be built similarly but be secured and in a manner that protects the stored clothing from accidental contamination or ultraviolet radiation exposure.
  - Cleaning, Testing and Maintenance:
    - Daily service cleaning of clothing should occur in the various stations and can easily be accommodated with a bucket of water, a small hose, and a brush.
    - Detailed cleaning after serious calls where the clothing has been exposed to chemicals, blood and body fluids or the products of combustion or where the clothing is damaged, requires a more comprehensive approach to cleaning and repair. This servicing requires competent individuals and complex equipment to return the clothing to a serviceable state.
    - Many agencies deliver these programs through the development of third-party arrangements with the private sector. These arrangements vary and can include a public-private partnership or a straight contract service arrangement.
- Vehicle Maintenance Programs:
  - Many organizations contract out maintenance and regular servicing work to private repair agencies. Many suppliers offer this type of service and can also provide maintenance schedules, individual vehicle maintenance records and reporting, as well as providing inventory services for frequently used parts. Value-added services like mobile and remote assistance are more likely to use existing agencies.

8 Potential Modernization Programme

8.1 Modernising the Building Infrastructure

This modernisation project recommends a number of activities for the improvement of the building infrastructure of the entire portfolio of FRSs with a total cost estimate of about $45M (in the range of $38M to $54M). Break down of the costs of the main activities is provided in Table 8.1. Further information is provided in Section 8.1.1 to Section 8.1.8.

Table 8.1: Activities for improving the building infrastructure

Activity	Number of FRSs	Central Estimate	Range		Phase
			Min	Max	
New construction	5[1]	$7.2M	$6.5M	$8.0M	Phase 1
Seismic retrofit	51[2]	$7.6M	$6.8M	$8.4M	Phase 2 and 3
Remodelling of interiors	51[2]	$5.1M	$4.0M	$6.1M	Phase 2 and 3
Area expansion (horizontal)	25	$10.2M	$9.0M	$11.3M	Phase 2 and 3
Area expansion (vertical)	11	$2.5M	$2.2M	$3.3M	Phase 2 and 3
Interior finishing	51[2]	$3.4M	$2.7M	$4.1M	Phase 2 and 3
Furniture	63	$1.3M	$0.6M	$2.5M	Phase 2 and 3
Garage – surface, HVAC, doors	63	$1.4M	$0.8M	$2.4M	Phase 2 and 3
Building services	51[2]	$3.3M	$2.6M	$4.1M	Phase 2 and 3
Energy efficiency and renewable energy sources	63	$3.2M	$2.5M	$3.8M	Phase 2 and 3
Total for building infrastructure		$45M	$38M	$54M	

Note:

[1] minimum number of FRSs that require replacement based on the baseline assessment conducted on 56 FRSs. Actual number is likely bigger when considering the 7 non visited FRSs. Some of the FRSs initially designated for remodelling may be designated for replacement in the later stages of the project.

[2] number of FRSs based on 56 visited stations and assuming that 5 stations will be replaced with new buildings. Actual number is likely bigger when considering the 7 non visited FRSs.

8.1.1 Construction of New Fire/Rescue Stations

The baseline study identified that at least five FRSs need replacement as the current condition of the building and the site does not justify reconstruction and remodelling of the existing facilities. It is considered that replacement with new facilities is the only viable solution. These are also the five FRSs where the fire commanders reported that they occupy the facilities only temporarily, and that there are plans for moving elsewhere. The following five FRSs are recommended for replacement with new facilities:

- ID7 Gymri
- ID16 Stepanavan
- ID18 Spitak
- ID40 Myasnikyan
- ID46 Surenavan

The potential construction cost is estimated is in the range of $6.5M to $8M based on the estimate that the total gross area of the five new FRSs is expected to be around 8,000 sq.m. (based on the minimum required area as per СП 380.1325800.2018 [S7] depending on the number of apparatus) and a construction cost of $800-$1,000/ sq.m. to construct a good quality building with adequate seismic resistance.

Case specific studies for each FRS will be needed to define an adequate size for each FRS. Cost savings can be achieved if the MoES considers developing and implementing standardised designs and potentially pre-fabricated construction. The latter could be economically viable if the MoES decide to increase the number of new constructed FRSs in expense of the number of FRSs that will undergo major remodelling with area expansion and seismic retrofit. A more detailed techno-economic study is needed to identify the most suitable solution for each FRS.

Figure 8.1:Example of a small and large urban fire stations

FRS for 3 fire engines, Vleuten, The Netherlands

Source: https://www.archdaily.com/351943/fire-station-van-rooijen

FRS with 4000 m2 - 8 bays for fire engines + 2 bays for maintenance, Vilnius, Lithuania Source: https://www.archdaily.com/248158/fire-station-in-vilnius-laimos-ir-ginto-projektai

Figure 8.2: Example of large regional fire & rescue station serving also as a regional training centre

Waterford Fire Station (Ireland) – regional centre for fire fighting, river rescue, public consultation and training for the whole of the south east of Ireland

3000 m2 - 10 bays – 8 front facing and 2 rear facing; Training facilities include vehicles extrication, underground and confined spaces training, breathing apparatus training and desk study training

Source: https://www.archdaily.com/786984/waterford-fire-station-mccullough-mulvin-architects

8.1.2 Seismic Retrofit

This measure is recommended for all FRSs that are to be rehabilitated. It is estimated that the cost to retrofit the FRSs in Armenia will be between $6.8M and $8.4M with a central budget estimate of $7.3M. The budget estimate is based on the seismic retrofit cost of 51 FRSs with total built area of 38,000 sq.m. and an average retrofit cost of $200 / sq.m. This seismic retrofit cost is based on the assumption that the FRSs are strengthened using conventional construction methods and their seismic resistance is upgraded to the level of a modern building designed to conventional design codes. This means that it is expected that the retrofitted buildings will not collapse in a strong earthquake. More detailed studies and updated cost estimate will be needed if the MoES will require the retrofitted FRSs to be fully operational after a strong earthquake.

8.1.3 Remodelling of Interiors

This measure is recommended for all FRSs with exception of these recommended for replacement by new buildings. This is essentially to reorganise the interior spaces to achieve a better functionality and occupational health conditions of the buildings by forming clearly separated functional zones, separation of contaminated and clean areas and establishing circulation routes. It is expected to cost about $5M to remodel the interiors of 51 FRSs with gross area for remodelling of circa 34,000 sq. m. and assumed cost of $150/sq.m. for adding and removing partition walls.

It should be highlighted that the floor area of 36 FRSs is much smaller than the modern requirements for such facilities and interior remodelling without expansion of the usable area will have a limited effect. It is estimated that about 14,000 sq.m. of new floor area need to be added in these 36 FRSs to meet the current international requirements for new FRSs – see sections 8.1.4.

8.1.4 Area Expansion (Horizontal and Vertical)

It is recommended to increase the floor area of 36 FRSs by means of horizontal and vertical expansion and the required budget for this is estimated to be about $13M.

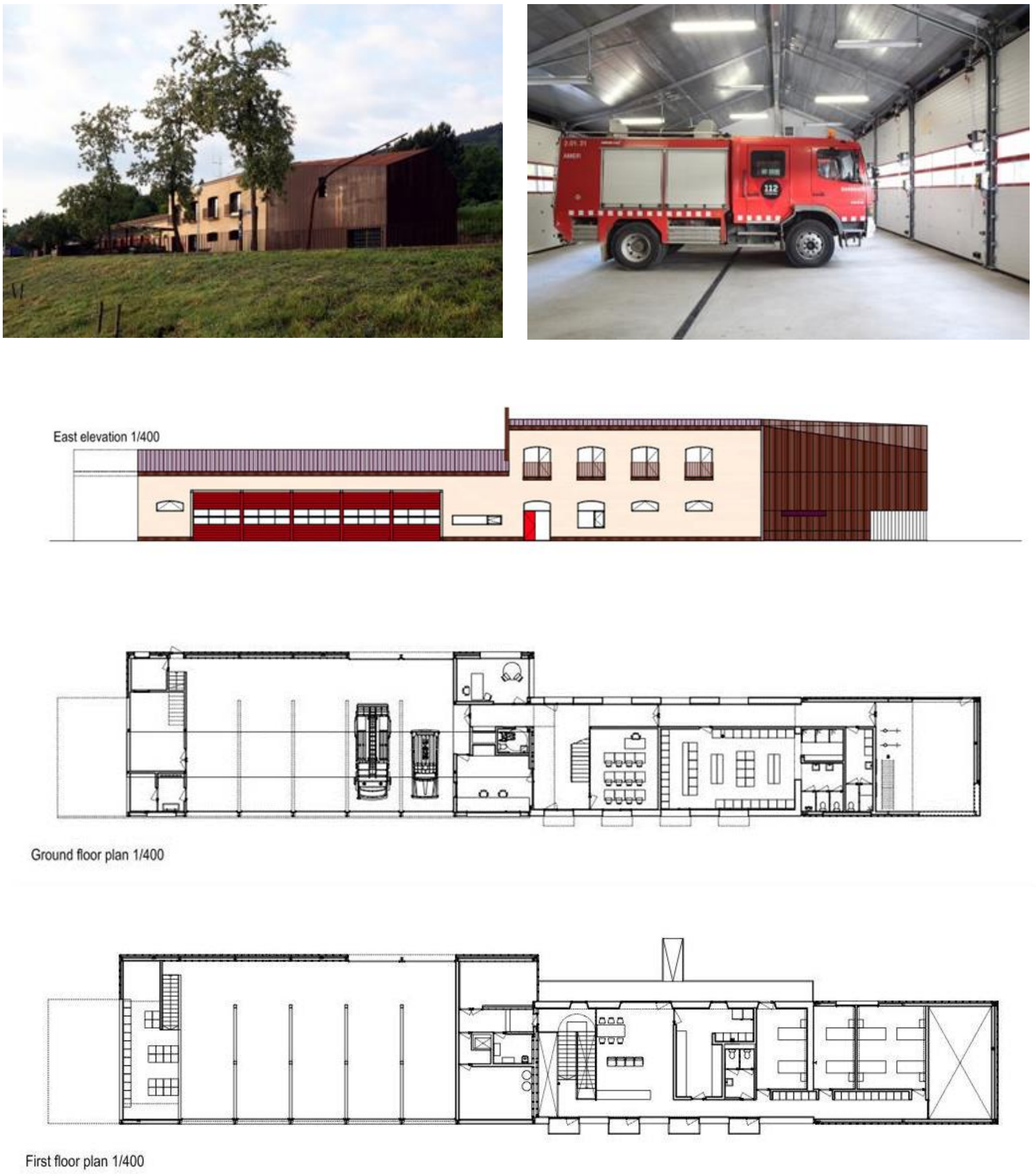
The sites of 25 facilities are judged to have sufficient size to accommodate bigger buildings and horizontal expansion is considered an easier option from a technological point of view. Between $9.0M and $11.0M is expected to be required to build approximately 11,000 sq.m of new floor area (the estimated additional floor area needed is circa 11,300 sq.m.) assuming that a budget of $800-1,000/sq.m will be sufficient to construct a good quality building in Armenia and integrate it with the existing facility.

It is estimated that a budget of about $2.5M may be sufficient for increasing the floor area of 11FRSs by construction of one additional floor. For these 11 FRSs the site is assessed to be too small to expand the floor area by increasing the footprint, and therefore it is recommended to build one floor on top of the existing building (the ratio of the site area to the footprint area is below 3). The budget estimate is based on the estimated additional required area of circa 2,700 sq.m. and average construction cost of $900/sq.m.

Examples for the remodelling of an existing FRS with expansion of the usable area by horizontal (and vertical) expansion is provided in Figure 8.3 and Figure 8.4. The added area provides space for new bathrooms, additional toilets, fitness centre, and better sleeping quarters.

Expanding the usable area of these 36 FRSs will greatly improve the functionality of these buildings and will provide opportunity to add spaces that are largely missing in the current FRS buildings like proper storage and cleaning/maintenance zones, kitchen and dining rooms, sufficient number of bathrooms and toilets, better sleeping quarters, fitness rooms and training/lecture class rooms. Case specific studies and conceptual designs will be needed to identify the most appropriate architectural layouts for the extensions and their integration with the existing (remodelled) buildings.

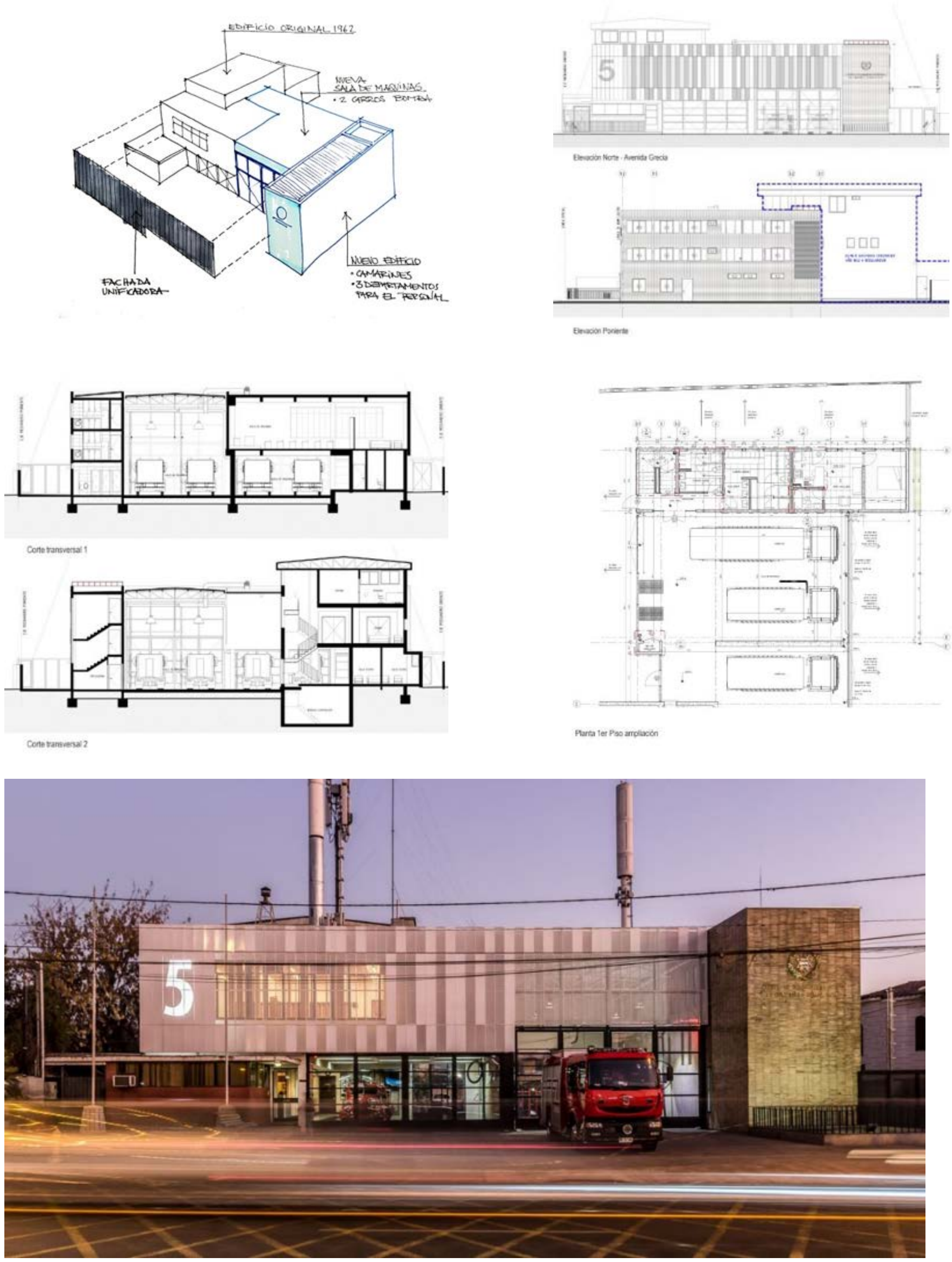
Figure 8.3: Example of area expansion of an existing FRS in Girona, Spain



Remodelling and expansion of a Fire Station in Girona, Spain - 930 m2 - 4 bays

Source: https://www.archdaily.com/234807/fire-station-in-girona-mizien?ad_source=search&ad_medium=search_result_projects

Figure 8.4: Example of area expansion of an existing FRS in Ñuñoa, Chile.



Enlargement and renovation of the old headquarters of the 5th Fireman brigade of Ñuñoa, Chile, originally built between 1960 and 1962. The new building includes the construction of 3 apartments for employees, a changing room for firefighters, and a new machine room for two large fire trucks.

Source: https://www.archdaily.com/787703/headquarters-extension-of-nunoas-5th-fireman-brigade-espiral?ad_source=search&ad_medium=search_result_projects

8.1.5 Interior Finishing Works and New Furniture

It is estimated that approximately $3.4M will be required for interior finishing works in 51 FRSs and about $1.3M for new furniture in all 63 FRSs. This budget is based on the estimate that approximately 34,000 sq.m of floor area will need interior finishing works with an average cost of $100/sq.m. and assuming that $20,000 per FRS will be sufficient to procure basic furniture and sanitary elements. It is safe to assume that the 7 FRSs not visited will need interior finishing works and this can be assumed to be proportional to the 51FRSs or circa $0.5M. An example of a high-quality interior from newly built and refurbished FRSs is given in Figure 8.5. It is unlikely that the same quality will be achieved with the proposed budget but considering the significant difference in the labour cost in Armenia and Western Europe and the craftsmanship of the Armenian builders, it is reasonable to expect that the budget will be sufficient to achieve reasonable quality and modern look of the refurbished FRSs. In any case it will significantly improve the quality compared to the conditions observed during the mission in March 2020.

Individual studies of each FRS are needed in order to prepare a more accurate budget estimate. It is important to mention that the budget above is based on the assumption that most FRSs will undergo interior remodelling with or without area expansion and therefore will need interior finishing works. If these measures are not implemented, only the FRSs that have not been refurbished already will need interior finishing works and the needed budget may be much smaller. The MoES is likely to be able to achieve significant savings (or increase the quality for each investment) if it develops and implements a nationwide programme and uses mass procurement and framework contracts. A majority of the works and the goods procured via this method can be delivered from local companies.

Figure 8.5: Example of high-quality interiors in retrofitted or newly designed FRSs

a) FRS N5 in Ñuñoa, Chile

b) FRS Van Rooijen, The Netherlands

c) FRS Doetincham

Source: a) https://www.archdaily.com/787703/headquarters-extension-of-nunoas-5th-fireman-brigade-espiral?ad_source=search&ad_medium=search_result_projects; b) https://www.archdaily.com/351943/fire-station-van-rooijen; c) https://www.archdaily.com/489594/fire-station-doetinchem-bekkering-adams-architects

8.1.6 Improving the Conditions in the Garage Areas

Adequate conditions in the garage area are essential from a health and safety point of view and very important for the operability of the fire engines and their equipment all year long. Specialised ventilation reduces the air contamination and hence the risk of cancer for the FRS staff, heating systems improve operability in winter conditions, non-slip surfaces reduce the risk of injuries and high-quality automatic doors improve daylight, energy efficiency, and speed up the response time.

An allocation of approximately $1.4M is envisaged for new non-slip surfaces, fume extraction systems, heating systems and better garage doors for all 63 FRSs. Depending on the type of materials and the technical specifications the budget may vary significantly, but it is reasonable to assume that a budget in the range of $0.6M to $2.4M will allow the garage areas of all 63 FRSs to be refitted to a reasonable standard. Example of high-quality garage interiors is shown in Figure 8.6

Figure 8.6: Example of high-quality interiors in retrofitted or newly designed FRSs

FRS N5 in Ñuñoa, Chile

Source: https://www.archdaily.com/787703/headquarters-extension-of-nunoas-5th-fireman-brigade-espiral;

FRS Van Rooijen, The Netherlands

Source: https://www.archdaily.com/351943/fire-station-van-rooijen

8.1.7 Building Services

To improve the building services in all FRSs, an allocation of between $2.5M and $4.0M is estimated. The budget estimate is based on replacement of the building services in the 51 FRSs designated for remodelling works with a central estimate of $3.3M. The cost of the building services for new buildings and added floor area is considered to be covered by the reported construction cost.

8.1.8 Energy Efficiency and Renewable Energy Sources

Despite not directly related to the functionality of the FRSs or to the occupational health improvements, it is strongly recommended to consider investments in energy efficiency and the use of renewable energy sources (mainly solar boilers). These improvements are directly related to the running costs of the FRSs and considering the climate of Armenia are likely to repay the investment in a short period through reduced energy bills. A more detailed energy audit and techno-economic analysis will be needed to identify the target energy performance and design the most appropriate Energy Efficiency (EE) measures for each FRS building.

For the needs of the current project, it is we estimate that between $2.5M and $3.8M (central estimate of $3.3M for 63 stations) for basic EE improvements as thermal insulation, new windows, solar boilers, etc. that will lead to reduced energy consumption and energy bills. Significant cost savings can be achieved if the EE improvement measures are integrated with the overall refurbishment of the buildings and if implemented on nationwide scale with large scale procurement of goods, works and services.

8.2 Modernising the Fleet of Specialised Vehicles

This modernisation project recommends the procurement of specialised vehicles with a total cost estimate of about $16.5M (in the range of $12.2M to $21.4M). Break down of the costs of the main activities is provided in Table 8.2. Further information is provided in Section 0 to Section 8.2.3.

Table 8.2: Activities for modernising the fleet of specialised vehicles

Activities	Number of FRSs	Central Estimate	Range		Phase
			Min	Max	
Brigade Response Vehicles (BRV)	30[1]	$4.0M	$3.4M	$5.4M	Phase 1
Emergency Tenders	20[2]	$6.1M	$5.6M	$8.0M	Phase 2
Heavy Rescue Vehicles	8[3]	$6.4M	$3.2M	$8.0M	Phase 3
Total for vehicles		$16.5M	$12.2M	$21.4M	

Note:

[1] assuming 30 BRVs and one BRV per FRS. Which FRSs will be most suitable to receive a BRV may be defined as part of the fleet assessment study and the fleet management strategy.

[2] assuming 20 ETs and one BRV per FRS. Which FRSs will be most suitable to receive a BRV may be defined as part of the fleet assessment study and the fleet management strategy. The same study may inform also should ETs be procured or more BRVs and/or other type of firefighting vehicles.

[3] assuming 8 HRVs located in 8 FRSs. Which FRSs will be most suitable to receive a HRV is to be defined as part of the hazard, risk and vulnerability study.

8.2.1 Brigade Response Vehicles

An allocation of between $3.4M and $5.4M is estimated to fund the procurement of 30 BRVs to be distributed across the FRSs in Armenia. The cost depends on the selected technical specification, size and country of assembly. For information, a BRV on chassis Mercedes Benz Sprinter 519 CDI 4x2 with 500l water tanks capacity provided by Rosenbauer [P5] costs approximately $180,000, including a set of rescue equipment [P4]. A small rescue vehicle on a chassis Toyota Land Cruiser Pick Up 4x4 by Rosenbauer costs approximately $150,000 (1/3 of the cost is the rescue equipment) [P4]. The central estimate of $4M is based on 30 BRVs with average cost of $130,000 (assuming pick-up chassis and basic equipment), but the same budget will allow to procure either 22 BRVs on Mercedes Benz Sprinter 519 CDI 4x2 or 16 BRVs [P4] on a Iveco Daily 4x4 chassis with approximately 1,500l water capacity. Example of BRVs of different sizes and producers are given in Figure 8.7, Figure 8.8 and Figure 8.9 and more details are presented in Section 7.2.5. in summary, current technologies provide the possibility to build efficient fire engines on a much smaller chassis which lead to significant monetary savings during both procurement and maintenance phase. The main limitation of the BRVs in the Armenian context is the reduced water capacity, which depending on the model varies between 300 litres and 2,000 litres. However, the majority of the fire/emergency calls for the majority of the FRSs in Armenia are likely to be covered efficiently enough with BRVs supported by Emergency Tenders as described in Section 7.2.5.

As recommended in Section 7.2.5 the MoES may conduct a detailed fleet assessment study and based on this develop a long-term fleet management strategy. These documents will guide best the selection of the most suitable type/types of BRVs and the most suitable locations for their deployment. However, even without additional studies, the procurement of circa 20 BRVs could be a “no regret” investment. BRVs are low-cost, high-value-for-money, versatile vehicles that will fit into any fire station and will be useful.

The examples provided in Figure 8.7 are based on a commercial 4x4 SUV/pick-up chassis and are much times cheaper than ETs on a truck chassis. These types of BRVs are available from variety of manufacturers in Western Europe and Russia as well. The examples in Figure 8.8 are for BRVs that are built from Russian and Ukrainian manufacturers using Russian (GAZ) or “Western” light truck chassis. These BRVs may be 2X4 or 4x4 and provide more space for crew and equipment and hauling more water, up to 2,000 litres in some models. The examples from Figure 8.9 show extreme applications of the BRV concept implemented on a 6x6 light truck chassis combining firefighting and rescue capabilities.

Figure 8.7: Example of BRVs built on a pick-up chassis.

BRV on a UAZ Patriot chassis

Source: http://paffst.com/app-02-03-100/

BRV on a Toyota Hilux chassis

Source: https://www.birminghammail.co.uk/news/local-news/west-midlands-fire-service-chooses-1493548

Figure 8.8: Example of BRVs built on a light truck chassis

Source: https://specialauto.ru/listings/acz-spk-10-40-s42r33/

Source: https://titalcompany.com/en/product-category/fire-rescue-vehicles-en/firefighting-pumpers-en/

Figure 8.9: Example of special purpose BRVs built on a light truck chassis

Source: https://www.rosenbauer.com/en/at/rosenbauer-world/vehicles/municipal-vehicles/cl

Source: http://www.transportengineer.org.uk/transport-engineer-news/first-6x6-mercedes-benz-sprinter-goes-to-west-sussex-fire-rescue/143813

8.2.2 Emergency Tenders

In Phase 2 of the project, the fleer of fire engines can be expanded with Emergency Tenders on truck chassis. The Baseline Assessment [P1] identified that in 21 FRSs the average age of the fire engines is above 25 years and in another 15 FRSs the average age is between 15 and 25 years. It is estimated that a budget between $5.6M and $8M will be enough to procure about 15 new emergency tenders on a truck chassis as a direct replacement of some of the oldest fire engines. The cost will depend on the technical specification for the ETs, the size and the country of origin. A central estimate of the cost of 15 modern ETs on a mid-size truck chassis is $6.1M based on the cost of Rosenbauer CBS Model TLF 6900 on chassis MAN TGM 18.320 4x4 with 8,000 litres water tank capacity [P4]. The same budget will be sufficient to procure 16 ETs based on Rosenbauer ET TLF 4000 on a MAN TGM 16.290 4X4 chassis with 4,000 litres water capacity or 12 Rosenbauer AT TLF 4000/400 on a MAN TGM18.340 4x4 chassis with 4,000 litres water and 500 litres foam tank capacity [P4].

The optimal selection of ETs to be deployed in Armenia should be based on:

- Hazard, risk and vulnerability studies of the FRS serviced areas and identification of the needs
- Detailed assessment of the current fleet and fleet management strategy:
  - Current conditions and the potential capabilities (potential for repair/upgrade)
  - Vehicles redeployment analysis (relocation within FRSs) and number/locations of the BRVs
- Long term testing, maintenance and repair considerations – availability and cost of spare parts, etc

However, even without the detailed information described above, the procurement of circa 15 ETs on a commercial truck chassis can be considered as a direct replacement of similarly sized old fire engines. Bigger or more specialised (extended off-road capabilities) ETs can be also procured for certain FRSs with clearly identified/confirmed need for this. Examples of ETs manufactured in Russia, Japan and Austria with 3,000 to 5,000 litres water capacity and built on a commercial truck chassis in 2x4, 4x4 and 6x6 configuration are provided in Figure 8.10, Figure 8.11 and Figure 8.12.

Figure 8.10: Example of ETs manufactured in Russia on a KAMAZ or URAL truck chassis in 2x4, 4x4 and 6x6 configuration

Source: https://specialauto.ru/katalog-produkczii/pozharnye-avtoczisterny/

Figure 8.11: Example of ETs manufactured in Japan on a ISUZU truck chassis in 2x4 and 4x4 configuration delivered to Armenia as donation from Japan

Source: https://www.azatutyun.am/a/29924989.html

Figure 8.12: Example of ETs of different size and for urban and wildland/mountain environment manufactured in Austria on a Mercedes and MAN truck chassis in 2x4 and 4x4 configuration

Source: https://www.rosenbauer.com/en/at/rosenbauer-world

8.2.3 Heavy Rescue Vehicles (HRV)

The Seismic Structural Assessment report [P2] highlighted the importance of seismic resilience of FRSs for the post-earthquake SAR activities, in the context of the expectations for widespread structural damage and collapses in the residential building stock. However, the Baseline Assessment [P1] identified that none of the visited 56 FRSs have large and modern HRV capable to support Heavy Urban Search And Rescue (HUSAR) activities. Examples of HRVs on a large truck chassis is provided in Figure 8.13.

An allocation of about $6.4M is estimated for the procurement of a fleet of 8 HRVs to be distributed in selected FRSs in Yerevan and major urban centres in high-hazard zones. The cost of 8 HRVs is estimated to very between $3.2M to $8.0M depending on the technical specification and the country of manufacturing/assembly. As an example a Rosenbauer Medium/Heavy Rescue Vehicle with crane on chassis MAN TGM 18.290 4x4 costs approximately $560,000 [P4]. Based on the seismic hazard and the urbanisation patterns in Armenia a suitable deployment model could be 3 HRVs in selected 3 FRSs in Yerevan and one HRV in Gyumri, Vanadzor, Kapan and either Hrazdan or Yeghegnadzor. It should be noted that this intervention should be combined with either FRS building remodelling or building of a separate standalone garages to host the new HRVs.

Figure 8.13: Example of HRVs manufactured in Austria and Russia on a commercial truck chassis in 6x4 and 6x6 configuration

Source: https://www.rosenbauer.com/en/at/rosenbauer-world

Source: https://specialauto.ru/listings/asa-20-kamaz/

8.3 Modernising the PPEs and the Specialised Equipment

The budget required to renew he personal protective equipment and the rescue equipment of the first line firefighters in all 63 FRS in Armenia is estimated to be around $20M (with range of $15M to $22M) for updating t. Breakdown of the estimated investments is provided in Table 8.3 and further information for each measure is provided in sections 8.3.1, 8.3.2, 8.3.3. The proposed measures aim to upgrade the PPE of the firefighters in Armenia to ensure the personnel's health and safety, as well as to provide the means for the proper storage and maintenance of the new equipment. The measures presented in Table 8.3 were estimated for the 56 visited stations and are further scaled to include all FRS in Armenia.

Table 8.3: Measures for improving the PPE and specialised equipment

Items to be modernised	Number of FRSs	Central Estimate	Range		Phase
			min	max	
PPE - clothing	63	$ 6.3M	$ 5.0M	$ 8.8M	Phase 1
PPE - SCBA	23	$ 1.3M	$ 0.8M	$ 1.4M	Phase 1
Laundering equipment	51	$ 0,26M	$ 0,23M	$ 0,28M	Phase 1
Storage racks	56	$ 0.31M	$ 0.25M	$ 0.38M	Phase 1
Intensive cleaning and repair equipment	12	$ 0.24M	$ 0.22M	$ 0.26M	Phase 1
Rescue equipment	63	$ 1.6M	$ 1.3M	$ 1.9M	Phase 1
Heavy rescue equipment	23	$ 1.3M	$ 1.2M	$ 1.4M	Phase 1
Total		$ 11.2M	$ 8.9M	$ 14.3M	

8.3.1 Personal Protective Equipment (PPE) and SCBA

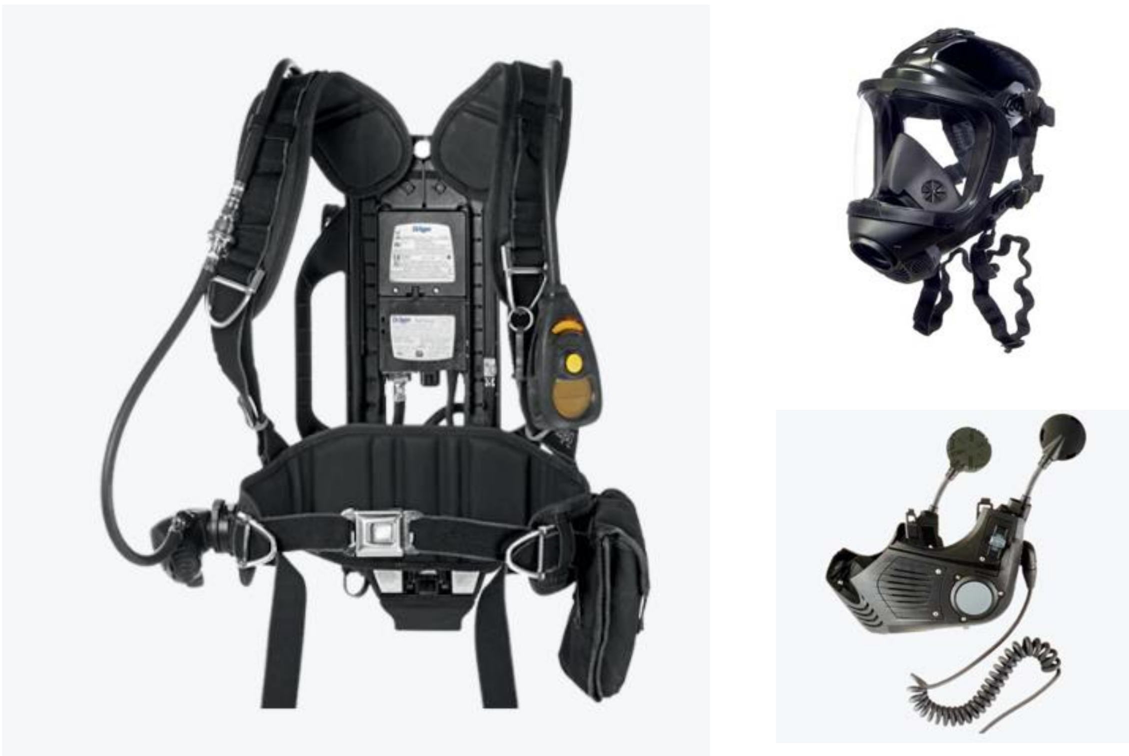
Basic set of firefighting protective clothing includes jacket, pants, helmet, gloves, boots and coveralls. It is multipurpose protective envelope with primary function to protect the firefighters from extreme temperatures, fire and its products of combustions, toxic smoke and chemicals dermal absorption, medical emergencies and various other emergencies that they are summoned to mitigate. Ideally, specific protective gear should be issued for firefighters designed for the type of incidents. For the estimation of the probable investments for modernizing the protective equipment of the firefighters in Armenia two sets of protective gear were proposed: structural firefighting ensemble (with estimated price from anecdotal sources of around 2,500 $). The recommendation is to supply each firefighter with new structural ensemble (an example of such is presented on Figure 8.14). The budget for PPE clothing presented in table Table 8.3 was estimated assuming that one structural firefighting ensemble is supplied to all firefighters in Armenia plus 25% reserve (2,500 sets).

Figure 8.14: Structural firefighting ensemble – jacket, pants, gloves, helmet, protective hood, googles, and boots

Source: https://pacfirenz.com/

The modern high-end equipment for the fire services practice includes SCBA for each fireman for respiratory protection from toxic smokes in a fire. Considering best international practices in terms of life cycle costs, availability of technical and service support the equipment recommendations in this report are set to ensure that the proposed upgrade for the equipment of the Armenian fire services can be sustained in proper condition and available to serve the emergency responders through its expected life cycle. The costs for proper SCBA maintenance can exceed the initial investment for equipment and the maintenance procedures require full time trained technicians. These costs should be considered by management when creating the improvement solutions. For this reason, the estimated initial investment for respiratory protective equipment is limited only to fire stations in major regional towns (10 FRS) and the 13 FRS in Yerevan, a total of 23 stations. The budget given in Table 8.3 for SCBA is estimated for 10 sets of SCBA per 23 stations with a price of around 5,500 $ for a high-end breathing apparatus with in mask heads up display, integrated personal alerting system and all modern technology add-ons. An example is presented on Figure 8.15.

Figure 8.15: SCBA apparatus



Dräger FPS 7000: flame resistant carrying system, full face mask, ground and tactical communication, monitoring air and firefighter safety system, in mask display notifiers for the remaining air, air container

Source: https://www.draeger.com/en-us_us/Safety/Firefighting/SCBA

8.3.2 Storage Racks and Laundering Equipment

To provide proper storage and maintenance for the structural firefighting ensembles two complementary measures for each FRS are proposed. These measures include storage racks for PPE clothing. However, likely savings could be made when the storage rack is locally produced. The budget presented in Table 8.3 was estimated as one storage rack with price 150 $ is provided for each firefighter in the visited stations. An example of storage rack for PPE clothing, that is vented to permit drying and airing out of the clothing and provides protection from ultraviolet radiation is presented in Figure 8.16.

Figure 8.16: Storage rack for PPE clothing

Source: https://www.allhandsfire.com/Groves-Red-Rack-20-Wall-Mounted-Gear-Storage_2?Option=448

For regular cleaning and decontamination of PPE a decontamination kit can be made relatively low-cost from commercially available materials. The laundering equipment for PPE clothing for fire stations was estimated in the $5,000 range. The budget presented in Table 8.3 was estimated as one gear washing machine with price 5000 $ is provided for each of the visited FRS, without considering the staff number in the FRS and the expected laundry volume.

Figure 8.17: Gear washer extractor

Source: https://www.fire-end.com/Equipment/Bunker-Gear-Washing-Machines/ew22-ready-rack-extractor

Equipment for intensive cleaning with higher capacity systems for the firefighters' gear was estimated to cost around 20,000$. Such equipment requires trained personnel whose duties could also include thorough inspection of the structural ensembles. The budget presented in Table 8.3 was estimated with the assumptions that intensive cleaning equipment will be provided only for cleaning and repair centers established in each region. It was further assumed that Yerevan region, would need 2 sets for intensive cleaning equipment.

8.3.3 Upgrade of Rescue Equipment

Light weight rescue systems including hand tools, basic shoring materials, lightweight electric combination cutter-spreader tools and basic accessories are likely estimated to cost around $20,000. Example for car accident rescue tools – spreader, cutter and rescue ram is presented in Figure 8.18. The budget presented in Table 8.3 for light weight rescue equipment was estimated as each FRS receives new light rescue set. The investments for new rescue equipment for each FRS were scaled to capture the different sizes of FRS based on the size of each FRS (assigned class depending on the shift size), a FRS with 8 or less people in one shift (FRS class 3 or 4) was assumed to need one set of rescue equipment, a FRS with more than 8 firefighters on shift (FRS class 1 or 2) was assumed to need 2 sets of rescue equipment.

Figure 8.18: Rescue tools – spreader, cutter, rescue ram

Source: https://www.weber-rescue.com/wAssets/docs/feuerwehr/kataloge-und-broschueren/de/en/CAT-Rescue-Systems_EN_2020B.pdf

In addition, a budget for heavy rescue equipment for relatively common emergencies of larger scale like building collapse and explosions was estimated. An example for such tools is presented on Figure 8.19. Heavy rescue systems that consist of air bags, shoring, heavy hydraulic spreaders and cutters, hand tools and other required equipment are expected to start with a budget of $50,000. The budget for heavy rescue equipment presented in Table 8.3 includes one set of heavy rescue equipment for each FRS in regional centers and for all FRS in Yerevan – a total of 23 sets.

Figure 8.19: Heavy rescue tools – lift bags,1.0 and 8.0 bars with accessories

Lift bag 8.0 bars

Lift bag 8.0 bars accessories

Lift bag 1.0 bar

Source: https://www.weber-rescue.com/wAssets/docs/feuerwehr/kataloge-und-broschueren/de/en/CAT-Rescue-Systems_EN_2020B.pdf

8.4 ICT Equipment and Data Management System

A budget of $0.5M (with range of $0.4M to $0.7M) is estimated to be needed for updating the communication system in the Armenian fire services (63 FRS). Breakdown of the estimate of the items to be modernised is provided in Table 8.4 and further information for each item is provided in sections 8.4.1, 8.4.2. The modernisation measures aim to upgrade the ICT equipment of the fire services, to ensure reliable communication and improve organizational cohesion and, to provide the means for data collection which should be the foundation of system optimization and would enable further informed decision making.

Table 8.4: Modernisation measures for ICT equipment and data management

Items to be modernised	Number of FRSs	Central Estimate	Range		Phase
			min	max	
PC and IT equipment	63	$ 95,000	$ 76,000	$ 113,000	Phase 1
Communication room - ICT equipment	63	$ 441,000	$ 315,000	$ 630,000	Phase 1
MoES Real time data management syst.	1				Phase 1
Total		$536,000	$391,000	$743,000	

8.4.1 ICT Equipment

The estimate for ICT equipment includes providing each FRS with personal computers (PC), internet access and modernising the equipment in the dispatcher room.

The estimate for PCs presented in Table 8.4 is based on the assumption that each station receive three computers – for the commander, the deputy commander and the for the dispatcher room. An average cost for one computer is estimated at 500$.

ICT equipment for communication room – PC, telephone, radio, voice over internet (VOIP) phone, was estimated to cost between 2500$ and 10,000$, depending on the technical specification. The central budget estimate is based on a cost of $7,000 per FRS.

8.4.2 Data Management System

The data management system could initially include online data forms for call types, times and distribution, response times, on-scene duration, as well as equipment inventories and maintenance records for the special equipment. It will be best if the data management system could evolve in time to real time data management system and integrate online services to support training, operation and administrative services as well. This system integration could support enhanced operational capabilities, situational awareness across the network and support improved deployment practices between FRS.

8.5 Emergency Diesel Generators

To ensure the operational continuity of the fire rescue services, an allocation of $0.5M (within range of $0.3M to $0.8M) is estimated to provide back-up power supply in all 63 FRS. The estimates of the item to be modernised presented in Table 8.5 was made for 62 FRS (all except Artashat - Figure 8.20).

Table 8.5: Modernisation measures for back-up power supply

Item to be modernised	Number of FRSs	Central Estimate	Range		Phase
			min	max	
Emergency diesel generators	62	$ 0.5M	$ 0.3M	$ 0.7M	Phase 1

Figure 8.20: Emergency diesel generator in Artashat FRS

8.6 Regional Centres for Specialised Training, Storage Depos, Maintenance and Repair of Vehicles and Equipment

The Baseline Assessment Report highlighted the lack of proper training facilities as a systemic deficiency across the Armenian FRSs. Developing of modern and comprehensive training facilities in each or most of the FRSs may not be a financially sustainable approach and in fact may not be necessary from operational point of view. An allocation of between $12M and $16M was estimated to build a few, but well equipped, regional centres.

A central estimate of $14M is considered adequate to develop four regional training centres with multi-purpose training facilities. It is the MoES to decide where these centres should be best placed, but in principle it is not necessary for these centres to be in the biggest Armenian cities. It might be cheaper to build (land acquisition) and maintain if these centres were built in smaller towns selected based on geographical considerations (travel distance from FRSs in the area). Building the training centres in smaller towns may also have more noticeable positive impact for the local economy as the training centre except training facilities will have also small administration and potentially will provide own accommodation options. Examples of modern training facilities for different types of training are provided in Figure 8.21 and Figure 8.22 The training centres can store also different types of mobile training facilities which to travel across the FRSs in the area on an annual schedule and allow some of the more basic training to be performed from the crews in their home FRS.

Figure 8.21: Example training towers

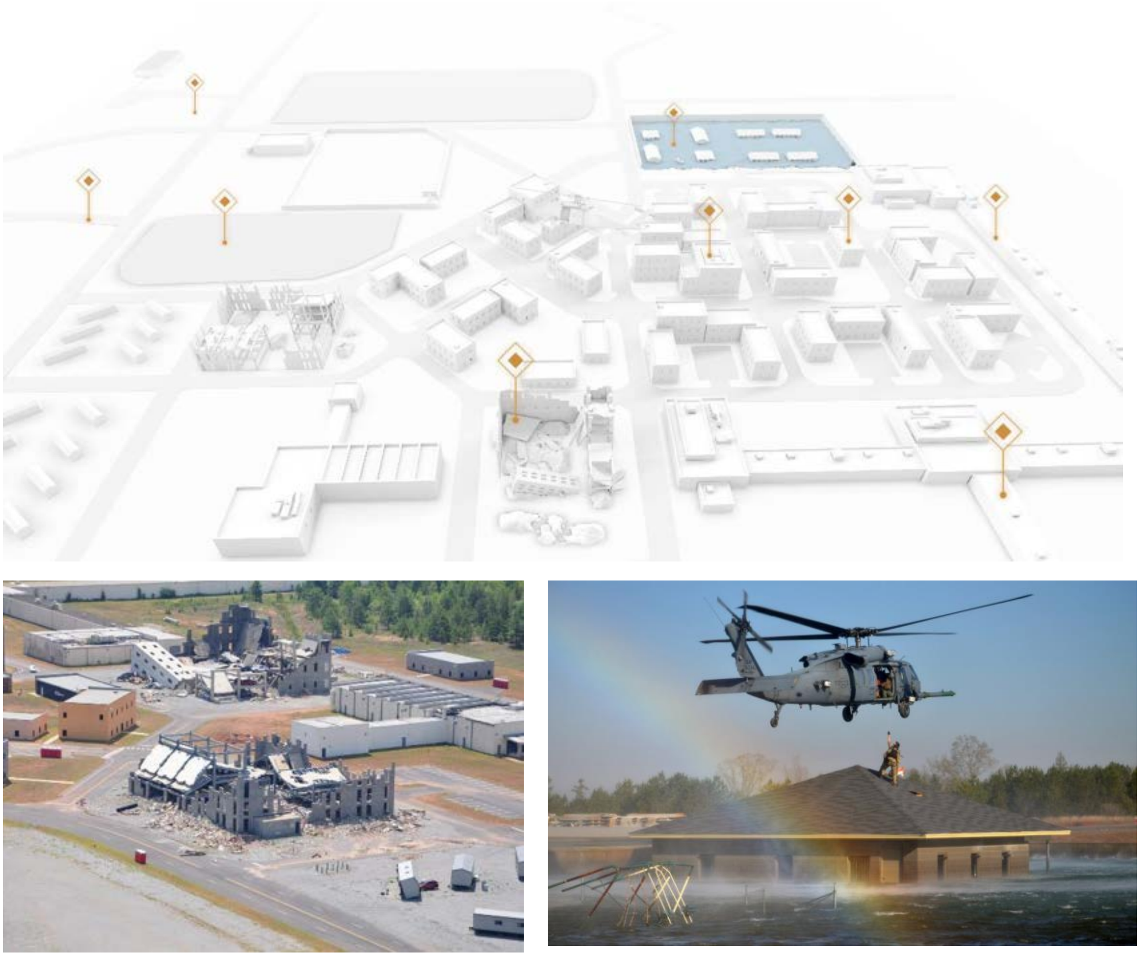
Figure 8.22: Example training facilities for confined spaces and work in toxic environment

These training centres can be combined with regional storage depos for firefighting clothing, PPEs, spare parts and reserve equipment. The storage depos can be extended to regional maintenance and repair centres to concentrate the investment in maintenance workshops, tools and technicians in fewer locations and hence allowing higher capability and quality of service. The technicians in these centres can travel across the FRSs in their service area on scheduled visits and do regular inspections of clothing, SCBA, PPEs, equipment and vehicles and collect items that need maintenance service or repair works.

Considering the Armenian context (distances between towns, number of FRSs and firefighters) the MoES may wish to consider developing less, but larger and better equipped training centres of the types shown in Figure 8.23 and Figure 8.24 within this or a bigger budget. The example shown in Figure 8.24 is a redevelopment of a site with existing facilities. This is a viable option for Armenia where abandoned industrial facilities can be used and converted into scenes for Urban SAR and industrial accidents training while the other training facilities can be built on a cleared from old facilities surface.

Another alternative to seek a more efficient spend of the investment in multipurpose training facilities could be to integrate them, potentially in combination with regional storage depo, maintenance and repair workshop with a FRS similarly to the example shown in Figure 8.25. This approach is likely to require the construction of more new FRSs compared to the recommendation in Section 8.1.1

Figure 8.23: Large multipurpose training centre



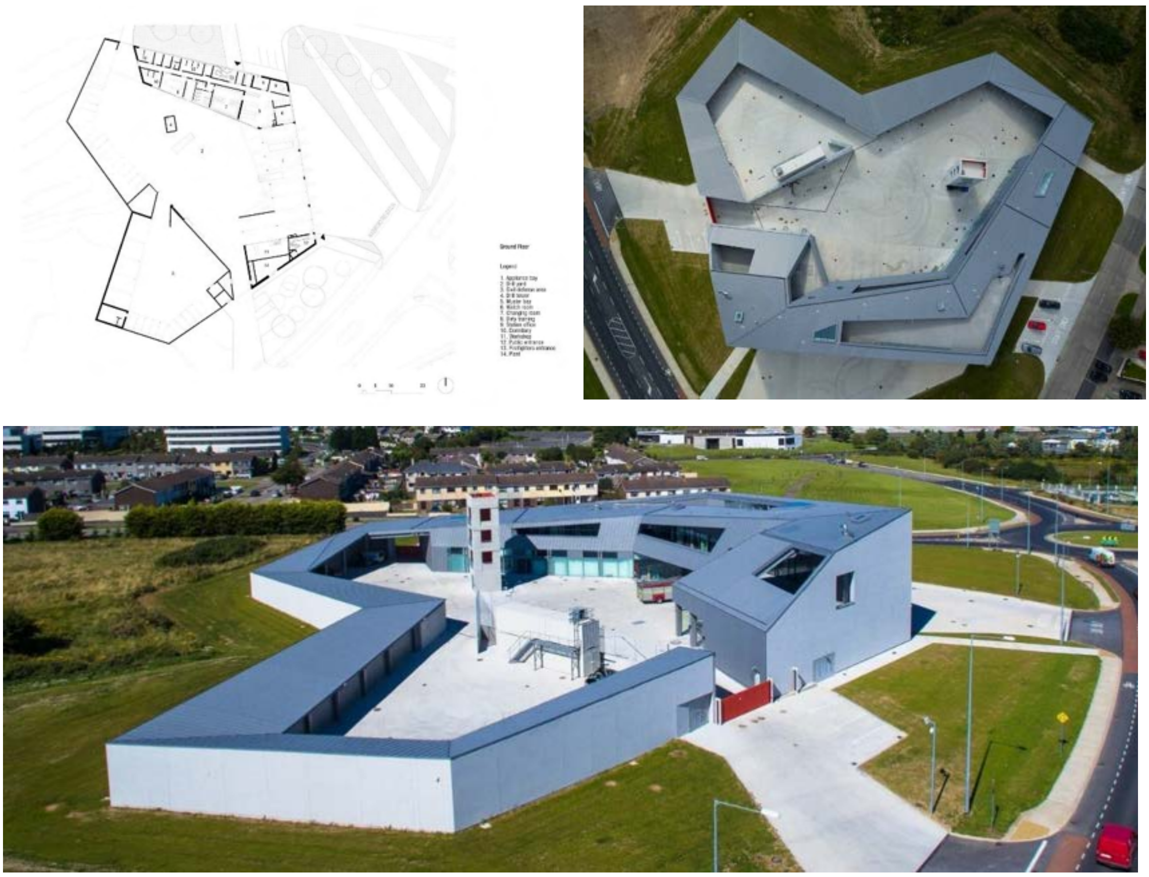
https://guardiancenters.com/

Figure 8.24: Multipurpose training centre developed on existing site reusing some of the existing facilities

Existing configuration Remodeled configuration

Source: https://www.cheshirefire.gov.uk/about-us/consultation/current-consultation/new-firefighter-training-centre-planned-for-winsford

Figure 8.25: Multipurpose regional training centre integrated in regional FRS with dedicated storage/operational space for the Civil Defense agency



Source: https://www.archdaily.com/786984/waterford-fire-station-mccullough-mulvin-architects

8.7 Project Phasing

The investment program based on the recommendations described above is already extracted based on a prioritisation (See Section 4.5) of the investment needs described in Section 6. In that respect they are all urgent and critical. However, they cannot be implemented at once for various reasons. The project phasing proposed below is based on the following main considerations:

- Urgency and criticality:
  - Phase 1: should be considered as stabilizing the existing Armenian fire & rescue service with limited expansion of services.
  - Phase 2 and 3: build on the foundation of the implemented actions of Phase 1 and are transformational with either expansion of the services or improved efficiency.
- Availability of information for decision making:
  - Phase 1: considers actions for which 1) there is enough data available to support decision making; 2) the needed new/additional data is easy and quick to generate/collect or 3) there is no need for detailed information to take adequate decision and this can be done based on common sense or based on experience/analogy with other jurisdictions.
  - Phase 2 and 3: consider interventions that are based on further studies or design projects developed during Phase 1
- Sequence of activities.

The total cost of the recommended modernisation programme is estimated to be approximately $88M (range of $72M to $107M) and it is judged that this program is realistic to be implemented over 8 years period. Details for the interventions recommended for each phase and the budget spending in each phase are summarised in Table 8.6.

Table 8.6: Breakdown of project costs in each phase

Phase / Project	Budget	Budget Range Min	Budget Range Max	Comment
Phase 1	**$31M**	**$26M**	**$39M**	**Stabilise the existing fire service**
Brigade Response Vehicles (BRV)	$4.0M	$3.4M	$5.4M	Will fit in every FRS. The budget will allow the procurement of circa 20-30 BRVs which is below the demand, i.e. all procured will be in in use. BRVs are easy to be relocated within the FRSs at later stage if need, therefore can be procured in Phase 1.
Personal Protective Equipment (PPE) and clothing	$6.3M	$5.0M	$8.8M	The central budget estimate is based on 2,500 sets of clothing and PPE with average cost of $2,500. This will allow to equip 100% of the staff and to allow for 25% reserve. Every fighter must have proper protective clothing, therefore clothing must be procured in Phase 1. Adequate temporary storage must be organised in the FRSs which receive the new clothing before the completion of the refurbishment/reconstruction works.

Phase	Project	Budget	Budget Range		Comment
			Min	Max	
	Self-Contained Breathing Apparatus (SCBA)	$1.3M	$0.8M	$1.4M	The central budget estimate is based on 230 sets with average cost of $5,500 each. This will allow to equip 23 large stations (10 regional and 13 in Yerevan) with shift size of 10 people. In the absence of more detailed Hazard, Risk, and Vulnerability Analysis (HRVA) it is reasonable to assume that the bigger towns contain the highest fire risk and these are the FRSs that need to be equipped with SCBA with priority. Alternatively, this budget will allow to equip 40 stations with sets of 6 SCBA. Adequate temporary storage must be organised in the FRSs which receive the new clothing before the completion of the refurbishment/reconstruction works. SCBA can be relocated within FRSs and therefore can be procured in Phase 1
	Computers	$0.1M	$0.1M	$0.1M	189 computers – 3 per each FRS. This will allow the offices of the FRS commander, the deputy commander and the dispatcher room to be equipped with computers. Each station must have computers to facilitate reporting and data storage. The difference between one and three computers per station is insignificant compared to the overall modernisation budget. Computers can be supplied to old facilities and moved back after the reconstruction or replacement of the FRS. It is also important to collect and process operational data in a consistent format and therefore the computers must be procured in Phase 1.
	Communication equipment	$0.4M	$0.3M	$0.6M	Communication equipment for the dispatcher room of all FRSs. Proper communication system is critical and therefore must be procured in Phase 1. Communication equipment can be installed to old facilities and moved back after the reconstruction or replacement of the FRS.
	Real time data management system	N/A	N/A	N/A	Cost may vary significantly depending on the technical specification and the provider.
	Acquisition of privately owned area	N/A	N/A	N/A	Cost may vary significantly depending on the location and the willingness of the private owners to sell their property. MoES may consider selling their part and use the funds to cover partially the construction costs for the new facilities. Alternatively, the MoES can keep these buildings but repurpose them for support functions, for example for maintenance and repair of equipment and vehicles. Decision on acquiring the privately owned parts of the FRSs, selling of FRS buildings or keeping them under MoES ownership but with different function must be taken in the early stages of the Phase 1 to unlock the investment projects related to these stations.
	Construction of five new fire and rescue stations	$7.3M	$6.5M	$8.1M	The central budget estimate is based on 8,000 sq.m. with average construction cost of $900/sq.m. The five stations designated for replacement are in very poor condition and the FRS commanders reported that they are planned for replacement. This is the minimum number of FRSs for replacement. The construction of these buildings is urgent and must start in

Phase	Project	Budget	Budget Range Min	Budget Range Max	Comment
					Phase 1. These buildings will be used also as a pilot projects and to explore design and construction cost optimisation which may influence the decision to increase the number of newly build FRSs and reduce the number of reconstructed FRSs.
	Emergency Diesel Generators (EDG)	$0.5M	$0.3M	$0.7M	The central budget estimate is based on 62 EDGs that can provide back-up power for the essential consumers – communication system and lights. EDGs are installed externally and do not affect the reconstruction process. If the FRS is replaced with new building in a new site, the EDG can be moved to the new locations with minimal additional installation costs. FRSs must be able to operate in black-out and EDGs are must have equipment. For this reason and because of the limited interface with the building improvement works EDGs can be procured and installed during Phase 1.
	Rescue equipment	$2.9M	$2.5M	$3.3M	The central budget estimate is based on 63 sets (all stations) of light rescue equipment and 23 sets (regional stations and Yerevan's stations) of heavy rescue equipment. Adequate temporary storage must be organised in the FRSs which receive the new rescue equipment before the completion of the refurbishment/reconstruction works. It is preferable that all the needed rescue equipment is procured during Phase 1 so that the FRSs become properly equipped as soon as possible.
	Laundering equipment	$0.5M	$0.4M	$0.6M	The central budget estimate is based on 51 professional laundering machines for standard use and 12 machines (in all regional centres and 2 in Yerevan) for intensive use. Temporary facilities may be needed to install the laundering equipment in the FRS which were not yet reconstructed or replaced. Equipment can be moved and reinstalled at another location if needed. Lack of equipment for cleaning and decontamination of clothing and PPE may reduce their lifespan of safe use and overall harm the health and safety of the personnel. Therefore this equipment needs to be procured in Phase 1 in parallel with the new clothing.
	Storage racks	$0.3M	$0.25M	$0.4M	The central budget estimate is based on imported storage racks for all 63 FRSs. Cost can be reduced by localisation of the production. Storage racks are needed for proper storage of the clothing and equipment and therefore must be procured in Phase 1 together with the new clothing.
	Building infrastructure improvements	$7.6M	$6.3M	$9.2M	The central budget estimate for Phase 1 assumes that 20% of all reconstruction activities with a total cost estimated of about $38M will be implemented during Phase 1. This is also the recommended approach since this will provide about 10 pilot projects of different scale and complexity to refine and optimise design, construction and procurement processes and hence lower the reconstruction costs in Phase 2 and Phase 3.
Phase 2		**$29M**	**$24M**	**$36M**	**Expand the fire and rescue service**
	Emergency Tenders (ET)	$6.1M	$5.6M	$8M	ETs on a compact truck chassis as a direct replacement of old (>25 years) fire engines. Likely to fit in every FRS. The

Phase	Project	Budget	Budget Range Min	Budget Range Max	Comment
					budget will allow the procurement of circa 15 ETs which is below the demand, i.e. all procured will be in use. If the HRVA studies and the fleet assessment studies recommended in Section 7 and Section 9 are implemented, then this information can be used to either specify more accurately the number and type of ETs or to relocate this budget towards the acquisition of more BRVs or other type of vehicles. Therefore, the procurement of ETs is better to be hold for Phase 2 until more information is collected.
Building infrastructure improvements		$22.8M	$18.8M	$27.6M	The central budget estimate for Phase 2 assumes that 60% of all reconstruction activities with a total cost estimated of about $38M will be implemented during Phase 2.
Phase 3		**$28M**	**$22M**	**$33M**	**Optimise the fire and rescue service**
Heavy Rescue Vehicles (HRV)		$6.4M	$3.2M	$8.0M	This project includes the acquisition of at least 8 (3 in Yerevan and 5 in regional towns) HRVs on a large truck chassis. This is considered needed to build the “backbone” of the Heavy Urban Search And Rescue (HUSAR) capability distributed across Armenia and to guarantee a certain level of autonomy and early response capability of the AFRS. HRVs are expensive investments and require proper selection which requires time for further studies. In addition, these are large vehicles and therefore it is better to wait to complete the FRS reconstruction and replacement programme so that the HRVs can be stored properly and in seismic resilient buildings.
Building infrastructure improvements		$7.6M	$6.3M	$9.2M	The central budget estimate for Phase 3 assumes that 20% of all reconstruction activities with a total cost estimated of about $38M will be implemented during Phase 3.
Regional Multipurpose Centres		$14M	$12M	$16M	This project includes construction works and procurement of equipment to develop four regional multipurpose centres with support functions. The priority is to develop 4 regional training centres with diverse and modern training facilities, but it is recommended that the MoES explore the opportunities to build at the same locations also facilities for storage of cashes of equipment and clothing, as well maintenance and repair workshops. This project needs more time for planning and therefore is left for the last Phase 3 of the FRS optimisation programme. Keeping this project in Phase 3 will allow more time to monitor the progress of the FRS reconstruction and replacement programme and to explore the options to integrate these regional multipurpose support centres with the construction of new FRSs.
Total		**$88M**	**$72M**	**$107M**	

8.8 Cost Optimisation Provisions

The investments costs described above can be optimised by different means, the most important summarised below:

- **Provision 1:** Development of national procurement programmes to procure larger sets of equipment and request volume discount.
- **Provision 2:** Conduct Hazard, Risk and Vulnerability Analysis studies for each FRS serviced area in combination with detailed fleet assessment study to identify more accurately the expected demand and the current capability and capacity of the fleet of fire engines and rescue vehicles – considering the Armenian context these studies are likely to guide the selection of fire engines towards smaller vehicles and lower technical specifications.
- **Provision 3:** Based on Provision 2, redesign the vehicle deployment model with a higher percentage of BRVs in the fleet, considering that 2-3 BRVs are at the cost of one ET. BRVs at the upper range (size and technical specification) are likely to be able to cover almost all type of calls in majority of FRS serviced areas.
- **Provision 4:** Based on Provision 2 and Provision 3 explore the use of advanced technologies to add extra capacity to support firefighting activities in periods of high demand due to seasonal fluctuation or in rare events aiming to further reduce the demand for permanent deployment of classical ETs and BRVs. Examples are the use of CAFS technology to reduce the demand for water (allowing smaller vehicles, see Figure 7.5) and/or mobile firefighting skids (see Figure 7.16) mounted on commercial cargo vehicles or on all terrain buggies. Using light mobile firefighting skids is a low-cost solution to expand fire flow capacity on top of the baseline fire flow capacity provided by classical ETs and BRVs, for example to equip remote/satellite fire bases, volunteer squads or to capacitate community response in a rare high demand events.
- **Provision 5:** Based on Provision 2 (required number and types of fire engines and required crew/shift size), develop FRS specific requirements for the usable area and the needed functional zones in combination with conceptual architectural designs of the FRS buildings remodelling and extension. This may lead to lower demand for usable area in FRS in smaller towns compared to these computed in this project based on the number of fire engines. This study will inform better on would remodelling or replacement will be a more economical solution for each FRS.
- **Provision 6:** Partially based on Provision 5, develop standardised designs for new construction of FRS and explore the use of hazard-resilient pre-fabricated or modular construction technologies.
- **Provision 7:** Partially based on Provision 5, explore the options for standardised designs for horizontal and/or vertical extension with individual FRS specific design of the interface between the existing and new spaces. Explore the options to use pre-fabricated/modular construction for the expansion zones.
- **Provision 8:** Explore the options to use light pre-fabricated steel, timber or fabrics structures for adding temporary/seasonally or permanently extra (standalone) space for storage, maintenance and repair workshops, apparatus bays (for example 2nd line of defence or reserve apparatus, large rescue vehicles), etc.
- **Provision 9:** Explore possibilities for localisation of the procured services, goods and works through a “Made in Armenia” initiative. This not only can reduce the investment costs (or increase quantity/quality of procured items) but also will support the local economy. Except the obvious items like architectural/engineering services and construction works, the MoES in discussion with the Armenian Government may wish to

discuss with the leading international providers of firefighting and rescue clothing, PPEs and equipment options for outsourcing the final assembly or part of the manufacturing to Armenia – for example assembling of light/mobile firefighting skids (some of the examples in this report are produced in Ukraine), final production of firefighting clothing (Viking firefighting clothing is produced in Bulgaria), etc. In addition, the low technology and non-critical items could be sourced locally, like the steel storage racks, new furniture for the FRSs, etc.

- **Provision 10:** Partially based on Provision 2, Provision 5 and additional studies explore the opportunity to concentrate storage, maintenance and repair functions in fewer but bigger, better equipped and better staffed regional facilities. Considering the size of Armenia, the size of the fire and rescue service and the intensity of use of fire/rescue services it is logical to consider the development of few large regional centres that will provide storage spaces for caches of equipment, clothing, PPEs and modern well equipped and adequately staffed workshops for maintenance and repair of clothing, equipment and vehicles. Properly trained and licensed technicians in these centres can travel across the FRSs in their service area on scheduled visits and do regular inspections of clothing, SCBA, PPEs, equipment and vehicles and collect items that need maintenance service or repair works. These centres could be standalone facilities or integrated with regional FRSs. Further concentration of the investment (and the investment efficiency) can be achieved with the integration with regional training centres.
- **Provision 11:** Explore the options to utilise public-private partnership by outsourcing non-critical services to the private sector based on long-term services contracts and hence reduce the investment needs or relocate the saved funds to invest in critical services. For example, the regional maintenance and repair workshops and training facilities could be developed as a private investment based on a guaranteed long-term contract with MoES.

9 Concluding Remarks and Recommendations for Further Technical Initiatives

9.1 Concluding Remarks

9.1.1 Armenian Context

There are several Armenian specific features that shape the unique contextual environment of this project. The most critical for the fire service optimisations study are:

- **Economic conditions and financial capacity:** Armenia is a relatively small country and is classified as a developing country and an upper-middle income economy. The overall annual budget for public expenditures is in the range of $3.5-4.0 Billion in the last few years. All this illustrates that Armenia has a limited financial capacity to build and maintain large and complex fire and rescue service comparable to the service maintained in more developed countries.
- **Urbanisation patterns and industry:** while approximately two-thirds of the Armenian population lives in urban settlements most of the 46 Armenian towns are relatively small and underdeveloped compared to similarly sized towns in more developed countries. The industrial sector has not recovered yet from the decline started in the 1990's and the population has now declined to 20% compared to the peak values during the Soviet era. Therefore, modernizing towards a more flexible, scale-appropriate and innovative fire and rescue service may be more justifiable than maintaining a large, costly and complex fire and rescue service in terms of overall benefit.
- **Geopolitical considerations:** Armenia is a landlocked country and relatively isolated geographically from global transportation roads and major industrial centres. This may make procurement and maintenance of specialised equipment and vehicles more complex and costly. In addition, mutual aid from some neighbouring countries may be complicated due to political considerations or capacity challenges within those nations. While international disaster aid is realistic to expect, even this support may be restricted due to many factors, e.g., other international disaster response operations, pandemic related aid limitations, etc. Therefore, a sustainable approach toward the optimisation of the Armenian fire and rescue service should maximise self-sufficiency.
- **Topography and climate:** Armenia is a mountainous country with high average elevation and harsh continental climate. Despite short travel distances, the travel times are long due to challenging terrain and road conditions. This makes it difficult to develop an efficient multi-station deployment model for many Armenian regions and those stations need to be largely autonomous. This reduces the options to optimise the investments and necessarily increases the stations' running costs by concentrating the essential functions in fewer, but better capacitated stations. In addition, the harsh continental climate, the high altitude, and the difficult road conditions further stress the fire and rescue service by increasing the demand on both their buildings (e.g. energy efficiency, seasonal maintenance) and vehicles (e.g. requires all wheel drive on a robust chassis, spare parts).
- **Current condition of the fire and rescue service:** While there is a noticeable improvement in capacitating the Armenian Fire and Rescue Service (AFRS) by

establishing a National Crisis Management Centre (NCMC), building of a National Medium Urban Search and Rescue (MUSAR) Team, repair works and interior improvements in some fire and rescue stations, increasing salaries of firefighters and acquisition of new equipment and vehicles, there is more to be done in order to stabilise, expand and optimise the Armenian Fire and Rescue Service (AFRS) and bring it closer to good international practice. The staff numbers for career firefighters (per capita) seems consistent with many international jurisdictions but the Armenian Fire and Rescue Service (AFRS) seems to be generally underequipped and with significant share of amortised and aged equipment and vehicles. The portfolio of Fire and Rescue Service buildings is not generally fit for purpose, many Fire and Rescue Station (FRS) buildings were not designed for FRSs and those that were designed were guided by outdated standards. This means that significant efforts and investments need to be devoted first to stabilise the existing service by mitigating and removing the most critical and urgent deficiencies in order to prepare the ground for expansion and optimisation of the fire and rescue service.

- **Seismicity in Armenia:** The entirety of Armenia is in a seismically active region with all major cities in areas with high seismic hazard. At the same time the building stock is largely based on old design concepts and is associated with high seismic risk. Various studies have shown that it is reasonable to expect a significant share of collapsed buildings in the event of a major earthquake. Therefore, it follows that in such case there would be significant demand for search and rescue activities and for the suppression of earthquake-induced fires. This statement is valid for practically every town in Armenia. Unfortunately, the same is valid for the portfolio of FRS buildings and this study highlighted their low seismic resilience. The high-level earthquake scenarios for Yerevan and Gyumri performed during this project have demonstrated that the Fire and Rescue Service in the region stricken by the earthquake will be seriously incapacitated. In combination with the increased demand for Fire and Rescue Service, this is likely to lead to amplified financial losses and death toll.
- **Limited information:** Despite the large amount of information collected and generated during this project there are still serious data gaps. In particular, the missing operational/performance records with detailed statistics about the type of calls and the FRS performance to these calls, the missing hazard, risk and vulnerability assessments of the FRS serviced area and the missing detailed inventory (inspection, testing and operational records) for the fleet of specialised vehicles are the main sources of uncertainty for the development of an optimal modernisation programme of the AFRS. However, the large number of critical and urgent issues that need to be addressed make it possible to specify with high confidence several modernisation projects that will resolve the most critical and urgent issues.

9.1.2 Key Deficiencies of Armenian FRSs Affecting the Fire and Rescue Service

During the implementation of this project, the project team managed to visit 56 fire and rescue stations across Armenia. There is a noticeable positive trend and many positive actions have been started, or already implemented, from the MoES. Examples are interior improvement works in around 30 stations, new equipment and fire engines (obtained mostly due to international aid), new garage doors and/or ventilation systems in some stations, some provisions for back-up power supply (Artashat). However, these positive interventions are still limited in coverage and in depth, and hence do not have significant impact on the fire rescue service capacity and efficiency. In the same time. The key deficiencies of Armenian FRSs identified during the implementation of this project are the following:

- **Information and Communications Technology (ICT) equipment:** although the National Crisis Management Centre (CMC) and the Regional CMCs have reasonably modern facilities and technology, the call processing communications system in most of the FRSs is old and the operational records are populated by hand on hard copies only. The lack of digital equipment combined with the manual record keeping in these stations make the communication of operability parameters difficult and prone to errors, which in turn may impact negatively strategic decision making. Computers are largely absent and where present are usually the personal computers brought from the FRS commanders.
- **Specialised vehicles:** In about one-third of the FRSs the average age of the fire engines and the rescue vehicles is above 25 years, well past the expected operational period. The fleet is dominated by vehicles on a truck chassis with a very small share of Brigade Response Vehicles (BRV) which make the fleet slow to react and potentially oversized for the majority of the calls received. The current fleet restricts operational flexibility and leads to higher running costs and increased time out of service while waiting for parts and repairs.
- **Clothing, Personal Protective Equipment (PPE) and specialised equipment:** Firefighting clothing is generally below the relevant international good practice for safety. Where new equipment is available it is usually stored and maintained inappropriately – professional laundering machines have not been seen in any of the 56 visited stations and proper storage racks were generally missing. In many locations the new Self-Contained Breathing Apparatus (SCBA) sets were stored inappropriately.
- **Missing or degraded training facilities:** Very few stations had any specialised training facilities but where these were available, they were typically unusable due to their poor conditions.
- **Inadequate building infrastructure:** The poor condition of the building infrastructure is a common deficiency of the portfolio of FRSs in Armenia. This is both in terms of adequacy of the building layout and size, and in terms of the current condition of the buildings due to inadequate maintenance during the years and the aged building stock (60% of the FRSs are older than 50 years).
- **Lack of back-up systems:** Only one of the visited 56 FRSs has a proper back-up power system and only few have some form or back-up water and back-up fuel supply. None of the FRSs have a communication system that can operate in full autonomy from external providers.
- **Low seismic resilience:** The overall seismic resilience of the FRS buildings is very low. The majority are with low seismic resistance and are not expected to remain functional (at least not without compromising staff safety) after a strong earthquake. Therefore, it is reasonable to expect that within an affected region following a strong earthquake the Fire and Rescue Service to be unable to perform its emergency response function due to incapacitation of the FRS building and personnel. This means that a proper fire and Search and Rescue (SAR) service will need to be provided by FRSs located further from the affected region which will lead to significant delays in the arrival of first (properly equipped) responders.
- **Lack of systematic approach:** It does not seem that the investments thus far in the AFRS follow a clear and long-term strategy. Problems are addressed on a case-by-case approach without considering the overall AFRS as a complex and interdependent system of FRSs. This is evident from the numerous examples of newly donor provided fire engines which do not fit into the existing buildings at the FRSs where they were deployed, FRSs receiving new SCBA equipment without having proper storage space

and maintenance facilities, or on the other extreme renovated stations equipped with old vehicles.

- **Shared ownership with private sector:** About 20% of the FRSs share their ownership on the building with private owners. It should be noted that these are not tenants which provide additional income to the FRS, but co-owners of the building that will need to provide at least a consent for any major reconstruction works.

Detailed overview of the characteristic deficiencies found across the Armenian FRSs is provided in Section 5 of this report.

9.1.3 Investment Needs

For the needs of this Fire Service Optimization (FSO) study an estimate of the investment needs on individual FRS, regional and national levels. Although investment needs are estimated on individual FRS basis, this is based on a process which prescribes the needed interventions/upgrades, and hence investments, by grouping the FRSs based on common deficiencies and applying to each group an identical predefined set of interventions. With this methodology, the list of interventions assigned to each individual FRS may vary when detailed and individualized assessments are performed on each fire rescue station. However, the used approach is considered sufficiently accurate for the needs of this project and, in particular, to build up the needed investments on a regional/marz and countrywide levels.

The identified investment needs were estimated to be **between $75M and $210M** depending on the selected modernisation strategy and the breakdown is as follows:

- **Variant 1 Stabilisation with Expansion and elements of Optimisation of the AFRS ($100M):**
  - Refurbishment of 16 FRSs keeping their original size, major remodelling with area expansion for another 35 FRSs and construction of 5 new FRSs at a new site with a total cost of the building infrastructure improvements of $41.7M;
  - Acquiring of 167 new vehicles, of which 26 Brigade Response Vehicles (BRVs), 18 Wildland Apparatus, 25 Emergency Tenders (ET) of different types/sizes, 26 tanker pumpers (to pair each BRV), 7 Heavy Rescue Vehicles (HRV) and 65 specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of about $41.5M;
  - Buying of 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 12 sets of heavy rescue equipment with a total expected cost of $12.1M;
  - Buying and installing 3 computers per FRS and modern communication equipment to equip the dispatcher rooms of all FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new or retrofit of the existing technical training facilities in 42 of the FRSs with a total expected cost of $3.3M;
- **Variant 2 Stabilisation with Expansion of the AFRS ($75M):**
  - Refurbishment of 40 FRSs keeping their original size, partial renovation and refurbishment of the 11 FRS with shared ownership and construction of 5 new FRSs at a new site with a total cost of the building infrastructure improvements of $26.9M;

  - Acquiring of 140 new vehicles, of which 21 BRVs, 17 wildland apparatus, 25 ETs of different types/sizes, 21 tanker pumpers, 4 HRVs and 52 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $31.2M;
  - Buying 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 4 sets of heavy rescue equipment with a total expected cost of $11.7M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new or retrofit of the existing technical training facilities in 21 of the FRSs with a total expected cost of $2.1M;

- **Variant 3 Expansion and Optimisation with elements of Transformation of the AFRS ($195M):**
  - Refurbishment of 6 FRSs keeping their original size, construction of 34 new FRSs at their current site and construction of 16 new FRSs at a new site with a total cost of the building infrastructure improvements of $95.3M;
  - Acquiring of 251 new vehicles of which 34 BRVs, 18 wildland apparatus, 63 ETs of different types/sizes, 34 tanker pumpers and 14 HRVs and 88 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $73.1M;
  - Buying of 1937 sets of firefighting clothes and 441 sets of SCBA, 56 sets of light rescue equipment and 20 sets of heavy rescue equipment with a total expected cost of $12.5M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;
  - Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
  - Developing new or retrofit of the existing technical training facilities in 43 of the FRSs with a total expected cost of $11.3M;

- **Variant 4 Expansion and Optimisation with Transformation of the AFRS ($210M):**
  - Construction of 21 new FRSs at their current site and construction of 35 new FRSs at a new site with a total cost of the building infrastructure improvements of $89.7M;
  - Acquiring of 282 new vehicles, of which 34 BRVs, 18 wildland apparatus, 63 ETs of different types/sizes, 34 tanker pumpers, 14 HRVs and 119 other specialised vehicles of different type (Aerials, Small Rescue Vehicles, Snow Rescue Vehicles, Swap Body Vehicles and Command Vehicles) with a total expected cost of $83.7M;
  - Buying 1937 sets of firefighting clothes and 441 sets of SCBA, 56 specialised/rescue equipment and 38 sets of heavy rescue equipment, 2 sets of water rescue equipment with a total expected cost of $13.4M;
  - Buying and installing computers to all 63 FRSs (3 computers per FRS) and modern communication equipment to equip the dispatcher rooms of all 63 FRSs with a total expected cost of $0.5M;

- Buying and installing Emergency Diesel Generators in all FRSs (except Artashat) for a total expected cost of $0.4M;
- Developing new technical training facilities in 51 of the FRSs with a total expected cost of $22.9M;

While all variants achieve great improvement of the Operational Capacity, each variant achieves very different level of improvement of the Building Infrastructure. Variant 4 and to large extend Variant 3 will lead to transformational change in the Armenian Fire and Rescue Service (AFRS) but is associated with an investment cost in the range of $200M. In addition, Variant 3 and 4 are scalable and provide great flexibility for modification and reorganisation (in the timeline) of the interventions. At the other extreme, is Variant 2 which will achieve mainly stabilisation of the current AFRS by improving the building infrastructure, strengthening the communication system, adding back-up power capacity and technical training facilities. It will, however, lead also to some expansion of the capacity due to the acquisition of new vehicles and new specialised equipment. The cost of Variant 2 could be reduced even further to about $50M by reducing the number of procured vehicles. The main disadvantage of Variant 2 is that this is not a scalable modernisation programme. Variant 1 describes a more balanced modernisation programme which for 50% of the cost of “best case” options and for 25% more than Variant 1 is likely to achieve stabilisation and expansion of the AFRS with some elements of optimisation of the service. The main difference and advantage of Variant 2 compared to Variant 1 is that it is scalable modernisation programme and provides greater flexibility to modify the type of interventions.

Considering the Armenian context (see Section 2), the characteristic deficiencies in the portfolio of FRS buildings (Section 5) and the high-level, top down fire service optimisation strategy (Section 7), the recommendations for interventions outlined in Section 8 are based most closely to Variant 1.

9.1.4 Potential Modernization Programme

The current report identifies and recommends six specific project areas implemented across 3 phases. This approach will improve considerably the Fire and Rescue Service capacity in Armenia and the functionality and the occupational health conditions in the Armenian FRSs. In principle, these projects can be implemented as standalone projects but this will compromise the results and will reduce the value for money of the investments. For example, if Heavy Rescue Vehicles are procured without modernising and expanding the area in the FRS buildings these vehicles may not be able to fit into the buildings. Similarly, if new clothing is procured without buying and installing professional laundering equipment, this will compromise the quality of the clothing and will expose the firefighters (and their families – in many stations it was reported that they wash their professional clothing at their homes) to contamination. Therefore, it is strongly recommended to implement the six modernisation projects together and following the recommended phasing which was designed to achieve maximum synergy between the projects. In addition, it is important to highlight that these projects were selected and recommended because the currently available information is sufficient to specify them with high confidence. Detailed information for these six project areas is provided in Section 8, and short summary is provided below:

- **Project 1 - Modernising the Building Infrastructure ($45M):** This project includes the construction of 5 new fire stations, refurbishment of 16 FRSs and major remodelling with area expansion of 35 FRSs together with seismic retrofit, energy efficiency measures, new building services, finishing works and new furniture for all stations with a total cost estimated at about $45M (range of $38M to $54M).

- **Project 2 - Modernising the Fleet of Specialised Vehicles ($16.5M):** This project includes the procurement of 30 Brigade Response Vehicles, 20 Emergency Tenders and 8 Heavy Rescue Vehicles with a total budget needed for this purpose estimated at about $16.5M (range of $12.2M to $21.4M).
- **Project 3 - Modernising the PPEs and the Specialised Equipment ($11.2M):** This project includes the procurement of firefighting clothing, PPE, SCBA, light and heavy rescue equipment, laundering machines and storage racks with a total budget estimated at about $11.2M (range of $8.9M and $14.3M).
- **Project 4 - New ICT Equipment and Data Management System ($0.5M):** This project includes procurement of 3 computers and communication equipment for the dispatch room of all FRSs with a total budget estimated at about $0.5M (range of $0.4M to $0.75M).
- **Project 5 - Install Emergency Diesel Generators ($0.5M):** This project includes the procurement and installation of 63 EDGs (all stations except Artashat) with a total budget estimated at about $0.5M (range of $0.3M to $0.75M).
- **Project 6 - Build New Multipurpose Regional Centres ($14M):** This project includes the construction of four multipurpose regional centres that will provide training facilities, storage depos and maintenance and repair workshops with a total budget estimated at about $14M (range of $12M to $16M).

The recommended AFRS modernisation programme is phased in three phases with a spending profile estimated to be as follows:

- Phase 1 - Stabilise: Approximately $31M over 3 years period (average spending of $10-11M/year)
- Phase 2 - Expand: Approximately $29M over 2 years period (average spending of $14-15M/year)
- Phase 3 - Optimise: Approximately $28M over 3 years period (average spending of $9-10M/year)

Summary of the costs of the proposed projects and comparison with the needed investments as defined in Section 6 is provide in Table 9.1.

Table 9.1: Summary of costs of the potential modernisation projects

Modernisation Projects	Variant 1	Variant 2	Variant 3	Variant 4	Potential Programme
Building infrastructure	$41,700,000	$26,900,000	$95,300,000	$89,700,000	**$45,000,000**
Fleet of special vehicles	$41,500,000	$31,200,000	$73,100,000	$83,700,000	**$16,500,000**
PPE and specialised equipment	$12,100,000	$11,700,000	$12,500,000	$13,400,000	**$11,200,000**
ICT equipment	$500,000	$500,000	$500,000	$500,000	**$500,000**
EDG	$400,000	$400,000	$400,000	$400,000	**$500,000**
Specialised Training Facilities	$3,300,000	$2,100,000	$11,300,000	$22,900,000	**$14,000,000**
Total	$99,500,000	$72,800,000	$193,100,000	$210,600,000	**$87,700,000**

9.2 Further Technical Initiatives

This report identifies and recommends six specific project areas estimated to cost about $90M and implemented over an eight years-long modernisation programme which is expected to first stabilise and then expand and optimise the AFRS. However, the six recommended project areas do not solve all problems with the AFRS and there are numerous other projects and actions that MoES can implement in parallel and/or after the completion of the recommended herein modernisation program. The most relevant additional projects with the highest potential for synergy with the recommended modernisation programme are summarised below.

9.2.1 Develop Fire and Rescue Service Master Plan

It is recommended that MoES use the information collected and generated with this study and the studies recommended below to support the development of a detailed Fire and Rescue Service Master Plan with a horizon of 5, 10 and 20+ years. The Master Plan will outline the expected future needs of the communities across Armenia and Armenia as a whole and what the MoES and the individual FRSs will require in order to provide fire and rescue protection services. The Master Plan will provide a framework to modernise and maintain the AFRS in well planned and sustainable fashion and will guide future investment programmes. It will also provide clarity and transparency for the short-term and long-term strategic needs of the AFRS which besides the improved internal decision making will inform better the external aid agencies on what the MoES/AFRS really need to meet their long-term goals.

9.2.2 Modernise the Armenian National Standards for Fire and Rescue Service

The MoES should review all its current fire and rescue service standards together with the leading international standards and use this review to develop a consistent and complete set of Armenian National standards in line with the international best practice adequate for the Armenian context. When developing this set of national standards the MoES and other governmental agencies do not need to develop all documents from scratch. Instead, the majority of the new national standards can be based on a process which selects an appropriate international standard, translates it to Armenian language, and adjusts the content/requirements to the Armenian context. The following framework of national standards is recommended together with a commentary for the recommended development approach:

- **Standards for Emergency Response System Performance:** these standards should be defined internally by the Ministry of Emergency Situations and reflect the expectations of the country and its residents. The Ministry should focus on system outcomes and allow AFRS to define their approach to delivering the services they are mandated to provide. Expected results can be articulated through operating guidelines and procedures which are developed internally. The Ministry and the AFRS understand their complex operational environment best. Reporting processes with Key Performance Indicators (KPIs) should be included in standards making to track the performance of the systems being measured and guide changes as required. Using KPIs will allow for continuous improvement as more data becomes available.
- **Equipment**: all fire-fighting equipment and particularly personal protective equipment should be specified to comply with an appropriate international standard. There are numerous standards that may make sense for the Armenian government to adopt. North America, European countries, Russia, and other countries have developed comprehensive standards that can guide Armenian efforts and improve safety, consistency and ensure the best possible value for taxpayers.

- **Vehicles**: All firefighting vehicles should be designed and built in accordance with an appropriate international standard. Again, there are numerous standards that may make sense for the Armenian government to adopt.
- **Training**: Standards for the basic training of firefighters related to new equipment, vehicles and processes should be evaluated and adopted.
- **Fire Station Design Standards**: These standards should be developed in consultation with building design professionals competent in fire station design. They may reflect some elements of international standards but should focus on sound engineering and architectural design principles related to operations, administration, and post-disaster construction.

9.2.3 Develop Effective Deployment Models

While implementing the projects recommended in Section 8 will certainly lead to improved fire and rescue service in Armenia, it will be beneficial for the MoES to conduct several additional studies that will help to develop more effective deployment models. This can cut investment costs and/or improve the value for money of the investments. The main additional studies/projects that are recommended are summarised below:

- **Conduct a Hazard, Risk and Vulnerability Assessments (HRVA):** This study will help to identify more accurately the likely demand for fire and rescue services in each serviced area and can guide the MoES in reassessing the number of needed firefighters, number and types of vehicles, etc. in each FRS.
- **Establish Service Level Descriptions Based on HRVA:** Service level policies describe the nature and extent of services that will be available to citizens. Service level policies frequently identify different service levels for various areas of the jurisdiction. It is simply not practical nor cost-effective to try and provide all services all the time everywhere in the country. This study will help to balance the demand for services with what is practically achievable in different parts of Armenia.
- **Develop Volunteer/Part-time Service and a Network of Satellite Bases:** Integrate volunteers and part-time staff to add extra capacity to career firefighters to support them for peak loads or to cover remote locations. Use the insights from the HRVA studies to identify which FRS serviced areas will benefit from adding volunteer and/or part-time firefighters as well to specify the most suitable locations and equipment requirements for satellite fire bases.
- **Develop and Implement Protocols for Multi-station Deployment:** Using the insight from the HRVAs and the rebalanced service levels for each FRS serviced area the MoES can develop and formalise (since FRSs are already supporting each other) protocols for multi-station deployment, at least for the regions where travel distances and road conditions will allow for this. This is expected to go much beyond the current practice, where FRSs support each other on peak demands. A truly multi-station deployment models will navigate the investment in FRSs towards developing a FRS network using a system approach where the capacity of selected FRSs is increased beyond their direct needs in order to be able to support neighbouring FRSs. This will allow to concentrate the investments in expensive (to buy and maintain) high-tech equipment and vehicles in lesser number of stations and reduce overall investment costs.
- **Develop plans to address business continuity for current and proposed facilities operated by Fire and Rescue Services:** Operational plans describing how services will

be delivered into communities struck by major disasters, recognizing that most of the critical infrastructure serving them is likely to be damaged or destroyed in the event. These plans should consider the deployment of regional and national resources, occupation of other facilities to deliver emergency and other services, as well as a national command and control systems able to guide response and resources. The loss of critical infrastructure in a community, no matter the cause, is a serious event and likely beyond the capability of local and regional agencies to manage. Early development of and clearly understood plans that start moving resources to assist is the best way to ensure continuity of critical services, including fire and rescue services in remote or damaged communities.

9.2.4 Improve Community Fire Protection Water Supplies

Access to adequate water supplies is an essential requirement for the delivery of effective fire suppression services. The Baseline Assessment [P1] identified the lack of access to dependable water supplies as a critical gap in many areas of Armenia, including developed areas, rural and wildland areas as well. This inevitably leads to a higher demand for water capacity in the fire engines and pushes the deployment model towards bigger vehicles which are more expensive to buy and maintain and are not necessary or even less efficient in majority of the fire and rescue calls to which the Armenian FRSs respond.

Managing water resources can follow either of the two options:

- More efficient use of the water they are able to carry on their trucks and tanker vehicles using various technology solutions.
- Develop infrastructure to transport, store, or access water in strategic locations to support fire department operations.

The MoES needs to explore the potential of both options and develop an integral solution of the water supply deficiency using combination of both. Improving the water supply for fire fighting and the water use efficiency will unlock the use of smaller and cheaper vehicles (see Section 9.2.5 below) which at the end will allow to redesign the deployment model (see Section 9.2.3) towards a more efficient fire suppression in terms of FRS network density/coverage, response time and running costs.

The first option regarding the more effective use of water is added to the discussion on the fleet management (Section 9.2.5 below). As to improving the fire protection water supply, it is recommended that MoES consider the following additional studies and projects:

- **Develop a Network of Cisterns:** Large cisterns can be installed under parks and other public developments to ensure an adequate fire flow during normal events and serve as an emergency backup system in case of a severe seismic event. Re-purposing of old industrial tanks is possible solution to reduce cost.
- **Develop a Network of Dry Hydrants:** Dry hydrants can be used to provide a secure and safe connection point to a standing water source like a lake, stream, or reservoir. They are a relatively simple assembly consisting of a pipe in the ground that runs into the water source. Dry hydrants seem to be suitable solution for the settlements along the shores of Sevan lake as well for the area in Yerevan around the Yerevan lake. It is for the MoES to identify other suitable locations.
- **Develop Procedures for Use of Commercial Water Tankers:** Many fire departments around the world have contracts with commercial water tanker companies to provide emergency water transport for emergency operations. The MoES may explore the possibilities to establish contracts with other public agencies and the private sector to secure the supply of additional water quantities in case of major events.

- **Convert Old Fire Engines into Water Tankers:** A proper assessment of the existing fleet may identify old fire engines which do not meet any more the requirements for a fire engine but can be retrofitted and converted into water tankers. This could be relatively inexpensive way for the MoES to build a fleet of water tankers.

In the ideal case the alternative water supply strategy will be based on the detailed HRVAs.

9.2.5 Develop and Implement an Effective Fleet Management Programme

An effective fleet management programme will help to identify the most suitable new vehicles and will reduce the long-term maintaining costs for the new vehicles and for the existing fleet. An effective fleet management programme will have the following main pillars:

- Detailed assessment of the existing fleet to identify the current capability and capacity – designate vehicles which can be used long-term, short-terms, as a 2^{nd} line, reserve or to be made redundant.
- Assess running costs, typical mechanical failures and service records and develop a fit-to-purpose maintenance and repair strategy.
- Compare the current fleet capability and capacity with the required one based on the HRVAs.
- Identify the gaps that need to be filled in with procurement of new vehicles and/or reorganisation of the existing vehicles, and develop a procurement strategy and technical specifications.
- Retrofit and upgrade the vehicles which have sufficient residual lifetime. Explore the options to increase firefighting capabilities by using Compressed Air Foam System retrofit kits.
- Explore the opportunities to reorganise the fleet towards higher percentage of BRVs. Evaluate the practicality of multifunctional vehicles using modules, trailers and skid units that can be loaded or changed to reflect seasonal or other needs.

9.2.6 Develop and Implement an Effective Communication Strategy

Effective communications between responders, dispatch systems and other agencies are critical to the effective management of any emergency event. Most effective systems depend on a combination of radios, repeaters and, in modern designs, voice over internet provider (VOIP) connections to central dispatch. It is recommended that MoES (probably with the support and/or shared funding with other government agencies) develop a comprehensive communications strategy that integrates internet, radio and telephone communications supporting an effective and robust communications system. This project is further development of the project recommended in Section 8.4 which improve the communication systems in individual FRSs. The additional steps in developing efficient emergency communication system will include:

- Design the architecture of the communication system integrating internet, radios, repeaters, telephones and voice over internet provider (VOIP) connections to central dispatch.
- Build a network of repeaters in areas with harsh terrain and explore the use of mobile repeaters in command vehicles.
- Increase the coordination capacity of the Crisis Management National Centre (CMNC) developing system for real-time communication between Fire Rescue Services and the CMNC and improve their ability to forecast the need for additional resources and provide improved support for Incident Commanders on serious incidents.

- Evaluate interoperability between AFRS, police, ambulance, and other first response agencies and link the communication system to police and other agencies that will be tasked with deployment on major disasters, including seismic events.

9.2.7 Develop a Detailed Modernisation Programme for the Portfolio of FRS Buildings

Section 8.1 recommends several specific projects for refurbishment of 16 FRSs, major remodelling with area expansion of 35 FRSs and construction of five new FRSs. While these recommendations can be implemented directly, the MoES will benefit to use them as a basis to develop a more detailed modernisation programme for the whole portfolio of FRS buildings. This is expected to lead to reduced construction costs, shorter project time schedules and lower project risks. It is expected that such portfolio modernisation programme will cover the following main elements:

- Development of standardised multidisciplinary conceptual designs for new construction of FRSs of different size.
- Benefit-cost analysis to compare remodelling vs. new build and identify when and where new construction will be preferable.
- Feasibility studies and benefit-cost analysis for using prefabricated and modular construction for new build and for major remodelling of existing buildings.
- Procure and contract architectural, engineering and construction firms on a programme level (nationwide) to retain knowledge and experience and improve design and construction quality with each project.
- Develop pilot projects to improve design and construction practice.
- Develop a detailed construction schedule for all new build and major remodelling FRS projects across Armenia aiming uniform workload for the design and construction teams over the entire period of the modernisation programme to allow optimal use of resources and hence optimal construction costs.

9.2.8 Develop Critical Infrastructure Seismic Resilience Programme

The Baseline Assessment Report [P1] and the Seismic Structural Assessment Report [P2] highlighted the low seismic resilience of the Armenian FRSs and the high seismic risk associated with the residential building stock in Armenia. The latter is confirmed from various other studies of local and international researchers which were also discussed in the Baseline Assessment Report [P1] and the Seismic Structural Assessment Report [P2]. This report recommends seismic retrofit of practically all FRSs and this recommendation will improve significantly the preparedness of the MoES to deploy effectively fire and rescue services after an earthquake compared to the current situation. However, seismic strengthening of FRSs only and just to the seismic resistance required by conventional design codes may not be enough for the high seismic hazard conditions in Armenia. It is recommended that the MoES develop a comprehensive Critical Infrastructure Seismic Resilience Programme which as a minimum should cover the following main aspects:

- Seismic Probabilistic Risk Assessment and Scenario Earthquake Assessments of Emergency Response Facilities (ERFs) – fire and rescue stations, police stations, essential hospitals and other relevant buildings.
- Development of a Technical Guideline for seismic design/retrofit of Emergency Response Facilities. This guideline should be based on the leading international practice, employing performance-based design concepts and specifying higher performance requirements.

- Develop and implement a Risk-Informed Seismic Retrofit Programme to strengthen all ERFs.
- Develop a procedure for rapid post-earthquake damage assessment of emergency facilities to speed up the decision-making process for safe reoccupation of emergency response facilities. It is recommended to explore the opportunities to use innovative solutions for automatic assessment of the expected damage state. For the Armenian context in particular, the detection of the natural modes of vibration of the ERF buildings through ambient vibrations measurement could be the most efficient method as this approach is already incorporated in the Armenian seismic design code (Table 24) [S8]. For the purpose permanent accelerometers can be installed in each FRS (or ERF) building (preferably additional at free field or the basement) with automatic record processing system that send automatic alarm message. For bigger and more important ERF the procedure can be refined with the support of advanced numerical analysis to link the expected damage state in the building to the expected (and hence measured) floor peak acceleration/velocity/displacement. The accelerographs installed on free field / basement of the ERFs can be integrated with the national seismic monitoring network and used also for scientific purposes.
- Expand the national seismic monitoring network of accelerographs to develop a denser grid in Yerevan, Gyumri and potentially other big Armenian towns and develop procedures for rapid (real-time) seismic damage assessment/prediction to inform emergency response and search and rescue activities immediately after the earthquake. Essentially, this system is a GIS based platform which links the measured accelerations in different locations within the city with the expected number of collapses buildings, trapped occupants and other relevant seismic risk metrics derived from seismic risk analysis of these cities.

9.2.9 Fire Prevention and Awareness Programming

Fire prevention and awareness programs can reduce dependence on expensive first response capabilities, reducing deaths, injuries and property damage over time. It is likely the most cost-effective intervention that a FRS could employ to make its community safer. Fire prevention follows several streams, and all should be evaluated to see how they fit into the Armenian context.

- **Inspections:** A limited inspection program should be considered for the urban areas of the country. It is not possible to inspect all buildings. A listing of high hazard, high-risk facilities and critical infrastructure should be developed, with an inspection program established based on the life safety risk profile the buildings represent. Inspection frequency should be related to the risk and the capacity of the Prevention Branch (the institutional body in charge of the inspection program).
- **Development Planning:** Fire Rescue Services should be included in all aspects of new construction and development planning. Adequate fire protection systems should begin with community design ensuring that these new communities or buildings are more resilient, less dependent on fire response services, but are accessible in an emergency. While fire emergencies are front of mind, rescue, evacuation of sick or injured building occupants, water supplies are all areas of interest for Fire Rescue Services.
- **Public Education:** Public education priorities are driven by the risks the community faces and should be anchored to statistics or an HRVA. Public education should take an “all-hazards” approach and could be more of a Ministry priority than simply the jurisdiction of the AFRS. This ensures that there is proper coordination of effort and resources, reduction in duplication and likely makes it easier to find program partners.

- **Wildland Fire Prevention and Protection:** A program for the protection of forest and other wildland areas should be developed and linked to improved fire prevention practices on agricultural lands. The program should emulate best practices from other jurisdictions to reduce development time and costs.

10 References

Reference ID	Description
Codes & Standards	
[S1]	https://www.usfa.fema.gov/downloads/pdf/publications/design_of_fire_ems_stations.pdf
[S2]	https://www.ontario.ca/document/firefighter-guidance-notes/4-1-firefighters-protective-equipment
[S3]	https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/fire-safety/playbook.pdf
[S4]	https://www.usfa.fema.gov/downloads/pdf/publications/voice_radio_communications_guide_for_the_fire_service.pdf
[S5]	NFPA 1500, Standard on Fire Department Occupational Safety, Health, and Wellness Program, 2018
[S6]	NFPA 1851, Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting, 2020
[S7]	СП 380.1325800.2018, СВОД ПРАВИЛ ЗДАНИЯ ПОЖАРНЫХ ДЕПО Правила проектирования (Fire station buildings. Design rules), 2018, In Russian
[S8]	Earthquake Resistant Construction Design Code RAB II-6.02-2006, Republic of Armenia Ministry of Public Development, 2009
Projects References	
[P1]	Baseline Assessment Report, Assessment and Optimization Study of Fire/Rescue Stations in Armenia; Mott MacDonald Limited, Revision A, August 2020
[P2]	Seismic Structural Assessment, Assessment and Optimization Study of Fire/Rescue Stations in Armenia; Mott MacDonald Limited, Revision A, August 2020
[P3]	Armenia Fire Service Optimisation, FireWise Consulting, September 2020
[P4]	BUDGERATY OFFER no. 460-20002, Various types of vehicles, Rosenbauer International AG, Paschingerstraße 90, 4060 Leonding, Austria, September 2020
[P5]	Rosenbauer International AG www.rosenbauer.com, Mr. Harun Acuma – Regional Sales Manager, e-mail: harun.acuma@rosenbauer.com, Phone: +43 732 6794-3872
Articles & Publications	
[A1]	http://www.mes.am/en/news/item/2020/08/31/24-30/
[A2]	https://apps.who.int/healthinfo/statistics/mortality/whodpms/
[A3]	https://www.ctif.org/sites/default/files/2018-06/CTIF_Report23_World_Fire_Statistics_2018_vs_2_0.pdf
[A4]	https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030
[A5]	: https://www.hdi.global/downloadcenter/International/risk-engineering-guidelines/liability-fire/20180108_403-HRCREG115GB201606_REG_Loeschwasserversorgung.pdf
[A6]	https://www.hne.ag/en/contact-germany
[A7]	: https://www.3mscott.com/download/air-pak-x3-pro-scba-nfpa-2018-operation-and-maintenance-english/
[A8]	https://www.fleetbusiness.com/features/asset-management-fleet-best-practices
[A9]	https://www.birminghammail.co.uk/news/local-news/west-midlands-fire-service-takes-5732868
[A10]	https://www.bdc.ca/en/articles-tools/entrepreneur-toolkit/templates-business-guides/pages/business-continuity-guide-templates-entrepreneurs.aspx
[A11]	https://caucasuswatch.de/news/3028.html
[A12]	https://firesmartcanada.ca/
[A13]	https://www.euneighbours.eu/en/east/stay-informed/news/armenia-eu-programme-teaches-how-prevent-forest-fires
[A14]	https://armenpress.am/eng/

A. List with Interventions

This section provides a complete list of all identified investment measures in Table A.1 to Table A.4. Additional information regarding the fire/rescue apparatus as listed in Table A.1 is provided in Appendix E.

Although a great effort was put in cost estimation of each exhibited measure, none of the exhibited costs claims high reliability. High reliability will have a cost for a particular item for which was made inquiry from a particular FRS, or a price for a particular item for a particular FRS verified from different sources. The presented costs are marked either with low or with medium reliability. A medium reliability has a cost for specific item, based on a source and calculated with some simple assumption. Price estimation for complex items (containing subitems), for not thoroughly specified items, for items with limited online presentation or prices based on expert judgment are graded with low reliability

Table A.1: List of interventions in Operational capacity

Code	Title	Cost	Quantity	Source	Description of the intervention	Reliability of the cost	Assumptions
OC1	Brigade Response Vehicle /BRV/	132000	$/unit	Rosenbauer proposal	These vehicles enable about 90 percent of coverage for fire and vehicular incident response and are typically used in areas with mixed urban and rural coverage. Water capacity 0.5t	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/municipalvehicles/cl/Dokumente/Prospekte/CL_Prospekt_bis_7_to_Sprinter_en.pdf http://www.flyingfireservices.in/mini-fire-tender-5144456.html https://www.google.co.uk/search?q=brigade+response+vehicle&safe=active&hl=en-GB&source=lnms&tbm=isch&sa=X&ved=2ahUKEwj-9Ny7nbvrAhUO_aQKHUypDCMQ_AUoAXoECAwQAw&biw=1778&bih=895#imgrc=8LQEptiZoSiMoM
OC2	Wildland Apparatus	112000	$/unit	unofficial conversation	Small rapid attack vehicles with extended off-road capabilities Water capacity 3.0t	low	https://www.rosenbauer.com/en/int/rosenbauer-world/vehicles/special-vehicles/forest-firefighting-vehicles
OC3	Emergency Tender - Type 1	276500	$/unit	Rosenbauer proposal	small 4x4 water hauling vehicle; Water capacity up to 4t	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/vehicles/et/docs/Brochure_ET_Efficient_Technology_EN.pdf
OC4	Emergency Tender - Type 2	306000	$/unit	Rosenbauer proposal	Large water hauling vehicle; Water capacity up to 8.0t	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/vehicles/et/docs/Brochure_ET_Efficient_Technology_EN.pdf
OC5	Triple Combination Pumper	370000	$/unit	Rosenbauer proposal	Urban style vehicle with water tank, pump, hoses and may carry limited rescue equipment, water capacity 4t	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/municipalvehicles/at2010/Dokumente/Prospekte/Prospekt_AT_EN_web.pdf
OC6	Aerial Truck	1001500	$/unit	Rosenbauer proposal	Vehicle equipped with a pump, ladder and waterway, 60m	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/vehicles/aerial_ladders/docs/VI0182_153355_Prospekt_Drehleitern_EN_web.pdf
OC7	Tanker Pumper Apparatus	396000	$/unit	Rosenbauer proposal	Water hauling vehicle with pumper without additional equipment such as ladders, blankets, and generators. Water capacity 9t	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/specialvehicles/INTERN_Interschutz_2015/Prospekte_Sonderfahrzeuge_neu/rb_gbk_broschure_CBS_EN_216x303_2015-05-11_v18_ks.pdf https://machmall.en.made-in-china.com/product/IqgEyHlGgYDS/China-

Code	Title	Cost	Quantity	Source	Description of the intervention	Reliability of the cost	Assumptions
							XCMG-Factory-Dg34m2-Brand-New-Aerial-Platform-Fire-Fighting-Truck.html
OC8	Aerial Ladder	497000	$/unit	Rosenbauer proposal	Ladder truck with ladder capability up to 27 m	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/vehicles/aerial_ladders/docs/VI0182_153355_Prospekt_Drehleitern_EN_web.pdf https://machmall.en.made-in-china.com/product/dbLEfOiCEpDq/China-XCMG-Brand-New-Aerial-Platform-Fire-Truck-Dg32K2.html
OC9	Aerial Platform	235000	$/unit	unofficial conversation	Hydraulic platform, height 40m	low	https://www.rosenbauer.com/fileadmin/sharepoint/products/vehicles/aerial_platforms/docs/Rosenbauer_brochure_hydraulic_platforms_2019.pdf https://machmall.en.made-in-china.com/product/dbLEfOiCEpDq/China-XCMG-Brand-New-Aerial-Platform-Fire-Truck-Dg32K2.html
OC10	Small Rescue Vehicle	111500	$/unit	Rosenbauer proposal	Small 4x4 Modular vehicle that carries personnel and equipment for rescue purposes (Not a patient transport vehicle)	medium	https://www.rosenbauer.com/fileadmin/sharepoint/products/specialvehicles/INTERN_Interschutz_2015/Prospekte_Sonderfahrzeuge_neu/rb_gbk_broschure_sonderfahrzeuge_EN_216x303_2015-05-11_v22_sj.pdf
OC11	Heavy Rescue Vehicle	405000	$/unit	Rosenbauer proposal	Large 4x4 Modular vehicle that carries personnel and rescue equipment for rescue purposes	medium	https://www.rosenbauer.com/en/int/rosenbauer-world/vehicles/special-vehicles/rescue-vehicles
OC12	Snow Rescue Vehicle	40000	$/unit	https://www.alamy.de/orange-verfolgt-snowcat-rettungsfahrzeug-mit-wagen-an-der-seite-der-strasse-geparkt-image218759656.html	Snow cat modular rescue vehicle	low	

Code	Title	Cost	Quantity	Source	Description of the intervention	Reliability of the cost	Assumptions
OC13	Swap body vehicles	829500	$/unit	Rosenbauer proposal	Swap body vehicles efficient solution with highest flexibility. For transport and storage of special equipment that is only needed in certain situations	medium	https://www.rosenbauer.com/en/int/rosenbauer-world/vehicles/special-vehicles/swap-body-vehicles-roll-off-containers
OC14	Command Vehicle	400000	$/unit	Rosenbauer proposal	A mobile command vehicle supports deployment crews in the management and coordination of tactical units for fighting fire and disaster operations.	medium	https://www.rosenbauer.com/en/int/rosenbauer-world/vehicles/special-vehicles/command-vehicles
OC15	Structural Firefighting ensembles	3500	$/unit	unofficial conversation	Structural firefighting clothing. Jacket, pants, boots, helmet, gloves	low	
OC16	Wildland firefighting ensembles	1000	$/unit	unofficial conversation	Wildland firefighting clothing - a simple helmet, coveralls, goggles and boots	low	
OC17	Rescue equipment	25000	$/unit	unofficial conversation	For car accidents and other relatively light situations: hand tools, basic shoring materials, lightweight electric combination cutter-spreader tools and basic accessories. Maybe included in the price of some of the vehicles	low	one unit for each FRS
OC18	Heavy Rescue Equip.	50000	$/unit	unofficial conversation	For heavy USAR operations after disasters: air bags, shoring, heavy hydraulic spreaders and	low	one unit for emergency regional centres or the biggest fire station in the region and for all FRS in Yerevan

Code	Title	Cost	Quantity	Source	Description of the intervention	Reliability of the cost	Assumptions
					cutters, hand tools and other required equipment		
OC19	Water rescue equip.	25000	$/unit	unofficial conversation	For water rescue operations	low	Maybe only in the station near lake Sevan
OC20	PPE (SCBA)	5000	$/unit	unofficial conversation	SCBA for the firefighters on shift	low	SCBA for the firefighters on shift
OC21	Tower - Type 1	1000	$/unit	IR3 Retrofit	Repair and upgrade of an existing training tower that is embedded in the building	medium	retrofitting the towers is inserted in the cost for retrofit for each station, the price here is only for non-structural systems
OC22	Tower - Type 2	1000	$/unit	IR3 Retrofit	Repair and upgrade of an existing training tower that is standalone	medium	assumed equal to the embedded tower
OC23	Tower - Type 3	38400	$/unit	https://affordabledrilltowers.com/products	Standalone steel training tower	medium	price per square meter, assumed two times smaller than the construction cost for new building 450 $, area of the tower is assumed 4x4x12 ZZ: the price for USA is 55 000 dollars (installation and transport included). Maybe two times cheaper in Armenia
OC24	Mobile Tower	50000	$/unit	unofficial condensation	Mobile standalone light steel training tower	low	
OC25	Vehicle Extrication Pad	5000	$/unit	unofficial condensation	Dedicated space to train vehicle extrication	low	
OC26	Forcibly entry training	5000	$/unit	https://www.forcibleentry.com/ https://shop.tacticalinnovations.ca/breaching-door-multi-purpose-wood-insert-forcible-entry-training-door/	Standalone doors for forcible entry training	medium	

Code	Title	Cost	Quantity	Source	Description of the intervention	Reliability of the cost	Assumptions
OC27	Confined spaces - Type 1	1200	$/unit	KK & TN translators table	Horizontal Tunnels	low	50 meters concrete tunnels +2 x total cost (for installation and transport)
OC28	Confined spaces - Type 2	54000	$/unit	IR3 Retrofit	Vertical and horizontal tunnels	low	price is assumed to be 30% of the new construction, the area is assumed 200m2 (two storeys with area 100m2)
OC29	Small USAR facility	135000	$/unit	IR3 Retrofit	Small polygon (500 m2) with building debris to practice USAR operations	low	price is assumed to be 30% of the new constructions (900$), the total price of the USAR facilities are calculated with assumed area for small one 500m2, and for large one 1500m2
OC30	Large USAR facility	405000	$/unit	IR3 Retrofit	Large polygon (1500 m2) with building debris to practice USAR operations	low	https://rdgusa.com/projects/fsfc-urban-search-and-rescue-training-prop https://guardiancenters.com/multi-purpose-collapsed-structures
OC31	Training centre	3375000	$/m2	IR3 Retrofit	Integral training centre covering all essential training facilities	low	price is calculated with the price for new construction with area 2500m2, increased with 50% for the special training facilities
OC32	PC and IT equipment	500	$/unit	online sources	PC and IT equipment for the commander, deputy commander	medium	https://www.led.am/en/products/category/notebooks_1-10.html https://dgcomp.am/product-category/computers,notebooks/

Table A.2: List of interventions in Back-up systems

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BS1	EDG - 15kW	11,505	$/unit	https://www.absolutegenerators.com/industrial-diesel-generator-15-kw-standby-14-4-kw-prime-1800-rpm-single-phase-or-3-phase	diesel generator with running power 15 kW, use in ERC+FRS, and in major FRS in Yerevan, Gyumri and Vanadzor for FRS+ERC and regional stations in Yerevan, Vanadzor, Gyumri	medium	the price of all generators is increased with 10% to account for additional works for installation (separate fundament outside of building) and connection to the buildings electrical system https://en.wikipedia.org/wiki/Diesel_generator#/media/File:Caterpillar_(Olympian)_Generator_Set.jpg
BS2	EDG - 10kW	7150	$/unit	https://www.generac.com/Industrial/products/diesel-generators/configured/10kw	diesel generator with running power 10 kW, use in FRS with more than 3 trucks	medium	price assumed equal to https://hyundaipowerequipment.co.uk/generators/diesel-standy-silent-generators/up-to-10kw/hyundai-dhy9ksem-1500rpm-9kva-single-phase-diesel-generator/
BS3	EDG-5kW	4400	$/unit	https://www.circuitsathome.com/best-diesel-generator/	diesel generator with running power 5 kW, use in FRS with 2 or 3 trucks	medium	assumed that the emergency power supply is used for lighting and communication systems in the FRS, a
BS4	UPS 10kV	5000	$/unit	https://www.eaton.com/us/en-us/catalog/backup-power-ups-surge-it-power-distribution/eaton-9355-ups.html	online UPS for data centre, generator compatible (for ERC)	medium	I have no justification for these UPS types
BS5	UPS 1000V	220	$/unit	https://www.serverroomenvironments.co.uk/eaton-5s-1000i-1000va-tower-ups	online, generator compatible UPS with 4 outlets: 8 minutes working time at 70 % load	medium	assumed that the price is international
BS6	Water basin	50	$/m3	Book march, sent from TN&KK translators https://www.feldfire.com/	open water basin for back up water supply for the fire engines https://www.feldfire.com/Porta	low	price for hole, increased with 20% ZZ: price: from 88 to 250 dollars / cubic meter (depends on the size of the tank)

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
				Portable-Water-Tank--Steel-Frame_p_869.html	ble-Water-Tank--Steel-Frame_p_869.html		
BS7	Closed water basin	80	$/m3	Book march, sent from TN&KK translators https://watertankchina.en.made-in-china.com/product/SseEFXKJkgkh/China-Large-Volume-Bdf-Collapsible-Underground-Water-Tank.html	underground water basin for back up water supply with hydrant or smth for refilling the fire engines reservoirs	low	price for hole, increased with 50% ZZ 150 dollars / cubic meter
BS8	Fuel storage with canisters	15	$/l	baseline assessment	separate from the building closed storage for fuel canisters	medium	assumed 60 l barrel/canister on 1 m2 and cost for new building (the estimated fuel storage varies between the FRS from 60 to 500 l)
BS9	Fuel storage with filling station	45000	$/unit	https://www.quora.com/How-much-does-it-cost-to-build-a-gas-station-property-in-the-United-States	fuel storage with filling station	low	Sam Khowaya answer for tanks, canopy pumps, gas monitoring, cash register passport divided by 10 to scale it for one FRS
BS10	Back-up communication	1000	$/unit	https://bsar.org/manual/remote-area-communications/ https://www.securelandcommunications.com/segments/fire-and-rescue https://en.wikipedia.org/wiki/Terrestrial_Trunked_Radio	UHF radio system, mobile phones working with all operators, special smartphones for firefighters working with TETRA and apps for case reporting Signal repeaters	low	one unit is for one person

Table A.3: Lists with interventions for Building infrastructure

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI1	Building replacement with relocation	900	$/m2	IR3-Retrofit options	Building replacement with relocation	medium	cost for new construction, work and materials
BI2	Building replacement	1350	$/m2	IR3-Retrofit options	Building replacement	medium	cost for demolishing the old construction assumed half of the price for a new construction
BI3	Area expansion	900	$/m2	IR3-Retrofit options	Area expansion (up to 80 % of the tolerable area)	medium	cost for new construction
BI4	Vertical area expansion	900	$/m2	IR3-Retrofit options	Vertical area expansion (up to 50 % of the tolerable area)	medium	cost for new construction
BI5	Seismic retrofit - carbon fibre	270	$/m2	IR3-Retrofit options	Seismic retrofit - carbon fibre	medium	average price from all FRS
BI6	Seismic retrofit - conventional	135	$/m2	IR3-Retrofit options	Seismic retrofit - conventional	medium	average price from all FRS
BI7	Seismic retrofit - RC walls	165	$/m2	IR3-Retrofit options	Seismic retrofit - RC walls	medium	average price from all FRS
BI8	Roof repair - structure	20	$/m2	https://hayshin.am/remonti-gner/	Roof repair - structure	medium	work and materials (the price from the online site is multiplied by two), price of wood in KK/TN table is 258$/m3
BI9	Roof repair – hydro insulation	5	$/m2	https://hayshin.am/remonti-gner/	Roof repair – hydro insulation	medium	work and materials (the price from the online site is multiplied by two) KK/TN table - 2.5$/m2 price only for material
BI10	Roof repair - thermal insulation	5	$/m2	https://hayshin.am/remonti-gner/	Roof repair - thermal insulation	medium	work and materials (the price from the online site is multiplied by two)

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI11	Roof repair - cladding / tiles	12	$/m2	https://hayshin.am/remonti-gner/ KK/TN table	Roof repair - cladding / tiles	medium	The price in hayshin is 2$/m2. The price of metal sheathings in KK/TN table is 7$/m2. Assumed price 12$/m2
BI12	Walls - thermal insulation	10	$/m2	https://hayshin.am/remonti-gner/	Walls - thermal insulation	medium	work and materials (the price from the online site is multiplied by two)
BI13	Energy efficient windows	80	$/m2	https://www.construction.am/arm/companies/aleksi-ayvazyan-private-entrepreneur/ KK/TN transtators table	Energy efficient windows	medium	90$ per window for work and materials aleksi ayvazyan; average price per plastic / metal / aluminium window per m2 56$ (only materials, from KK/TN table)
BI14	Interior remodelling	150	$/m2	IR3-Retrofit options	Interior remodelling	medium	assumed 15% of the price for new construction
BI15	Inside cosmetic renovation	100	$/m2	IR3-Retrofit options	Inside cosmetic renovation	medium	assumed 10% of the price for new construction
BI16	Heating system - central heating system	50	$/m2	https://24market.am/product/alyumine-jerucman-radiator-global-mix-500/	Heating system - central heating system	medium	cost for installation and materials, assumed equal to the price for water pipes replacement + cost of radiators (the cost of radiator is given for segment ?)
BI17	Heating system - individual electric heaters	5	$/m2	https://gorciqner.am/product/ом-12нв-էլեկտրական-յուղով-տաքացուցիչ/	Heating system - individual electric heaters	medium	assumed 4 radiators each 100$ for heating 100m2, with ceiling height 2.5

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI18	Central HVAC	22	$/m2	https://www.google.co.uk/search?safe=active&ei=48ZDX9vsMemCjLsPybKVqAI&q=hvac+cost+per+square+meter&oq=hvac+cost+per+square+meter&gs_lcp=CgZwc3ktYWIQAzICCAA6BAgAEEc6BggAEBYQHlDqS1iWUWDmUWgAcAF4AIABlwGIAeADkgEDMC40mAEAoAEBqgEHZ3dzLXdpesABAQ&sclient=psy-ab&ved=0ahUKEwib6saM_7PrAhVpAWMBHUlZBSUQ4dUDCAs&uact=5	Central HVAC	medium	cost for installation and materials, assumed equal to the price for water pipes replacement
BI19	Air Conditioning	20	$/m2	https://vega.am/hy/klimat-kontrol/a-c/electrolux-eacs-i-12hm-n3-t.html	Air Conditioning	medium	assumed price for an air - conditioner with capacity 40m2, room height 2.5 - 750$, and individual air conditioners are applied in 15% of the building area
BI20	Garage heating devices	7	$/m2	https://www.amazon.co.uk/dp/B002G51BZU?tag=uk-tools-21	Garage heating devices	medium	assumed capacity 50m2, room height 4
BI21	El system replacement	20	$/m2	https://hayshin.am/remonti-gner/	El system replacement	medium	assumed half the price for water pipe replacement
BI22	Gas system replacement	40	$/m2	https://hayshin.am/remonti-gner/	Gas system replacement	medium	assumed equal to the price for water pipe replacement
BI23	Replacing water pipes	40	$/m2	https://hayshin.am/remonti-gner/	Replacing water pipes	medium	work and materials (the price from the online site is multiplied by two)
BI24	Remodelling sewage system (pipes)	40	$/m2	https://hayshin.am/remonti-gner/	Remodelling sewage system (pipes)	medium	assumed equal to the price for water pipe replacement

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI25	Garage - surface	10	$/m2	Book march, sent from TN&KK translators	Garage - surface	medium	2.2 price for concrete asphalt per m2, with thickness 10 cm, assumed surface cleaning preparations and work 8$
BI26	Garage - non-slip epoxy surface	10	$/m2	Book march, sent from TN&KK translators	Garage - non-slip epoxy surface	medium	price of an additive - 8 $/l (protective materials for concrete or stone (hydrophobizers) from KK/TN table), needed 0.3l per m2 (average for all additives for concrete is 3 $) equals 3$ per m2 + price for work : assumed 10 $/m2
BI27	Garage - drainage	10	$/m2	Book march, sent from TN&KK translators	Garage - drainage	medium	drilling and forming channel, pipes, coverage; roughly estimated 0.15x10m channel beneath the truck, 0.3/5m in front of the truck, price for metal pipes with these dimensions for bay: 300$, assumed price for work 100$:
BI28	Garage - new doors	12000	$/bay	https://raynor.com/commercial/fire-station-doors/ https://www.thegaragedoorcentre.co.uk/type-and-price-guide/Up-and-Over-Garage-Doors	Garage - new doors	low	automatic garage doors for single residential garage - average price from online British source 3500$, assumed price for FRS garage doors 4 times larger
BI29	Garage - improving doors	2000	$/bay	Book march, sent from TN&KK translators	Garage - improving doors	medium	new frame, new door simple non automatic, bi fold, with windows and thermal insulation, with assumed dimensions 4.5x4.5 price for materials: Frame 7$/m*13.5m=90$ metal sheets with insulation in between: 30$*4.5*4.5= 600$ + work
BI30	Fume exhaust system - source capture	3000	$/bay	https://www.fumeavent.com/fire-station-exhaust-removal	Fume exhaust system - source capture	medium	assumed cost in Armenia is equal to USA, without installation
BI31	Fume exhaust system - ventilation system	3000	$/bay	http://www.airvac911.com/system.html?utm_source=FR1_Product2	ventilation system with sensors for CO and NO and filters for fine particles and HC CO and NO	medium	Assumed with price comparable to the fume exhaust system ventilation system with sensors for CO2 and NO2 and filters for fine particles and S and N

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI32	Fire extinguisher system	1	$/m2	http://www.pozhmaster.am/ https://hakmanshop.am/en/catalog/security-systems https://www.amazon.com/Amerex-B500-Chemical-Class-Extinguisher/dp/B00F5CKJJU/ref=psdc_13400621_t2_B00F5CK9X6 https://firefightergarage.com/best-fire-extinguisher/	Dedicated only for the building and the garage fire extinguishers 10kg type ABCE every 50m2	medium	only dedicated for the building and the garage fire extinguishers type ABCE every 50m2, each cost
BI33	Fire detectors	25	$/m2	https://www.homeadvisor.com/cost/safety-and-security/smoke-co-detector-prices/	Fire detecting system, detecting heat and smoke, with sound and noise alarms	low	need information for number of fire detectors per square meter or per room in FRS
BI34	Automatic fire suppression system	30	$/m2	https://www.garagejournal.com/forum/showthread.php?t=5492	Fire detecting system, detecting heat and smoke, with sound and noise alarms with sprinklers connected to the plumbing system	medium	including system installation 10$ for home fire suppression system connected to the FRS plumbing + some additional water pipes
BI35	Cleaning and decontamination room	1500	$/unit	https://www.olx.bg/ad/nerazhdaemi-mivki-nerazhdaemi-plotove-dvoyni-mivki-edenichni-i-dr-CID1012-ID836hN.html https://www.signaturehardware.com/72-stainless-steel-double-well-wall-mount-commercial-sink.html	large stainless sinks, particulate cleaning machine, scrubbing tables, soak tanks, handheld sprayers, floor drain, foot scrubber, scrub brushes, drying area with good air ventilation	low	FRS with 7 people

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI36	Hose wash cleaning machine	783	$/unit	https://vatropromet.hr/en/fire-hose-washer-device-product-271/ https://www.firehosedirect.com/fire-hose-washers		medium	
BI37	Laundering equipment for FRS	5000	$/unit	https://www.fire-end.com/Equipment/Bunker-Gear-Washing-Machines	mail Ernie 10.09.2020	medium	FRS with 7 people
BI38	Bathroom (finishing materials, sinks, showers, etc)	708	$/unit	https://full.am/ru/view/Լվացարան-զուգարանակոնք/175415 https://www.facebook.com/govazdayinhaytararutyunner/posts/2226742044210321/ https://www.okdam.com/brizo-hand-shower	showers, sinks, toilets, hanging storage for PPE	medium	30m2 bathroom/showers in FRS with 7 people
BI39	Office furniture - desks, chairs, shelves	410	$/cabinet	https://www.kahuyq.info/object.php?ID=17804 https://office.am/grasenyakayin-ator-prestizh-sharzhakan-ator-sev-ktorits http://www.findglocal.com/AM/Yerevan/246414108820234/Դարակաշար	Office furniture - desks, chairs, shelves	medium	FRS with 7 people

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI40	Kitchen & dayroom - furniture	1580	$/kitchen	http://sarnaran.am/?product=samsung-rl28fbsi1-174-cm https://eldorado.am/en/catalog/catalog_large_home_appliances/microwave/ https://www.craftatoz.com/in/p/craftatoz-dinging-tables-set-with-dark-brown-finish-6-chairs/936 https://topx.am/hy/1271 https://beko.arstilbeko.am/texnikayi-xanut/katalog/tv/ https://ms-my.facebook.com/bazmoc.am/posts/602097269987389:0	refrigerator, oven / stoves, microwave, table, chairs, sofa, tv	medium	FRS with 7 people
BI41	Dormitory - furniture	2974	$/bedroom	https://www.walmart.ca/en/ip/Wooden-Iron-Wall-Shelf-Wall-Mounted-Storage-Rack-Organization-Holder-For-Bedroom-Kid-Room-Home-Decoration/1CIN9C55Q3IV https://harmar.am/hy/s59127318.html	beds, shelves, wardrobe	medium	FRS with 7 people
BI42	Meeting/training room - furniture & equipment	805	$/room	https://shinplaza.am/view/laminate-table-27 https://office.am/ator-grasenyakayin-fiqsvats-otqerov http://learnersupply.com/classroom-whiteboard	shelves, desks, whiteboard, projector	low	FRS with 7 people

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI43	Communication room - furniture	370	$/room	https://zakazidea.am/ikea-tesakani/mahtwakal_songesand/2019-04-15-78	Office furniture, storage shelves, bed	low	FRS with 7 people
BI44	Communication room - ICT equipment	5000	$/room		PC, telephone, radio, voice over internet (VOIP) phone	low	FRS with 7 people
BI45	Passive lightning protection	7	$/m2	https://www.homeadvisor.com/cost/environmental-safety/install-lightning-protection/ https://www.angieslist.com/articles/how-much-does-lightning-protection-system-cost.htm https://ecle.biz/coststudy/ https://www.indiamart.com/proddetail/franklin-lightning-copper-rod-12528662755.html https://www.facebook.com/682633651878376/posts/1182171821924554/	Grounded steel pole	medium	Average cost of materials and installation in US per m2 building area is 0.58$/ft2
BI46	Storage racks	150	$/unit	storage rack for three for three firefighters: (https://www.allhandsfire.com/Groves-Red-Rack-20-Wall-Mounted-Gear-Storage_2?Option=448)	Open storage racks for firefighters' ensembles	medium	one unit is for one firefighter Cost estimation based on materials from KK& TN translators table assumption: two types of steel profiles: hollow pipe: D=40mm, t=3mm, l=22m steel rod d=10mm, l=70m m1/m = 3.1415*(0.02^2-0.0185^2)*7850 = 1.42 kg/m m2/m = 0.617kg/m M=1.41*22 + 0.617*70 = 74 kg

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
							370 drams/kg * 74 kg = 27,457 drams = 57 dollars the price is double this price (because 57 dollars is for the steel profiles only) this means the price for 1 firefighter is: 38 dollars for 1 firefighter
BI47	Maintenance workshop	2000	$/unit		Price for equipment and tools	low	the price includes equipment and machinery
BI48	Electrical boiler	249	$/unit	https://dklux.com/za-da-e-toplo-v-kushti/elektricheski-uredi/120l-boiler-sus-serpentina-tesy-bilight-vertikalen	Electrical boiler 120 l	medium	FRS with 7 people
BI49	Gas boiler	567	$/unit	https://electro.am/hy/category/24-pati-gazi-katsaner-beretta	Gas boiler	medium	FRS with 7 people
BI50	Instant heating boiler	110	$/unit	https://aliexpress.ru/item/32867410461.html https://www.toolstation.com/strom-11kw-touch-instantaneous-water-heater/p78066	Instant heating boiler	medium	FRS with 7 people

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI51	Fitness equipment	890	$/unit	https://www.alibaba.com/product-detail/Professional-commercial-fitness-Smith-machine-gym_60677686180.html https://www.amazon.com/Day-Fitness-Dumbbell-Prevent-Rolling/dp/B07CC363RS/ref=sr_1_6?c=ts&dchild=1&keywords=Exercise+%26+Fitness+Dumbbells&m=ATVPDKIKX0DER&qid=1598338946&refinements=p_6%3AATVPDKIKX0DER&sr=8-6&ts_id=3408401 https://magnusdesign.co/product-eng-4628-Bent-pull-up-bar-for-ceiling-Magnus-Power-MP1021.html	Fitness equipment	medium	FRS with 7 people
BI52	Outside fitness area	1500	$/unit	https://www.reddit.com/r/bodyweightfitness/comments/cj8vkg/the_average_complete_cost_of_creating_an_outdoors/	calisthenics park – mostly pull up bars	medium	FRS with 7 people
BI53	Roof repair	35	$/m2	https://hayshin.am/remonti-gner/	Roof repair including all the above listed options	medium	work and materials
BI54	Solar water heater	2400	$/unit	https://energypedia.info/wiki/Solar_Water_Heater	Solar water heater, aera 2m2, 100l,	low	FRS with 5 or less people

code	title	cost	(per sq m, or per entity)	source	Description of the intervention	Reliability of the cost	assumptions
BI55	Intensive cleaning and repair centre	2000 0	$/unit	Unofficial conversation with experts	Intensive cleaning and repair centre in central locations	low	10 extensive cleaning centres for each region + 3 in Yerevan table investment recommendation 11.09.2020

Table A.4: List of interventions in Site infrastructure

code	title	cost	(per sq m, ot per entity)	source	Description of the intervention	Reliability of the cost	assumptions
SI1	Yard pavement	20	$/m2	Book march, sent from TN&KK translators	Yard pavement	medium	prices for concrete pavement blocks, to include labour, multiplied by two
SI2	Yard asphalt	50	$/m2	Book march, sent from TN&KK translators	Yard asphalt	medium	the price of the materials is around 100 $/t, the density is 2.5t/m3, for a layer with thickness 0.1m, 25$/m2, the cost for machinery and labour is assumed equal to the price of the materials
SI3	Automatic gate	2000	$/bay	https://howmuch.net/costs/driveway-gate-installation	Automatic gate for the site of the FRS	medium	

code	title	cost	(per sq m, ot per entity)	source	Description of the intervention	Reliability of the cost	assumptions
SI4	Automatic barrier	400	$/unit	https://safefence.co.uk/standard-manual-raise-arm-barrier.html https://safefence.co.uk/swing-access-gate.html https://aliexpress.ru/item/32369150435.html https://wejoin2010.en.made-in-china.com/product/OsAnStGjfhkC/China-Factory-Waterproof-Automatic-Boom-Barrier-Gate-for-Best-Price.html	Automatic barrier for the site of the FRS	medium	the cost of automatic park barrier is assumed 1000$ based on the cost of British manual barriers
SI5	Traffic light system	50000	$/unit	https://www.quora.com/How-much-does-a-traffic-light-cost https://wsdot.wa.gov/Operations/Traffic/signals.htm	Traffic light system	low	cost of traffic light in the states, divided by two. Cost excluding roadwork, buried conduit, etc is often around $100,000 or more. This would include mast arm poles, signal heads, controller cabinet, internal wiring, traffic detector loops, and the labour and equipment to install it. A complete project to signalize an intersection from scratch might be three to five times that amount, especially if purchase of right of way is necessary.
SI6	Retaining wall	26240	$/unit	Structural assessment report https://www.fixr.com/costs/retaining-wall-building https://www.homeadvisor.com/cost/landscape/install-a-retaining-wall/	in areas with reported mudflows/rockfalls,	medium	assumed price 690$/m', assumed length 50 m 4000 US dollars per 25 feet: 4000US$ x 2 (because we need 50 m) x 3.28 (feet to meter) {assumed length - 50m}

code	title	cost	(per sq m, ot per entity)	source	Description of the intervention	Reliability of the cost	assumptions
SI7	Drainage system	100	$/m	https://homeguide.com/costs/drainage-system-installation-cost https://www.costimates.com/costs/basements/interior-french-drain/	cost for labour, materials and design in areas with reported flooding's	medium	assumed on a perimeter around the building, twice as large as the building. The perimeter of the building is roughly estimated with the building area, assuming all buildings are squares
SI8	Surveillance system	400	$/unit	https://www.google.co.uk/search?safe=active&ei=iuVEX_P8MvLQxgOG-pn4CA&q=Surveillance+camera+cost&oq=Surveillance+camera+cost&gs_lcp=CgZwc3ktYWIQAzICCAAyAggAMgYIABAWEB4yBggAEBYQHjIGCAAQFhAeMgYIABAWEB4yBggAEBYQHjIGCAAQFhAeMgYIABAWEB4yBggAEBYQHjoECAAQQzoFCAAQkQI6AgguUJyzFljLyhZg6MsWaABwAHgBgAHbAogBlw2SAQc4LjEuMi4xmAEAoAEBqgEHZ3d zLXdpesABAQ&sclient=psy-ab&ved=0ahUKEwjz6aa8kLbrAhVyqHEKHQZ9Bo8Q4dUDCAw&uact=5	security cameras and monitoring / record keeping system	medium	assumed two cameras per fire station - at important locations (for example: front and back main door of the building) the price includes the camera, the setup and installation

code	title	cost	(per sq m, ot per entity)	source	Description of the intervention	Reliability of the cost	assumptions
SI9	Cable Internet access	240	$/month	https://www.numbeo.com/cost-of-living/prices_by_country.jsp?itemId=33	Internet access on site 60 Mbps or more	medium	initial price for installation is assumed equal to 12 monthly taxes
SI10	Back-up cable Internet access	240	$/month	https://www.numbeo.com/cost-of-living/prices_by_country.jsp?itemId=33	Back-up provider for cable Internet 60 Mbps or more	medium	initial price for installation is assumed equal to 12 monthly taxes
SI11	Rebuying shared parts	1	$/m2	-		low	For the purpose of the high-level cost estimation in this project this measure is included without a price, just as a recommendation

B. Application of Interventions to Individual FRSs

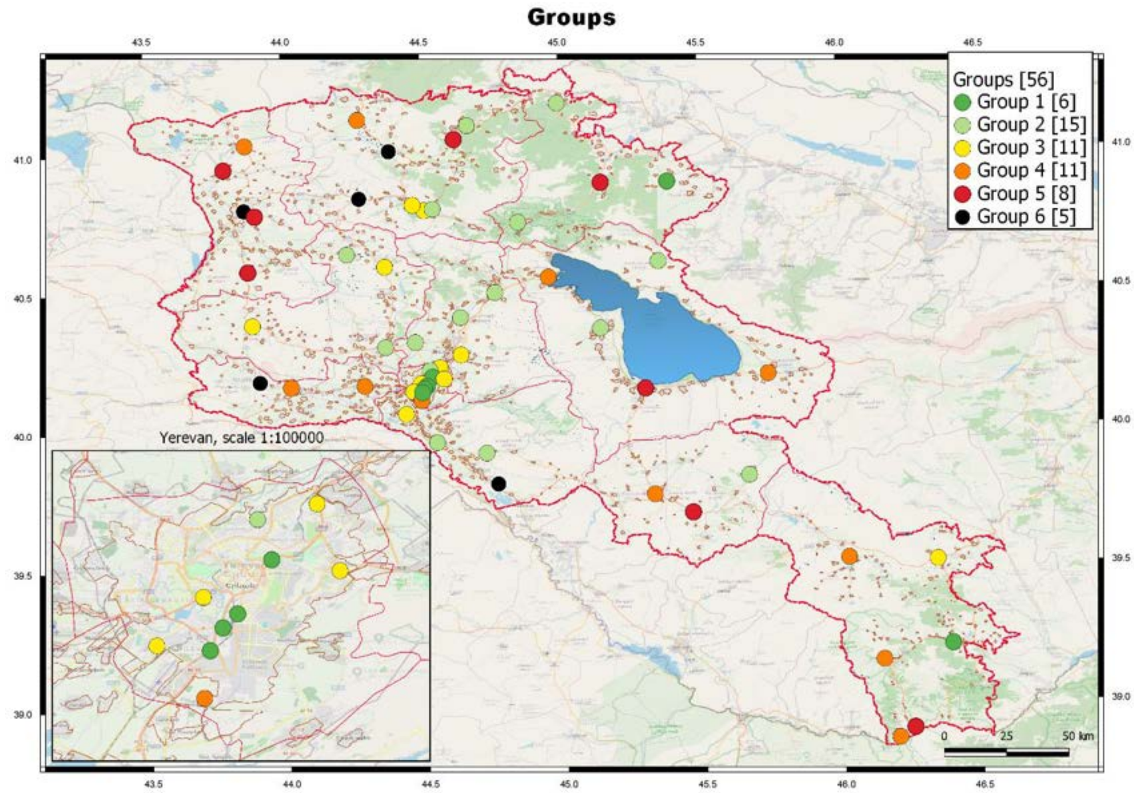
B.1 Groups, Options, Sets of Interventions

The criteria used for categorising the FRS into the groups described in Section 4.2 are provided in Table B.5 below. The groups in which each FRS is categorized are presented on Figure B.1

Table B.5: Criteria for categorising the FRS into 6 groups based on identified similar deficiencies

Group	Description	Criteria
Group 1 Without remarks	FRS with sufficient size of the infrastructure and no major issues	The FRS is not known to be planned for replacement, no hazards (rockfall, mudflow, floods, soil settlements) were reported for the site of the FRS, it is not with shared ownership, the building area is more than 80% of the tolerable building area, the garage height is more than 4 m
Group 2 Small sized infrastructure	FRS with insufficient size of the infrastructure and no major issues	The FRS is not known to be planned for replacement, no hazards (rockfall, mudflow, floods, soil settlements) were reported for the site of the FRS, it is not with shared ownership, the building area is between 25 and 80% of the tolerable building area
Group 3 Shared ownership	FRS with shared ownership	The FRS is with shared ownership
Group 4 Poor building infrastructure	FRS with insufficient size of the infrastructure, infrastructure in poor condition and with expected hazards on the site	The FRS is not known to be planned for replacement; it is not with shared ownership. Hazards from floods, mudflows or soil settlements can be expected or the building area is less than 25 % of the tolerable or the BII is Very poor. The site size allows building expansion and the site infrastructure index is at least Poor
Group 5 Poor building and site infrastructure	FRS with insufficient size of the infrastructure, infrastructure in poor condition and with expected hazards and additional problems on the site	The FRS is not planned for replacement, it is not with shared ownership. Hazards from floods, mudflows or soil settlements can be expected or the building area is less than 25% of the tolerable. The site size does not allow expansion, or the site infrastructure index is Very poor.
Group 6 Relocation	FRS known to be planned for relocation	The FRS is known to be planned for relocation

Figure B.1: Visited FRS in Armenia categorised by group



The four upgrade options described in 4.3 were defined ranging from repair and rehabilitation of existing buildings to new construction at a new site. The four options are also summarised in Table B.6

Table B.6: Definitions of the predefined upgrade options

Upgrade option	Description	Definition
Option 1 Repair	Interventions in the existing building and site	Seismic strengthening, remodelling to separate the functional zones and separate clean from contaminated areas, cosmetic renovation, new equipment and furniture, communication lines on site
Option 2 Expansion	Expansion of the building area and interventions in the existing building and site	Building area enlargement or rebuying shared parts, seismic strengthening, remodelling to separate the functional zones and separate clean from contaminated areas, cosmetic renovation, new equipment and furniture, communication lines on site.
Option 3 Replacement	Building replacement	New building on the same site
Option 4 Relocation	FRS relocation	Relocating the FRS in a new building on different location

The five classes as described in 4.3 defined to incorporate the size of the FRS are presented on Table B.7

Table B.7: Classification of the FRS based on the number of firefighters in one shift

Number of firefighters in one shift	Class
FRS with 5 or less firefighters in one shift	Class 4
FRS with 6 or 7 firefighters in one shift	Class 3
FRS with 8, 9, 10 firefighters in one shift	Class 2
FRS with more than 10 firefighters in one shift	Class 1
FRS and ERC	Class 0

Sets of measures, 22 in number, further scaled into subsets as explained in 4.3 are presented in tables Table B.8 to Table B.24.

B.1.1 Sets of Interventions for Option 1

Table B.8: Sets of interventions for Option 1, Group 1

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC3 - Emergency Tender - Type 1
OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC4 - Emergency Tender - Type 2
OC5 - Triple Combination Pumper	OC7 - Tanker Pumper Apparatus	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC5 - Triple Combination Pumper
OC7 - Tanker Pumper Apparatus	OC8 - Aerial Ladder	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC10 - Small Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC8 - Aerial Ladder
OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC10 - Small Rescue Vehicle
OC11 - Heavy Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC20 - PPE (SCBA)	OC21 - Tower - Type 1	OC11 - Heavy Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC21 - Tower - Type 1	OC32 - PC and IT equipment	OC12 - Snow Rescue Vehicle
OC13 - Swap body vehicles	OC20 - PPE (SCBA)	OC32 - PC and IT equipment	BS3 - EDG-5kW	OC13 - Swap body vehicles
OC15 - Structural Firefighting ensembles	OC21 - Tower - Type 1	BS2 - EDG - 10kW	BS5 - UPS 1000V	OC15 - Structural Firefighting ensembles
OC17 - Rescue equipment	OC23 - Tower - Type 3	BS5 - UPS 1000V	BS6 - Water basin	OC17 - Rescue equipment
OC18 - Heavy Rescue Equip.	OC25 - Vehicle Extrication Pad	BS6 - Water basin	BS10 - Back-up communication	OC18 - Heavy Rescue Equip.
OC20 - PPE (SCBA)	OC26 - Forcibly entry training	BS10 - Back-up communication	BI6 - Seismic retrofit - conventional	OC20 - PPE (SCBA)
OC21 - Tower - Type 1	OC27 - Confined spaces - Type 1	BI6 - Seismic retrofit - conventional	BI12 - Walls - thermal insulation	OC21 - Tower - Type 1

Class 1	Class 2	Class 3	Class 4	Class 0
OC23 - Tower - Type 3	OC32 - PC and IT equipment	BI12 - Walls - thermal insulation	BI13 - Energy efficient windows	OC23 - Tower - Type 3
OC25 - Vehicle Extrication Pad	BS2 - EDG - 10kW	BI13 - Energy efficient windows	BI14 - Interior remodelling	OC25 - Vehicle Extrication Pad
OC26 - Forcibly entry training	BS5 - UPS 1000V	BI14 - Interior remodelling	BI15 - Inside cosmetic renovation	OC26 - Forcibly entry training
OC28 - Confined spaces - Type 2	BS6 - Water basin	BI15 - Inside cosmetic renovation	BI17 - Heating system - individual electric heaters	OC28 - Confined spaces - Type 2
OC29 - Small USAR facility	BS8 - Fuel storage with canisters	BI17 - Heating system - individual electric heaters	BI20 - Garage heating devices	OC30 - Large USAR facility
OC32 - PC and IT equipment	BS10 - Back-up communication	BI20 - Garage heating devices	BI21 - El system replacement	OC32 - PC and IT equipment
BS1 - EDG - 15kW	BI6 - Seismic retrofit - conventional	BI21 - El system replacement	BI22 - Gas system replacement	BS1 - EDG - 15kW
BS4 - UPS 10kV	BI12 - Walls - thermal insulation	BI22 - Gas system replacement	BI23 - Replacing water pipes	BS4 - UPS 10kV
BS6 - Water basin	BI13 - Energy efficient windows	BI23 - Replacing water pipes	BI24 - Remodelling sewage system (pipes)	BS6 - Water basin
BS8 - Fuel storage with canisters	BI14 - Interior remodelling	BI24 - Remodelling sewage system (pipes)	BI25 - Garage - surface	BS8 - Fuel storage with canisters
BS10 - Back-up communication	BI15 - Inside cosmetic renovation	BI25 - Garage - surface	BI26 - Garage - non-slip epoxy surface	BS10 - Back-up communication
BI6 - Seismic retrofit - conventional	BI16 - Heating system - central heating system	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BI6 - Seismic retrofit - conventional
BI12 - Walls - thermal insulation	BI18 - Central HVAC	BI27 - Garage - drainage	BI28 - Garage - new doors	BI12 - Walls - thermal insulation
BI13 - Energy efficient windows	BI19 - Air Conditioning	BI28 - Garage - new doors	BI30 - Fume exhaust system - source capture	BI13 - Energy efficient windows
BI14 - Interior remodelling	BI20 - Garage heating devices	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI14 - Interior remodelling
BI15 - Inside cosmetic renovation	BI21 - El system replacement	BI31 - Fume exhaust system - ventilation system	BI32 - Fire extinguisher system	BI15 - Inside cosmetic renovation
BI16 - Heating system - central heating system	BI22 - Gas system replacement	BI32 - Fire extinguisher system	BI35 - Cleaning and decontamination room	BI16 - Heating system - central heating system
BI18 - Central HVAC	BI23 - Replacing water pipes	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI18 - Central HVAC
BI19 - Air Conditioning	BI24 - Remodelling sewage system (pipes)	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI19 - Air Conditioning
BI20 - Garage heating devices	BI25 - Garage - surface	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI20 - Garage heating devices
BI21 - El system replacement	BI26 - Garage - non-slip epoxy surface	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI21 - El system replacement

Class 1	Class 2	Class 3	Class 4	Class 0
BI22 - Gas system replacement	BI27 - Garage - drainage	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI22 - Gas system replacement
BI23 - Replacing water pipes	BI28 - Garage - new doors	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI23 - Replacing water pipes
BI24 - Remodelling sewage system (pipes)	BI30 - Fume exhaust system - source capture	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI24 - Remodelling sewage system (pipes)
BI25 - Garage - surface	BI31 - Fume exhaust system - ventilation system	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI25 - Garage - surface
BI26 - Garage - non-slip epoxy surface	BI32 - Fire extinguisher system	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI26 - Garage - non-slip epoxy surface
BI27 - Garage - drainage	BI33 - Fire detectors	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI27 - Garage - drainage
BI28 - Garage - new doors	BI35 - Cleaning and decontamination room	BI45 - Passive lightning protection	BI46 - Storage racks	BI28 - Garage - new doors
BI30 - Fume exhaust system - source capture	BI36 - Hose wash cleaning machine	BI46 - Storage racks	BI48 - Electrical boiler	BI30 - Fume exhaust system - source capture
BI31 - Fume exhaust system - ventilation system	BI37 - Laundering equipment for FRS	BI48 - Electrical boiler	BI51 - Fitness equipment	BI31 - Fume exhaust system - ventilation system
BI32 - Fire extinguisher system	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI51 - Fitness equipment	BI52 - Outside fitness area	BI32 - Fire extinguisher system
BI33 - Fire detectors	BI39 - Office furniture - desks, chairs, shelves	BI52 - Outside fitness area	BI53 - Roof repair	BI33 - Fire detectors
BI35 - Cleaning and decontamination room	BI40 - Kitchen & dayroom - furniture	BI53 - Roof repair	BI54 - Solar water heater	BI34 - Automatic fire suppression system
BI36 - Hose wash cleaning machine	BI41 - Dormitory - furniture	BI54 - Solar water heater	SI1 - Yard pavement	BI35 - Cleaning and decontamination room
BI37 - Laundering equipment for FRS	BI42 - Meeting/training room - furniture & equipment	SI1 - Yard pavement	SI2 - Yard asphalt	BI36 - Hose wash cleaning machine
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI43 - Communication room - furniture	SI2 - Yard asphalt	SI8 - Surveillance system	BI37 - Laundering equipment for FRS
BI39 - Office furniture - desks, chairs, shelves	BI44 - Communication room - ICT equipment	SI8 - Surveillance system	SI9 - Cable Internet access	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI40 - Kitchen & dayroom - furniture	BI45 - Passive lightning protection	SI9 - Cable Internet access	SI10 - Back-up cable Internet access	BI39 - Office furniture - desks, chairs, shelves
BI41 - Dormitory - furniture	BI46 - Storage racks	SI10 - Back-up cable Internet access		BI40 - Kitchen & dayroom - furniture
BI42 - Meeting/training room - furniture & equipment	BI47 - Maintenance workshop			BI41 - Dormitory - furniture
BI43 - Communication room - furniture	BI49 - Gas boiler			BI42 - Meeting/training room - furniture & equipment
BI44 - Communication room - ICT equipment	BI51 - Fitness equipment			BI43 - Communication room - furniture

Class 1	Class 2	Class 3	Class 4	Class 0
BI45 - Passive lightning protection	BI52 - Outside fitness area			BI44 - Communication room - ICT equipment
BI46 - Storage racks	BI53 - Roof repair			BI45 - Passive lightning protection
BI47 - Maintenance workshop	BI54 - Solar water heater			BI46 - Storage racks
BI49 - Gas boiler	BI55 - Intensive cleaing and repair centre			BI47 - Maintenance workshop
BI51 - Fitness equipment	SI1 - Yard pavement			BI49 - Gas boiler
BI52 - Outside fitness area	SI2 - Yard asphalt			BI51 - Fitness equipment
BI53 - Roof repair	SI4 - Automatic barrier			BI52 - Outside fitness area
BI54 - Solar water heater	SI8 - Surveillance system			BI53 - Roof repair
BI55 - Intensive cleaing and repair centre	SI9 - Cable Internet access			BI54 - Solar water heater
SI1 - Yard pavement	SI10 - Back-up cable Internet access			BI55 - Intensive cleaing and repair centre
SI2 - Yard asphalt				SI1 - Yard pavement
SI3 - Automatic gate				SI2 - Yard asphalt
SI4 - Automatic barrier				SI3 - Automatic gate
SI5 - Traffic light system				SI4 - Automatic barrier

Table B.9: Sets of interventions for Option 1, Group 2

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC7 - Tanker Pumper Apparatus	OC4 - Emergency Tender - Type 2
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC12 - Snow Rescue Vehicle	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC15 - Structural	OC8 - Aerial Ladder

			Firefighting ensembles	
OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC10 - Small Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC20 - PPE (SCBA)	OC12 - Snow Rescue Vehicle
OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC17 - Rescue equipment	OC32 - PC and IT equipment	OC15 - Structural Firefighting ensembles
OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	BS3 - EDG-5kW	OC17 - Rescue equipment
OC20 - PPE (SCBA)	OC21 - Tower - Type 1	OC21 - Tower - Type 1	BS5 - UPS 1000V	OC18 - Heavy Rescue Equip.
OC21 - Tower - Type 1	OC32 - PC and IT equipment	OC32 - PC and IT equipment	BS6 - Water basin	OC20 - PPE (SCBA)
OC25 - Vehicle Extrication Pad	BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS10 - Back-up communication	OC21 - Tower - Type 1
OC26 - Forcibly entry training	BS5 - UPS 1000V	BS5 - UPS 1000V	BI6 - Seismic retrofit - conventional	OC23 - Tower - Type 3
OC32 - PC and IT equipment	BS6 - Water basin	BS6 - Water basin	BI12 - Walls - thermal insulation	OC25 - Vehicle Extrication Pad
BS1 - EDG - 15kW	BS10 - Back-up communication	BS10 - Back-up communication	BI13 - Energy efficient windows	OC26 - Forcibly entry training
BS4 - UPS 10kV	BI6 - Seismic retrofit - conventional	BI6 - Seismic retrofit - conventional	BI14 - Interior remodelling	OC27 - Confined spaces - Type 1
BS6 - Water basin	BI12 - Walls - thermal insulation	BI12 - Walls - thermal insulation	BI15 - Inside cosmetic renovation	OC29 - Small USAR facility
BS10 - Back-up communication	BI13 - Energy efficient windows	BI13 - Energy efficient windows	BI17 - Heating system - individual electric heaters	OC32 - PC and IT equipment

BI6 - Seismic retrofit - conventional	BI14 - Interior remodelling	BI14 - Interior remodelling	BI20 - Garage heating devices	BS1 - EDG - 15kW
BI12 - Walls - thermal insulation	BI15 - Inside cosmetic renovation	BI15 - Inside cosmetic renovation	BI21 - El system replacement	BS4 - UPS 10kV
BI13 - Energy efficient windows	BI17 - Heating system - individual electric heaters	BI17 - Heating system - individual electric heaters	BI22 - Gas system replacement	BS6 - Water basin
BI14 - Interior remodelling	BI20 - Garage heating devices	BI20 - Garage heating devices	BI23 - Replacing water pipes	BS8 - Fuel storage with canisters
BI15 - Inside cosmetic renovation	BI21 - El system replacement	BI21 - El system replacement	BI24 - Remodelling sewage system (pipes)	BS10 - Back-up communication
BI16 - Heating system - central heating system	BI22 - Gas system replacement	BI22 - Gas system replacement	BI25 - Garage - surface	BI6 - Seismic retrofit - conventional
BI18 - Central HVAC	BI23 - Replacing water pipes	BI23 - Replacing water pipes	BI26 - Garage - non-slip epoxy surface	BI12 - Walls - thermal insulation
BI19 - Air Conditioning	BI24 - Remodelling sewage system (pipes)	BI24 - Remodelling sewage system (pipes)	BI27 - Garage - drainage	BI13 - Energy efficient windows
BI20 - Garage heating devices	BI25 - Garage - surface	BI25 - Garage - surface	BI29 - Garage - improving doors	BI14 - Interior remodelling
BI21 - El system replacement	BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI30 - Fume exhaust system - source capture	BI15 - Inside cosmetic renovation
BI22 - Gas system replacement	BI27 - Garage - drainage	BI27 - Garage - drainage	BI31 - Fume exhaust system - ventilation system	BI17 - Heating system - individual electric heaters
BI23 - Replacing water pipes	BI29 - Garage - improving doors	BI29 - Garage - improving doors	BI32 - Fire extinguisher system	BI18 - Central HVAC

BI24 - Remodelling sewage system (pipes)	BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI35 - Cleaning and decontaminatio n room	BI20 - Garage heating devices
BI25 - Garage - surface	BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI36 - Hose wash cleaning machine	BI21 - El system replacement
BI26 - Garage - non-slip epoxy surface	BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI37 - Laundering equipment for FRS	BI22 - Gas system replacement
BI27 - Garage - drainage	BI33 - Fire detectors	BI35 - Cleaning and decontaminatio n room	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI23 - Replacing water pipes
BI29 - Garage - improving doors	BI35 - Cleaning and decontaminatio n room	BI36 - Hose wash cleaning machine	BI39 - Office furniture - desks, chairs, shelves	BI24 - Remodelling sewage system (pipes)
BI30 - Fume exhaust system - source capture	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI40 - Kitchen & dayroom - furniture	BI25 - Garage - surface
BI31 - Fume exhaust system - ventilation system	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI41 - Dormitory - furniture	BI26 - Garage - non-slip epoxy surface
BI32 - Fire extinguisher system	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI42 - Meeting/trainin g room - furniture & equipment	BI27 - Garage - drainage
BI33 - Fire detectors	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI43 - Communication room - furniture	BI29 - Garage - improving doors
BI35 - Cleaning and	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI44 - Communication	BI30 - Fume exhaust system - source capture

decontamination room			room - ICT equipment	
BI36 - Hose wash cleaning machine	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI45 - Passive lightning protection	BI31 - Fume exhaust system - ventilation system
BI37 - Laundering equipment for FRS	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI46 - Storage racks	BI32 - Fire extinguisher system
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI48 - Electrical boiler	BI33 - Fire detectors
BI39 - Office furniture - desks, chairs, shelves	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI51 - Fitness equipment	BI34 - Automatic fire suppression system
BI40 - Kitchen & dayroom - furniture	BI45 - Passive lightning protection	BI46 - Storage racks	BI52 - Outside fitness area	BI35 - Cleaning and decontamination room
BI41 - Dormitory - furniture	BI46 - Storage racks	BI48 - Electrical boiler	BI53 - Roof repair	BI36 - Hose wash cleaning machine
BI42 - Meeting/training room - furniture & equipment	BI49 - Gas boiler	BI51 - Fitness equipment	BI54 - Solar water heater	BI37 - Laundering equipment for FRS
BI43 - Communication room - furniture	BI51 - Fitness equipment	BI52 - Outside fitness area	SI1 - Yard pavement	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI44 - Communication room - ICT equipment	BI52 - Outside fitness area	BI53 - Roof repair	SI2 - Yard asphalt	BI39 - Office furniture - desks, chairs, shelves

BI45 - Passive lightning protection	BI53 - Roof repair	BI54 - Solar water heater	SI8 - Surveillance system	BI40 - Kitchen & dayroom - furniture
BI46 - Storage racks	BI54 - Solar water heater	SI1 - Yard pavement	SI9 - Cable Internet access	BI41 - Dormitory - furniture
BI49 - Gas boiler	SI1 - Yard pavement	SI2 - Yard asphalt	SI10 - Back-up cable Internet access	BI42 - Meeting/training room - furniture & equipment
BI51 - Fitness equipment	SI2 - Yard asphalt	SI8 - Surveillance system		BI43 - Communication room - furniture
BI52 - Outside fitness area	SI4 - Automatic barrier	SI9 - Cable Internet access		BI44 - Communication room - ICT equipment
BI53 - Roof repair	SI8 - Surveillance system	SI10 - Back-up cable Internet access		BI45 - Passive lightning protection
BI54 - Solar water heater	SI9 - Cable Internet access			BI46 - Storage racks
SI1 - Yard pavement	SI10 - Back-up cable Internet access			BI49 - Gas boiler
SI2 - Yard asphalt				BI51 - Fitness equipment
SI3 - Automatic gate				BI52 - Outside fitness area
SI4 - Automatic barrier				BI53 - Roof repair
SI5 - Traffic light system				BI54 - Solar water heater
SI8 - Surveillance system				SI1 - Yard pavement
SI9 - Cable Internet access				SI2 - Yard asphalt

SI10 - Back-up cable Internet access				SI3 - Automatic gate
				SI4 - Automatic barrier
				SI5 - Traffic light system
				SI8 - Surveillance system
				SI9 - Cable Internet access

Table B.10: Sets of interventions for Option 1, Group 3

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC4 - Emergency Tender - Type 2
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC8 - Aerial Ladder
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC10 - Small Rescue Vehicle
OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC12 - Snow Rescue Vehicle
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC15 - Structural Firefighting ensembles
OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC21 - Tower - Type 1	OC17 - Rescue equipment

Class 1	Class 2	Class 3	Class 4	Class 0
OC21 - Tower - Type 1	OC21 - Tower - Type 1	OC21 - Tower - Type 1	OC32 - PC and IT equipment	OC20 - PPE (SCBA)
OC25 - Vehicle Extrication Pad	OC32 - PC and IT equipment	OC32 - PC and IT equipment	BS2 - EDG - 10kW	OC21 - Tower - Type 1
OC26 - Forcibly entry training	BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS5 - UPS 1000V	OC25 - Vehicle Extrication Pad
OC32 - PC and IT equipment	BS5 - UPS 1000V	BS5 - UPS 1000V	BS10 - Back-up communication	OC26 - Forcibly entry training
BS1 - EDG - 15kW	BS10 - Back-up communication	BS10 - Back-up communication	BI12 - Walls - thermal insulation	OC27 - Confined spaces - Type 1
BS4 - UPS 10kV	BI12 - Walls - thermal insulation	BI12 - Walls - thermal insulation	BI13 - Energy efficient windows	OC29 - Small USAR facility
BS7 - Closed water basin	BI13 - Energy efficient windows	BI13 - Energy efficient windows	BI14 - Interior remodelling	OC32 - PC and IT equipment
BS10 - Back-up communication	BI14 - Interior remodelling	BI14 - Interior remodelling	BI15 - Inside cosmetic renovation	BS1 - EDG - 15kW
BI12 - Walls - thermal insulation	BI15 - Inside cosmetic renovation	BI15 - Inside cosmetic renovation	BI17 - Heating system - individual electric heaters	BS4 - UPS 10kV
BI13 - Energy efficient windows	BI17 - Heating system - individual electric heaters	BI17 - Heating system - individual electric heaters	BI20 - Garage heating devices	BS7 - Closed water basin
BI14 - Interior remodelling	BI19 - Air Conditioning	BI20 - Garage heating devices	BI21 - El system replacement	BS8 - Fuel storage with canisters
BI15 - Inside cosmetic renovation	BI20 - Garage heating devices	BI21 - El system replacement	BI22 - Gas system replacement	BS10 - Back-up communication
BI17 - Heating system - individual electric heaters	BI21 - El system replacement	BI22 - Gas system replacement	BI25 - Garage - surface	BI12 - Walls - thermal insulation
BI19 - Air Conditioning	BI22 - Gas system replacement	BI25 - Garage - surface	BI26 - Garage - non-slip epoxy surface	BI13 - Energy efficient windows

Class 1	Class 2	Class 3	Class 4	Class 0
BI20 - Garage heating devices	BI25 - Garage - surface	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BI14 - Interior remodelling
BI21 - El system replacement	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BI29 - Garage - improving doors	BI15 - Inside cosmetic renovation
BI22 - Gas system replacement	BI27 - Garage - drainage	BI29 - Garage - improving doors	BI30 - Fume exhaust system - source capture	BI16 - Heating system - central heating system
BI25 - Garage - surface	BI29 - Garage - improving doors	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI18 - Central HVAC
BI26 - Garage - non-slip epoxy surface	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI32 - Fire extinguisher system	BI20 - Garage heating devices
BI27 - Garage - drainage	BI31 - Fume exhaust system - ventilation system	BI32 - Fire extinguisher system	BI33 - Fire detectors	BI21 - El system replacement
BI29 - Garage - improving doors	BI32 - Fire extinguisher system	BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI22 - Gas system replacement
BI30 - Fume exhaust system - source capture	BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI25 - Garage - surface
BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI26 - Garage - non-slip epoxy surface
BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI27 - Garage - drainage
BI33 - Fire detectors	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI29 - Garage - improving doors

Class 1	Class 2	Class 3	Class 4	Class 0
BI35 - Cleaning and decontamination room	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI30 - Fume exhaust system - source capture
BI36 - Hose wash cleaning machine	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI31 - Fume exhaust system - ventilation system
BI37 - Laundering equipment for FRS	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI32 - Fire extinguisher system
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI33 - Fire detectors
BI39 - Office furniture - desks, chairs, shelves	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI34 - Automatic fire suppression system
BI40 - Kitchen & dayroom - furniture	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI35 - Cleaning and decontamination room
BI41 - Dormitory - furniture	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI46 - Storage racks	BI36 - Hose wash cleaning machine
BI42 - Meeting/training room - furniture & equipment	BI45 - Passive lightning protection	BI46 - Storage racks	BI48 - Electrical boiler	BI37 - Laundering equipment for FRS
BI43 - Communication room - furniture	BI46 - Storage racks	BI48 - Electrical boiler	BI51 - Fitness equipment	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI44 - Communication room - ICT equipment	BI49 - Gas boiler	BI51 - Fitness equipment	BI54 - Solar water heater	BI39 - Office furniture - desks, chairs, shelves

Class 1	Class 2	Class 3	Class 4	Class 0
BI45 - Passive lightning protection	BI51 - Fitness equipment	BI54 - Solar water heater	SI1 - Yard pavement	BI40 - Kitchen & dayroom - furniture
BI46 - Storage racks	BI54 - Solar water heater	SI1 - Yard pavement	SI9 - Cable Internet access	BI41 - Dormitory - furniture
BI49 - Gas boiler	SI1 - Yard pavement	SI9 - Cable Internet access	SI10 - Back-up cable Internet access	BI42 - Meeting/training room - furniture & equipment
BI51 - Fitness equipment	SI9 - Cable Internet access	SI10 - Back-up cable Internet access		BI43 - Communication room - furniture
BI54 - Solar water heater	SI10 - Back-up cable Internet access			BI44 - Communication room - ICT equipment
SI1 - Yard pavement				BI45 - Passive lightning protection

Table B.11: Sets of interventions for Option 1, Group 4

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC4 - Emergency Tender - Type 2
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC8 - Aerial Ladder
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC10 - Small Rescue Vehicle

Class 1	Class 2	Class 3	Class 4	Class 0
OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC12 - Snow Rescue Vehicle
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC15 - Structural Firefighting ensembles
OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC32 - PC and IT equipment	OC17 - Rescue equipment
OC21 - Tower - Type 1	OC21 - Tower - Type 1	OC21 - Tower - Type 1	BS3 - EDG-5kW	OC20 - PPE (SCBA)
OC32 - PC and IT equipment	OC32 - PC and IT equipment	OC32 - PC and IT equipment	BS5 - UPS 1000V	OC21 - Tower - Type 1
BS1 - EDG - 15kW	BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS10 - Back-up communication	OC23 - Tower - Type 3
BS4 - UPS 10kV	BS5 - UPS 1000V	BS5 - UPS 1000V	BI6 - Seismic retrofit - conventional	OC25 - Vehicle Extrication Pad
BS7 - Closed water basin	BS10 - Back-up communication	BS10 - Back-up communication	BI12 - Walls - thermal insulation	OC26 - Forcibly entry training
BS10 - Back-up communication	BI6 - Seismic retrofit - conventional	BI6 - Seismic retrofit - conventional	BI13 - Energy efficient windows	OC28 - Confined spaces - Type 2
BI6 - Seismic retrofit - conventional	BI12 - Walls - thermal insulation	BI12 - Walls - thermal insulation	BI14 - Interior remodelling	OC29 - Small USAR facility
BI12 - Walls - thermal insulation	BI13 - Energy efficient windows	BI13 - Energy efficient windows	BI15 - Inside cosmetic renovation	OC32 - PC and IT equipment
BI13 - Energy efficient windows	BI14 - Interior remodelling	BI14 - Interior remodelling	BI17 - Heating system - individual electric heaters	BS1 - EDG - 15kW
BI14 - Interior remodelling	BI15 - Inside cosmetic renovation	BI15 - Inside cosmetic renovation	BI20 - Garage heating devices	BS4 - UPS 10kV
BI15 - Inside cosmetic renovation	BI17 - Heating system -	BI17 - Heating system -	BI21 - El system replacement	BS7 - Closed water basin

Class 1	Class 2	Class 3	Class 4	Class 0
	individual electric heaters	individual electric heaters		
BI16 - Heating system - central heating system	BI20 - Garage heating devices	BI20 - Garage heating devices	BI22 - Gas system replacement	BS8 - Fuel storage with canisters
BI18 - Central HVAC	BI21 - El system replacement	BI21 - El system replacement	BI23 - Replacing water pipes	BS10 - Back-up communication
BI20 - Garage heating devices	BI22 - Gas system replacement	BI22 - Gas system replacement	BI24 - Remodelling sewage system (pipes)	BI6 - Seismic retrofit - conventional
BI21 - El system replacement	BI23 - Replacing water pipes	BI23 - Replacing water pipes	BI25 - Garage - surface	BI12 - Walls - thermal insulation
BI22 - Gas system replacement	BI24 - Remodelling sewage system (pipes)	BI24 - Remodelling sewage system (pipes)	BI26 - Garage - non-slip epoxy surface	BI13 - Energy efficient windows
BI23 - Replacing water pipes	BI25 - Garage - surface	BI25 - Garage - surface	BI27 - Garage - drainage	BI14 - Interior remodelling
BI24 - Remodelling sewage system (pipes)	BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI29 - Garage - improving doors	BI15 - Inside cosmetic renovation
BI25 - Garage - surface	BI27 - Garage - drainage	BI27 - Garage - drainage	BI30 - Fume exhaust system - source capture	BI17 - Heating system - individual electric heaters
BI26 - Garage - non-slip epoxy surface	BI29 - Garage - improving doors	BI29 - Garage - improving doors	BI31 - Fume exhaust system - ventilation system	BI18 - Central HVAC
BI27 - Garage - drainage	BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI32 - Fire extinguisher system	BI20 - Garage heating devices
BI29 - Garage - improving doors	BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI21 - El system replacement

Class 1	Class 2	Class 3	Class 4	Class 0
BI30 - Fume exhaust system - source capture	BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI22 - Gas system replacement
BI31 - Fume exhaust system - ventilation system	BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI37 - Laundering equipment for FRS	BI23 - Replacing water pipes
BI32 - Fire extinguisher system	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI24 - Remodelling sewage system (pipes)
BI33 - Fire detectors	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI39 - Office furniture - desks, chairs, shelves	BI25 - Garage - surface
BI35 - Cleaning and decontamination room	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI40 - Kitchen & dayroom - furniture	BI26 - Garage - non-slip epoxy surface
BI36 - Hose wash cleaning machine	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI41 - Dormitory - furniture	BI27 - Garage - drainage
BI37 - Laundering equipment for FRS	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI42 - Meeting/training room - furniture & equipment	BI29 - Garage - improving doors
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI43 - Communication room - furniture	BI30 - Fume exhaust system - source capture
BI39 - Office furniture - desks, chairs, shelves	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI44 - Communication room - ICT equipment	BI31 - Fume exhaust system - ventilation system
BI40 - Kitchen & dayroom - furniture	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI45 - Passive lightning protection	BI32 - Fire extinguisher system

Class 1	Class 2	Class 3	Class 4	Class 0
BI41 - Dormitory - furniture	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI46 - Storage racks	BI33 - Fire detectors
BI42 - Meeting/training room - furniture & equipment	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI48 - Electrical boiler	BI34 - Automatic fire suppression system
BI43 - Communication room - furniture	BI45 - Passive lightning protection	BI46 - Storage racks	BI51 - Fitness equipment	BI35 - Cleaning and decontamination room
BI44 - Communication room - ICT equipment	BI46 - Storage racks	BI48 - Electrical boiler	BI52 - Outside fitness area	BI36 - Hose wash cleaning machine
BI45 - Passive lightning protection	BI49 - Gas boiler	BI51 - Fitness equipment	BI53 - Roof repair	BI37 - Laundering equipment for FRS
BI46 - Storage racks	BI51 - Fitness equipment	BI52 - Outside fitness area	BI54 - Solar water heater	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI49 - Gas boiler	BI52 - Outside fitness area	BI53 - Roof repair	SI1 - Yard pavement	BI39 - Office furniture - desks, chairs, shelves
BI51 - Fitness equipment	BI53 - Roof repair	BI54 - Solar water heater	SI2 - Yard asphalt	BI40 - Kitchen & dayroom - furniture
BI52 - Outside fitness area	BI54 - Solar water heater	SI1 - Yard pavement	SI6 - Retaining wall	BI41 - Dormitory - furniture
BI53 - Roof repair	SI1 - Yard pavement	SI2 - Yard asphalt	SI7 - Drainage system	BI42 - Meeting/training room - furniture & equipment
BI54 - Solar water heater	SI2 - Yard asphalt	SI6 - Retaining wall	SI8 - Surveillance system	BI43 - Communication room - furniture

Class 1	Class 2	Class 3	Class 4	Class 0
SI1 - Yard pavement	SI4 - Automatic barrier	SI7 - Drainage system	SI9 - Cable Internet access	BI44 - Communication room - ICT equipment
SI2 - Yard asphalt	SI6 - Retaining wall	SI8 - Surveillance system	SI10 - Back-up cable Internet access	BI45 - Passive lightning protection
SI3 - Automatic gate	SI7 - Drainage system	SI9 - Cable Internet access		BI46 - Storage racks
SI4 - Automatic barrier	SI8 - Surveillance system	SI10 - Back-up cable Internet access		BI49 - Gas boiler
SI5 - Traffic light system	SI9 - Cable Internet access			BI51 - Fitness equipment
SI6 - Retaining wall	SI10 - Back-up cable Internet access			BI52 - Outside fitness area
SI7 - Drainage system				BI53 - Roof repair
SI8 - Surveillance system				BI54 - Solar water heater
SI9 - Cable Internet access				SI1 - Yard pavement
SI10 - Back-up cable Internet access				SI2 - Yard asphalt
				SI3 - Automatic gate
				SI4 - Automatic barrier
				SI5 - Traffic light system
				SI6 - Retaining wall
				SI7 - Drainage system
				SI8 - Surveillance system

Class 1	Class 2	Class 3	Class 4	Class 0
				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

Table B.12: Sets of interventions for Option 1, Group 5

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC8 - Aerial Ladder
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC10 - Small Rescue Vehicle
OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC12 - Snow Rescue Vehicle
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC15 - Structural Firefighting ensembles
OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC32 - PC and IT equipment	OC17 - Rescue equipment
OC21 - Tower - Type 1	OC21 - Tower - Type 1	OC21 - Tower - Type 1	BS3 - EDG-5kW	OC20 - PPE (SCBA)
OC32 - PC and IT equipment	OC32 - PC and IT equipment	OC32 - PC and IT equipment	BS5 - UPS 1000V	OC32 - PC and IT equipment
BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS10 - Back-up communication	BS1 - EDG - 15kW

Class 1	Class 2	Class 3	Class 4	Class 0
BS5 - UPS 1000V	BS5 - UPS 1000V	BS5 - UPS 1000V	BI6 - Seismic retrofit - conventional	BS4 - UPS 10kV
BS10 - Back-up communication	BS10 - Back-up communication	BS10 - Back-up communication	BI12 - Walls - thermal insulation	BS7 - Closed water basin
BI6 - Seismic retrofit - conventional	BI6 - Seismic retrofit - conventional	BI6 - Seismic retrofit - conventional	BI13 - Energy efficient windows	BS10 - Back-up communication
BI12 - Walls - thermal insulation	BI12 - Walls - thermal insulation	BI12 - Walls - thermal insulation	BI14 - Interior remodelling	BI6 - Seismic retrofit - conventional
BI13 - Energy efficient windows	BI13 - Energy efficient windows	BI13 - Energy efficient windows	BI15 - Inside cosmetic renovation	BI12 - Walls - thermal insulation
BI14 - Interior remodelling	BI14 - Interior remodelling	BI14 - Interior remodelling	BI17 - Heating system - individual electric heaters	BI13 - Energy efficient windows
BI15 - Inside cosmetic renovation	BI15 - Inside cosmetic renovation	BI15 - Inside cosmetic renovation	BI20 - Garage heating devices	BI14 - Interior remodelling
BI17 - Heating system - individual electric heaters	BI17 - Heating system - individual electric heaters	BI17 - Heating system - individual electric heaters	BI21 - El system replacement	BI15 - Inside cosmetic renovation
BI20 - Garage heating devices	BI20 - Garage heating devices	BI20 - Garage heating devices	BI22 - Gas system replacement	BI17 - Heating system - individual electric heaters
BI21 - El system replacement	BI21 - El system replacement	BI21 - El system replacement	BI23 - Replacing water pipes	BI18 - Central HVAC
BI22 - Gas system replacement	BI22 - Gas system replacement	BI22 - Gas system replacement	BI24 - Remodelling sewage system (pipes)	BI20 - Garage heating devices
BI23 - Replacing water pipes	BI23 - Replacing water pipes	BI23 - Replacing water pipes	BI25 - Garage - surface	BI21 - El system replacement

Class 1	Class 2	Class 3	Class 4	Class 0
BI24 - Remodelling sewage system (pipes)	BI24 - Remodelling sewage system (pipes)	BI24 - Remodelling sewage system (pipes)	BI26 - Garage - non-slip epoxy surface	BI22 - Gas system replacement
BI25 - Garage - surface	BI25 - Garage - surface	BI25 - Garage - surface	BI27 - Garage - drainage	BI23 - Replacing water pipes
BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI29 - Garage - improving doors	BI24 - Remodelling sewage system (pipes)
BI27 - Garage - drainage	BI27 - Garage - drainage	BI27 - Garage - drainage	BI30 - Fume exhaust system - source capture	BI25 - Garage - surface
BI29 - Garage - improving doors	BI29 - Garage - improving doors	BI29 - Garage - improving doors	BI31 - Fume exhaust system - ventilation system	BI26 - Garage - non-slip epoxy surface
BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI32 - Fire extinguisher system	BI27 - Garage - drainage
BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI29 - Garage - improving doors
BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI30 - Fume exhaust system - source capture
BI33 - Fire detectors	BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI37 - Laundering equipment for FRS	BI31 - Fume exhaust system - ventilation system
BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI32 - Fire extinguisher system
BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI39 - Office furniture - desks, chairs, shelves	BI33 - Fire detectors

Class 1	Class 2	Class 3	Class 4	Class 0
BI37 - Laundering equipment for FRS	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI40 - Kitchen & dayroom - furniture	BI34 - Automatic fire suppression system
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI41 - Dormitory - furniture	BI35 - Cleaning and decontamination room
BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI42 - Meeting/training room - furniture & equipment	BI36 - Hose wash cleaning machine
BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI43 - Communication room - furniture	BI37 - Laundering equipment for FRS
BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI44 - Communication room - ICT equipment	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI45 - Passive lightning protection	BI39 - Office furniture - desks, chairs, shelves
BI43 - Communication room - furniture	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI46 - Storage racks	BI40 - Kitchen & dayroom - furniture
BI44 - Communication room - ICT equipment	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI48 - Electrical boiler	BI41 - Dormitory - furniture
BI45 - Passive lightning protection	BI45 - Passive lightning protection	BI46 - Storage racks	BI51 - Fitness equipment	BI42 - Meeting/training room - furniture & equipment
BI46 - Storage racks	BI46 - Storage racks	BI48 - Electrical boiler	BI53 - Roof repair	BI43 - Communication room - furniture

Class 1	Class 2	Class 3	Class 4	Class 0
BI49 - Gas boiler	BI49 - Gas boiler	BI51 - Fitness equipment	BI54 - Solar water heater	BI44 - Communication room - ICT equipment
BI51 - Fitness equipment	BI51 - Fitness equipment	BI53 - Roof repair	SI1 - Yard pavement	BI45 - Passive lightning protection
BI53 - Roof repair	BI53 - Roof repair	BI54 - Solar water heater	SI2 - Yard asphalt	BI46 - Storage racks
BI54 - Solar water heater	BI54 - Solar water heater	SI1 - Yard pavement	SI6 - Retaining wall	BI49 - Gas boiler
SI1 - Yard pavement	SI1 - Yard pavement	SI2 - Yard asphalt	SI7 - Drainage system	BI51 - Fitness equipment
SI2 - Yard asphalt	SI2 - Yard asphalt	SI6 - Retaining wall	SI8 - Surveillance system	BI53 - Roof repair
SI4 - Automatic barrier	SI4 - Automatic barrier	SI7 - Drainage system	SI9 - Cable Internet access	BI54 - Solar water heater
SI6 - Retaining wall	SI6 - Retaining wall	SI8 - Surveillance system	SI10 - Back-up cable Internet access	SI1 - Yard pavement
SI7 - Drainage system	SI7 - Drainage system	SI9 - Cable Internet access		SI2 - Yard asphalt
SI8 - Surveillance system	SI8 - Surveillance system	SI10 - Back-up cable Internet access		SI3 - Automatic gate
SI9 - Cable Internet access	SI9 - Cable Internet access			SI4 - Automatic barrier
SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access			SI5 - Traffic light system
				SI6 - Retaining wall
				SI7 - Drainage system
				SI8 - Surveillance system
				SI9 - Cable Internet access

Class 1	Class 2	Class 3	Class 4	Class 0
				SI10 - Back-up cable Internet access

Table B.13: Sets of interventions for Option 1, Group 6

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC10 - Small Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC12 - Snow Rescue Vehicle

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC15 - Structural Firefighting ensembles
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC17 - Rescue equipment
OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC32 - PC and IT equipment	OC20 - PPE (SCBA)
OC32 - PC and IT equipment	OC32 - PC and IT equipment	OC32 - PC and IT equipment	BS3 - EDG-5kW	OC32 - PC and IT equipment
BS3 - EDG-5kW	BS3 - EDG-5kW	BS3 - EDG-5kW	BS5 - UPS 1000V	BS3 - EDG-5kW
BS4 - UPS 10kV	BS4 - UPS 10kV	BS5 - UPS 1000V	BS10 - Back-up communication	BS4 - UPS 10kV
BS10 - Back-up communication	BS10 - Back-up communication	BS10 - Back-up communication	BI21 - El system replacement	BS10 - Back-up communication
BI21 - El system replacement	BI21 - El system replacement	BI21 - El system replacement	BI22 - Gas system replacement	BI21 - El system

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
				replacement
BI22 - Gas system replacement	BI22 - Gas system replacement	BI22 - Gas system replacement	BI44 - Communication room - ICT equipment	BI22 - Gas system replacement
BI44 - Communication room - ICT equipment	BI44 - Communication room - ICT equipment	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI44 - Communication room - ICT equipment
BI45 - Passive lightning protection	BI45 - Passive lightning protection	BI45 - Passive lightning protection	BI46 - Storage racks	BI45 - Passive lightning protection
BI46 - Storage racks	BI46 - Storage racks	BI46 - Storage racks	SI9 - Cable Internet access	BI46 - Storage racks
SI9 - Cable Internet access	SI9 - Cable Internet access	SI9 - Cable Internet access	SI10 - Back-up cable Internet access	SI9 - Cable Internet access
SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access		SI10 - Back-up cable Interne

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
				t access
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus

B.1.2 Sets of Interventions for Option 2

Table B.14: Sets of interventions for Option 2, Group 1

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC3 - Emergency Tender - Type 1
OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC4 - Emergency Tender - Type 2
OC5 - Triple Combination Pumper	OC7 - Tanker Pumper Apparatus	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC5 - Triple Combination Pumper

Class 1	Class 2	Class 3	Class 4	Class 0
OC7 - Tanker Pumper Apparatus	OC8 - Aerial Ladder	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC10 - Small Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC8 - Aerial Ladder
OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC10 - Small Rescue Vehicle
OC11 - Heavy Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC20 - PPE (SCBA)	OC21 - Tower - Type 1	OC11 - Heavy Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC21 - Tower - Type 1	OC32 - PC and IT equipment	OC12 - Snow Rescue Vehicle
OC13 - Swap body vehicles	OC20 - PPE (SCBA)	OC32 - PC and IT equipment	BS3 - EDG-5kW	OC13 - Swap body vehicles
OC15 - Structural Firefighting ensembles	OC21 - Tower - Type 1	BS2 - EDG - 10kW	BS5 - UPS 1000V	OC15 - Structural Firefighting ensembles
OC17 - Rescue equipment	OC23 - Tower - Type 3	BS5 - UPS 1000V	BS6 - Water basin	OC17 - Rescue equipment
OC18 - Heavy Rescue Equip.	OC25 - Vehicle Extrication Pad	BS6 - Water basin	BS10 - Back-up communication	OC18 - Heavy Rescue Equip.
OC20 - PPE (SCBA)	OC26 - Forcibly entry training	BS10 - Back-up communication	BI3 - Area expansion	OC20 - PPE (SCBA)
OC21 - Tower - Type 1	OC27 - Confined spaces - Type 1	BI3 - Area expansion	BI4 - Vertical area expansion	OC21 - Tower - Type 1
OC23 - Tower - Type 3	OC32 - PC and IT equipment	BI4 - Vertical area expansion	BI6 - Seismic retrofit - conventional	OC23 - Tower - Type 3
OC25 - Vehicle Extrication Pad	BS2 - EDG - 10kW	BI6 - Seismic retrofit - conventional	BI12 - Walls - thermal insulation	OC25 - Vehicle Extrication Pad
OC26 - Forcibly entry training	BS5 - UPS 1000V	BI12 - Walls - thermal insulation	BI13 - Energy efficient windows	OC26 - Forcibly entry training
OC28 - Confined spaces - Type 2	BS6 - Water basin	BI13 - Energy efficient windows	BI14 - Interior remodelling	OC28 - Confined spaces - Type 2

Class 1	Class 2	Class 3	Class 4	Class 0
OC29 - Small USAR facility	BS8 - Fuel storage with canisters	BI14 - Interior remodelling	BI15 - Inside cosmetic renovation	OC30 - Large USAR facility
OC32 - PC and IT equipment	BS10 - Back-up communication	BI15 - Inside cosmetic renovation	BI17 - Heating system - individual electric heaters	OC32 - PC and IT equipment
BS1 - EDG - 15kW	BI3 - Area expansion	BI17 - Heating system - individual electric heaters	BI20 - Garage heating devices	BS1 - EDG - 15kW
BS4 - UPS 10kV	BI4 - Vertical area expansion	BI20 - Garage heating devices	BI21 - El system replacement	BS4 - UPS 10kV
BS6 - Water basin	BI6 - Seismic retrofit - conventional	BI21 - El system replacement	BI22 - Gas system replacement	BS6 - Water basin
BS8 - Fuel storage with canisters	BI12 - Walls - thermal insulation	BI22 - Gas system replacement	BI23 - Replacing water pipes	BS8 - Fuel storage with canisters
BS10 - Back-up communication	BI13 - Energy efficient windows	BI23 - Replacing water pipes	BI24 - Remodelling sewage system (pipes)	BS10 - Back-up communication
BI3 - Area expansion	BI14 - Interior remodelling	BI24 - Remodelling sewage system (pipes)	BI25 - Garage - surface	BI3 - Area expansion
BI4 - Vertical area expansion	BI15 - Inside cosmetic renovation	BI25 - Garage - surface	BI26 - Garage - non-slip epoxy surface	BI4 - Vertical area expansion
BI6 - Seismic retrofit - conventional	BI16 - Heating system - central heating system	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BI6 - Seismic retrofit - conventional
BI12 - Walls - thermal insulation	BI18 - Central HVAC	BI27 - Garage - drainage	BI29 - Garage - improving doors	BI12 - Walls - thermal insulation
BI13 - Energy efficient windows	BI20 - Garage heating devices	BI29 - Garage - improving doors	BI30 - Fume exhaust system - source capture	BI13 - Energy efficient windows

Class 1	Class 2	Class 3	Class 4	Class 0
BI14 - Interior remodelling	BI21 - El system replacement	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI14 - Interior remodelling
BI15 - Inside cosmetic renovation	BI22 - Gas system replacement	BI31 - Fume exhaust system - ventilation system	BI32 - Fire extinguisher system	BI15 - Inside cosmetic renovation
BI16 - Heating system - central heating system	BI23 - Replacing water pipes	BI32 - Fire extinguisher system	BI35 - Cleaning and decontamination room	BI16 - Heating system - central heating system
BI18 - Central HVAC	BI24 - Remodelling sewage system (pipes)	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI18 - Central HVAC
BI20 - Garage heating devices	BI25 - Garage - surface	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI20 - Garage heating devices
BI21 - El system replacement	BI26 - Garage - non-slip epoxy surface	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI21 - El system replacement
BI22 - Gas system replacement	BI27 - Garage - drainage	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI22 - Gas system replacement
BI23 - Replacing water pipes	BI28 - Garage - new doors	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI23 - Replacing water pipes
BI24 - Remodelling sewage system (pipes)	BI30 - Fume exhaust system - source capture	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI24 - Remodelling sewage system (pipes)
BI25 - Garage - surface	BI31 - Fume exhaust system - ventilation system	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI25 - Garage - surface
BI26 - Garage - non-slip epoxy surface	BI32 - Fire extinguisher system	BI42 - Meeting/training	BI43 - Communication room - furniture	BI26 - Garage - non-slip epoxy surface

Class 1	Class 2	Class 3	Class 4	Class 0
		room - furniture & equipment		
BI27 - Garage - drainage	BI33 - Fire detectors	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI27 - Garage - drainage
BI28 - Garage - new doors	BI35 - Cleaning and decontamination room	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI28 - Garage - new doors
BI30 - Fume exhaust system - source capture	BI36 - Hose wash cleaning machine	BI45 - Passive lightning protection	BI46 - Storage racks	BI30 - Fume exhaust system - source capture
BI31 - Fume exhaust system - ventilation system	BI37 - Laundering equipment for FRS	BI46 - Storage racks	BI48 - Electrical boiler	BI31 - Fume exhaust system - ventilation system
BI32 - Fire extinguisher system	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI48 - Electrical boiler	BI51 - Fitness equipment	BI32 - Fire extinguisher system
BI33 - Fire detectors	BI39 - Office furniture - desks, chairs, shelves	BI51 - Fitness equipment	BI52 - Outside fitness area	BI33 - Fire detectors
BI35 - Cleaning and decontamination room	BI40 - Kitchen & dayroom - furniture	BI52 - Outside fitness area	BI53 - Roof repair	BI34 - Automatic fire suppression system
BI36 - Hose wash cleaning machine	BI41 - Dormitory - furniture	BI53 - Roof repair	BI54 - Solar water heater	BI35 - Cleaning and decontamination room
BI37 - Laundering equipment for FRS	BI42 - Meeting/training room - furniture & equipment	BI54 - Solar water heater	SI1 - Yard pavement	BI36 - Hose wash cleaning machine
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI43 - Communication room - furniture	SI1 - Yard pavement	SI2 - Yard asphalt	BI37 - Laundering equipment for FRS

Class 1	Class 2	Class 3	Class 4	Class 0
BI39 - Office furniture - desks, chairs, shelves	BI44 - Communication room - ICT equipment	SI2 - Yard asphalt	SI8 - Surveillance system	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI40 - Kitchen & dayroom - furniture	BI45 - Passive lightning protection	SI8 - Surveillance system	SI9 - Cable Internet access	BI39 - Office furniture - desks, chairs, shelves
BI41 - Dormitory - furniture	BI46 - Storage racks	SI9 - Cable Internet access	SI10 - Back-up cable Internet access	BI40 - Kitchen & dayroom - furniture
BI42 - Meeting/training room - furniture & equipment	BI47 - Maintenance workshop	SI10 - Back-up cable Internet access		BI41 - Dormitory - furniture
BI43 - Communication room - furniture	BI49 - Gas boiler			BI42 - Meeting/training room - furniture & equipment
BI44 - Communication room - ICT equipment	BI51 - Fitness equipment			BI43 - Communication room - furniture
BI45 - Passive lightning protection	BI52 - Outside fitness area			BI44 - Communication room - ICT equipment
BI46 - Storage racks	BI53 - Roof repair			BI45 - Passive lightning protection
BI47 - Maintenance workshop	BI54 - Solar water heater			BI46 - Storage racks
BI49 - Gas boiler	BI55 - Intensive cleaing and repair centre			BI47 - Maintenance workshop
BI51 - Fitness equipment	SI1 - Yard pavement			BI49 - Gas boiler
BI52 - Outside fitness area	SI2 - Yard asphalt			BI51 - Fitness equipment

Class 1	Class 2	Class 3	Class 4	Class 0
BI53 - Roof repair	SI4 - Automatic barrier			BI52 - Outside fitness area
BI54 - Solar water heater	SI8 - Surveillance system			BI53 - Roof repair
BI55 - Intensive cleaing and repair centre	SI9 - Cable Internet access			BI54 - Solar water heater
SI1 - Yard pavement	SI10 - Back-up cable Internet access			BI55 - Intensive cleaing and repair centre
SI2 - Yard asphalt				SI1 - Yard pavement
SI3 - Automatic gate				SI2 - Yard asphalt
SI4 - Automatic barrier				SI3 - Automatic gate
SI5 - Traffic light system				SI4 - Automatic barrier
				SI5 - Traffic light system
				SI8 - Surveillance system
				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

Table B.15: Sets of interventions for Option 2, Group 2

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC3 - Emergency Tender - Type 1

Class 1	Class 2	Class 3	Class 4	Class 0
OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC4 - Emergency Tender - Type 2
OC5 - Triple Combination Pumper	OC7 - Tanker Pumper Apparatus	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC5 - Triple Combination Pumper
OC7 - Tanker Pumper Apparatus	OC8 - Aerial Ladder	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC10 - Small Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC8 - Aerial Ladder
OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC10 - Small Rescue Vehicle
OC11 - Heavy Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC20 - PPE (SCBA)	OC32 - PC and IT equipment	OC11 - Heavy Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC21 - Tower - Type 1	BS3 - EDG-5kW	OC12 - Snow Rescue Vehicle
OC13 - Swap body vehicles	OC20 - PPE (SCBA)	OC32 - PC and IT equipment	BS5 - UPS 1000V	OC13 - Swap body vehicles
OC15 - Structural Firefighting ensembles	OC21 - Tower - Type 1	BS2 - EDG - 10kW	BS6 - Water basin	OC15 - Structural Firefighting ensembles
OC17 - Rescue equipment	OC23 - Tower - Type 3	BS5 - UPS 1000V	BS10 - Back-up communication	OC17 - Rescue equipment
OC18 - Heavy Rescue Equip.	OC25 - Vehicle Extrication Pad	BS6 - Water basin	BI3 - Area expansion	OC18 - Heavy Rescue Equip.
OC20 - PPE (SCBA)	OC26 - Forcibly entry training	BS10 - Back-up communication	BI4 - Vertical area expansion	OC20 - PPE (SCBA)
OC21 - Tower - Type 1	OC27 - Confined spaces - Type 1	BI3 - Area expansion	BI6 - Seismic retrofit - conventional	OC21 - Tower - Type 1
OC23 - Tower - Type 3	OC32 - PC and IT equipment	BI4 - Vertical area expansion	BI12 - Walls - thermal insulation	OC23 - Tower - Type 3
OC25 - Vehicle Extrication Pad	BS2 - EDG - 10kW	BI6 - Seismic retrofit - conventional	BI13 - Energy efficient windows	OC25 - Vehicle Extrication Pad

Class 1	Class 2	Class 3	Class 4	Class 0
OC26 - Forcibly entry training	BS5 - UPS 1000V	BI12 - Walls - thermal insulation	BI14 - Interior remodelling	OC26 - Forcibly entry training
OC27 - Confined spaces - Type 1	BS6 - Water basin	BI13 - Energy efficient windows	BI15 - Inside cosmetic renovation	OC28 - Confined spaces - Type 2
OC29 - Small USAR facility	BS8 - Fuel storage with canisters	BI14 - Interior remodelling	BI17 - Heating system - individual electric heaters	OC30 - Large USAR facility
OC32 - PC and IT equipment	BS10 - Back-up communication	BI15 - Inside cosmetic renovation	BI20 - Garage heating devices	OC32 - PC and IT equipment
BS1 - EDG - 15kW	BI3 - Area expansion	BI17 - Heating system - individual electric heaters	BI21 - El system replacement	BS1 - EDG - 15kW
BS4 - UPS 10kV	BI4 - Vertical area expansion	BI20 - Garage heating devices	BI22 - Gas system replacement	BS4 - UPS 10kV
BS6 - Water basin	BI6 - Seismic retrofit - conventional	BI21 - El system replacement	BI23 - Replacing water pipes	BS6 - Water basin
BS8 - Fuel storage with canisters	BI12 - Walls - thermal insulation	BI22 - Gas system replacement	BI24 - Remodelling sewage system (pipes)	BS8 - Fuel storage with canisters
BS10 - Back-up communication	BI13 - Energy efficient windows	BI23 - Replacing water pipes	BI25 - Garage - surface	BS10 - Back-up communication
BI3 - Area expansion	BI14 - Interior remodelling	BI24 - Remodelling sewage system (pipes)	BI26 - Garage - non-slip epoxy surface	BI3 - Area expansion
BI4 - Vertical area expansion	BI15 - Inside cosmetic renovation	BI25 - Garage - surface	BI27 - Garage - drainage	BI4 - Vertical area expansion
BI6 - Seismic retrofit - conventional	BI16 - Heating system - central heating system	BI26 - Garage - non-slip epoxy surface	BI29 - Garage - improving doors	BI6 - Seismic retrofit - conventional

Class 1	Class 2	Class 3	Class 4	Class 0
BI12 - Walls - thermal insulation	BI18 - Central HVAC	BI27 - Garage - drainage	BI30 - Fume exhaust system - source capture	BI12 - Walls - thermal insulation
BI13 - Energy efficient windows	BI20 - Garage heating devices	BI29 - Garage - improving doors	BI31 - Fume exhaust system - ventilation system	BI13 - Energy efficient windows
BI14 - Interior remodelling	BI21 - El system replacement	BI30 - Fume exhaust system - source capture	BI32 - Fire extinguisher system	BI14 - Interior remodelling
BI15 - Inside cosmetic renovation	BI22 - Gas system replacement	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI15 - Inside cosmetic renovation
BI16 - Heating system - central heating system	BI23 - Replacing water pipes	BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI16 - Heating system - central heating system
BI18 - Central HVAC	BI24 - Remodelling sewage system (pipes)	BI35 - Cleaning and decontamination room	BI37 - Laundering equipment for FRS	BI18 - Central HVAC
BI20 - Garage heating devices	BI25 - Garage - surface	BI36 - Hose wash cleaning machine	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI20 - Garage heating devices
BI21 - El system replacement	BI26 - Garage - non-slip epoxy surface	BI37 - Laundering equipment for FRS	BI39 - Office furniture - desks, chairs, shelves	BI21 - El system replacement
BI22 - Gas system replacement	BI27 - Garage - drainage	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI40 - Kitchen & dayroom - furniture	BI22 - Gas system replacement
BI23 - Replacing water pipes	BI28 - Garage - new doors	BI39 - Office furniture - desks, chairs, shelves	BI41 - Dormitory - furniture	BI23 - Replacing water pipes
BI24 - Remodelling sewage system (pipes)	BI30 - Fume exhaust system - source capture	BI40 - Kitchen & dayroom - furniture	BI42 - Meeting/training room - furniture & equipment	BI24 - Remodelling sewage system (pipes)

Class 1	Class 2	Class 3	Class 4	Class 0
BI25 - Garage - surface	BI31 - Fume exhaust system - ventilation system	BI41 - Dormitory - furniture	BI43 - Communication room - furniture	BI25 - Garage - surface
BI26 - Garage - non-slip epoxy surface	BI32 - Fire extinguisher system	BI42 - Meeting/training room - furniture & equipment	BI44 - Communication room - ICT equipment	BI26 - Garage - non-slip epoxy surface
BI27 - Garage - drainage	BI33 - Fire detectors	BI43 - Communication room - furniture	BI45 - Passive lightning protection	BI27 - Garage - drainage
BI28 - Garage - new doors	BI35 - Cleaning and decontamination room	BI44 - Communication room - ICT equipment	BI46 - Storage racks	BI28 - Garage - new doors
BI30 - Fume exhaust system - source capture	BI36 - Hose wash cleaning machine	BI45 - Passive lightning protection	BI48 - Electrical boiler	BI30 - Fume exhaust system - source capture
BI31 - Fume exhaust system - ventilation system	BI37 - Laundering equipment for FRS	BI46 - Storage racks	BI51 - Fitness equipment	BI31 - Fume exhaust system - ventilation system
BI32 - Fire extinguisher system	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI48 - Electrical boiler	BI52 - Outside fitness area	BI32 - Fire extinguisher system
BI33 - Fire detectors	BI39 - Office furniture - desks, chairs, shelves	BI51 - Fitness equipment	BI53 - Roof repair	BI33 - Fire detectors
BI35 - Cleaning and decontamination room	BI40 - Kitchen & dayroom - furniture	BI52 - Outside fitness area	BI54 - Solar water heater	BI34 - Automatic fire suppression system
BI36 - Hose wash cleaning machine	BI41 - Dormitory - furniture	BI53 - Roof repair	SI1 - Yard pavement	BI35 - Cleaning and decontamination room
BI37 - Laundering equipment for FRS	BI42 - Meeting/training room - furniture & equipment	BI54 - Solar water heater	SI2 - Yard asphalt	BI36 - Hose wash cleaning machine

Class 1	Class 2	Class 3	Class 4	Class 0
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI43 - Communication room - furniture	SI1 - Yard pavement	SI8 - Surveillance system	BI37 - Laundering equipment for FRS
BI39 - Office furniture - desks, chairs, shelves	BI44 - Communication room - ICT equipment	SI2 - Yard asphalt	SI9 - Cable Internet access	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI40 - Kitchen & dayroom - furniture	BI45 - Passive lightning protection	SI8 - Surveillance system	SI10 - Back-up cable Internet access	BI39 - Office furniture - desks, chairs, shelves
BI41 - Dormitory - furniture	BI46 - Storage racks	SI9 - Cable Internet access		BI40 - Kitchen & dayroom - furniture
BI42 - Meeting/training room - furniture & equipment	BI47 - Maintenance workshop	SI10 - Back-up cable Internet access		BI41 - Dormitory - furniture
BI43 - Communication room - furniture	BI49 - Gas boiler			BI42 - Meeting/training room - furniture & equipment
BI44 - Communication room - ICT equipment	BI51 - Fitness equipment			BI43 - Communication room - furniture
BI45 - Passive lightning protection	BI52 - Outside fitness area			BI44 - Communication room - ICT equipment
BI46 - Storage racks	BI53 - Roof repair			BI45 - Passive lightning protection
BI47 - Maintenance workshop	BI54 - Solar water heater			BI46 - Storage racks
BI49 - Gas boiler	BI55 - Intensive cleaing and repair centre			BI47 - Maintenance workshop

Class 1	Class 2	Class 3	Class 4	Class 0
BI51 - Fitness equipment	SI1 - Yard pavement			BI49 - Gas boiler
BI52 - Outside fitness area	SI2 - Yard asphalt			BI51 - Fitness equipment
BI53 - Roof repair	SI4 - Automatic barrier			BI52 - Outside fitness area
BI54 - Solar water heater	SI8 - Surveillance system			BI53 - Roof repair
BI55 - Intensive cleaing and repair centre	SI9 - Cable Internet access			BI54 - Solar water heater
SI1 - Yard pavement	SI10 - Back-up cable Internet access			BI55 - Intensive cleaing and repair centre
SI2 - Yard asphalt				SI1 - Yard pavement
SI3 - Automatic gate				SI2 - Yard asphalt
SI4 - Automatic barrier				SI3 - Automatic gate
SI5 - Traffic light system				SI4 - Automatic barrier
SI8 - Surveillance system				SI5 - Traffic light system
				SI8 - Surveillance system
				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

Table B.16: Sets of interventions for Option 2, Group 3

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle

Class 1	Class 2	Class 3	Class 4	Class 0
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC4 - Emergency Tender - Type 2
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC8 - Aerial Ladder
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC10 - Small Rescue Vehicle
OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC12 - Snow Rescue Vehicle
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC15 - Structural Firefighting ensembles
OC18 - Heavy Rescue Equip.	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC21 - Tower - Type 1	OC17 - Rescue equipment
OC20 - PPE (SCBA)	OC21 - Tower - Type 1	OC21 - Tower - Type 1	OC32 - PC and IT equipment	OC18 - Heavy Rescue Equip.
OC21 - Tower - Type 1	OC23 - Tower - Type 3	OC32 - PC and IT equipment	BS3 - EDG-5kW	OC20 - PPE (SCBA)
OC23 - Tower - Type 3	OC32 - PC and IT equipment	BS2 - EDG - 10kW	BS5 - UPS 1000V	OC21 - Tower - Type 1
OC25 - Vehicle Extrication Pad	BS2 - EDG - 10kW	BS5 - UPS 1000V	BS10 - Back-up communication	OC23 - Tower - Type 3
OC26 - Forcibly entry training	BS5 - UPS 1000V	BS10 - Back-up communication	BI3 - Area expansion	OC25 - Vehicle Extrication Pad
OC32 - PC and IT equipment	BS6 - Water basin	BI3 - Area expansion	BI4 - Vertical area expansion	OC26 - Forcibly entry training
BS1 - EDG - 15kW	BS10 - Back-up communication	BI4 - Vertical area expansion	BI6 - Seismic retrofit - conventional	OC27 - Confined spaces - Type 1
BS4 - UPS 10kV	BI3 - Area expansion	BI6 - Seismic retrofit - conventional	BI12 - Walls - thermal insulation	OC29 - Small USAR facility

Class 1	Class 2	Class 3	Class 4	Class 0
BS6 - Water basin	BI4 - Vertical area expansion	BI12 - Walls - thermal insulation	BI13 - Energy efficient windows	OC32 - PC and IT equipment
BS10 - Back-up communication	BI6 - Seismic retrofit - conventional	BI13 - Energy efficient windows	BI14 - Interior remodelling	BS1 - EDG - 15kW
BI3 - Area expansion	BI12 - Walls - thermal insulation	BI14 - Interior remodelling	BI15 - Inside cosmetic renovation	BS4 - UPS 10kV
BI4 - Vertical area expansion	BI13 - Energy efficient windows	BI15 - Inside cosmetic renovation	BI17 - Heating system - individual electric heaters	BS6 - Water basin
BI6 - Seismic retrofit - conventional	BI14 - Interior remodelling	BI17 - Heating system - individual electric heaters	BI20 - Garage heating devices	BS8 - Fuel storage with canisters
BI12 - Walls - thermal insulation	BI15 - Inside cosmetic renovation	BI20 - Garage heating devices	BI21 - El system replacement	BS10 - Back-up communication
BI13 - Energy efficient windows	BI16 - Heating system - central heating system	BI21 - El system replacement	BI22 - Gas system replacement	BI3 - Area expansion
BI14 - Interior remodelling	BI18 - Central HVAC	BI22 - Gas system replacement	BI23 - Replacing water pipes	BI4 - Vertical area expansion
BI15 - Inside cosmetic renovation	BI20 - Garage heating devices	BI23 - Replacing water pipes	BI24 - Remodelling sewage system (pipes)	BI6 - Seismic retrofit - conventional
BI16 - Heating system - central heating system	BI21 - El system replacement	BI24 - Remodelling sewage system (pipes)	BI25 - Garage - surface	BI12 - Walls - thermal insulation
BI18 - Central HVAC	BI22 - Gas system replacement	BI25 - Garage - surface	BI26 - Garage - non-slip epoxy surface	BI13 - Energy efficient windows
BI20 - Garage heating devices	BI23 - Replacing water pipes	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BI14 - Interior remodelling

Class 1	Class 2	Class 3	Class 4	Class 0
BI21 - El system replacement	BI24 - Remodelling sewage system (pipes)	BI27 - Garage - drainage	BI29 - Garage - improving doors	BI15 - Inside cosmetic renovation
BI22 - Gas system replacement	BI25 - Garage - surface	BI29 - Garage - improving doors	BI30 - Fume exhaust system - source capture	BI16 - Heating system - central heating system
BI23 - Replacing water pipes	BI26 - Garage - non-slip epoxy surface	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI18 - Central HVAC
BI24 - Remodelling sewage system (pipes)	BI27 - Garage - drainage	BI31 - Fume exhaust system - ventilation system	BI32 - Fire extinguisher system	BI20 - Garage heating devices
BI25 - Garage - surface	BI28 - Garage - new doors	BI32 - Fire extinguisher system	BI33 - Fire detectors	BI21 - El system replacement
BI26 - Garage - non-slip epoxy surface	BI30 - Fume exhaust system - source capture	BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI22 - Gas system replacement
BI27 - Garage - drainage	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI23 - Replacing water pipes
BI28 - Garage - new doors	BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI24 - Remodelling sewage system (pipes)
BI30 - Fume exhaust system - source capture	BI33 - Fire detectors	BI37 - Laundering equipment for FRS	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI25 - Garage - surface
BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI26 - Garage - non-slip epoxy surface

Class 1	Class 2	Class 3	Class 4	Class 0
BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI27 - Garage - drainage
BI33 - Fire detectors	BI37 - Laundering equipment for FRS	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI28 - Garage - new doors
BI35 - Cleaning and decontamination room	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI30 - Fume exhaust system - source capture
BI36 - Hose wash cleaning machine	BI39 - Office furniture - desks, chairs, shelves	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI31 - Fume exhaust system - ventilation system
BI37 - Laundering equipment for FRS	BI40 - Kitchen & dayroom - furniture	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI32 - Fire extinguisher system
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI41 - Dormitory - furniture	BI44 - Communication room - ICT equipment	BI45 - Passive lightning protection	BI33 - Fire detectors
BI39 - Office furniture - desks, chairs, shelves	BI42 - Meeting/training room - furniture & equipment	BI45 - Passive lightning protection	BI46 - Storage racks	BI34 - Automatic fire suppression system
BI40 - Kitchen & dayroom - furniture	BI43 - Communication room - furniture	BI46 - Storage racks	BI48 - Electrical boiler	BI35 - Cleaning and decontamination room
BI41 - Dormitory - furniture	BI44 - Communication room - ICT equipment	BI48 - Electrical boiler	BI51 - Fitness equipment	BI36 - Hose wash cleaning machine
BI42 - Meeting/training room - furniture & equipment	BI45 - Passive lightning protection	BI51 - Fitness equipment	BI52 - Outside fitness area	BI37 - Laundering equipment for FRS

Class 1	Class 2	Class 3	Class 4	Class 0
BI43 - Communication room - furniture	BI46 - Storage racks	BI52 - Outside fitness area	BI53 - Roof repair	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI44 - Communication room - ICT equipment	BI47 - Maintenance workshop	BI53 - Roof repair	BI54 - Solar water heater	BI39 - Office furniture - desks, chairs, shelves
BI45 - Passive lightning protection	BI49 - Gas boiler	BI54 - Solar water heater	SI1 - Yard pavement	BI40 - Kitchen & dayroom - furniture
BI46 - Storage racks	BI51 - Fitness equipment	SI1 - Yard pavement	SI2 - Yard asphalt	BI41 - Dormitory - furniture
BI47 - Maintenance workshop	BI52 - Outside fitness area	SI2 - Yard asphalt	SI8 - Surveillance system	BI42 - Meeting/training room - furniture & equipment
BI49 - Gas boiler	BI53 - Roof repair	SI8 - Surveillance system	SI9 - Cable Internet access	BI43 - Communication room - furniture
BI51 - Fitness equipment	BI54 - Solar water heater	SI9 - Cable Internet access	SI10 - Back-up cable Internet access	BI44 - Communication room - ICT equipment
BI52 - Outside fitness area	BI55 - Intensive cleaing and repair centre	SI10 - Back-up cable Internet access	SI11 - Rebuying shared parts	BI45 - Passive lightning protection
BI53 - Roof repair	SI1 - Yard pavement	SI11 - Rebuying shared parts		BI46 - Storage racks
BI54 - Solar water heater	SI2 - Yard asphalt			BI47 - Maintenance workshop
BI55 - Intensive cleaing and repair centre	SI4 - Automatic barrier			BI48 - Electrical boiler
SI1 - Yard pavement	SI8 - Surveillance system			BI51 - Fitness equipment

Class 1	Class 2	Class 3	Class 4	Class 0
SI2 - Yard asphalt	SI9 - Cable Internet access			BI52 - Outside fitness area
SI3 - Automatic gate	SI10 - Back-up cable Internet access			BI53 - Roof repair
SI4 - Automatic barrier	SI11 - Rebuying shared parts			BI54 - Solar water heater
SI5 - Traffic light system				BI55 - Intensive cleaing and repair centre
SI8 - Surveillance system				SI1 - Yard pavement
SI9 - Cable Internet access				SI2 - Yard asphalt
SI10 - Back-up cable Internet access				SI3 - Automatic gate
SI11 - Rebuying shared parts				SI4 - Automatic barrier
				SI5 - Traffic light system
				SI6 - Retaining wall
				SI7 - Drainage system
				SI8 - Surveillance system
				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

Table B.17: Sets of interventions for Option 2, Group 4

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle

Class 1	Class 2	Class 3	Class 4	Class 0
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC7 - Tanker Pumper Apparatus	OC4 - Emergency Tender - Type 2
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC12 - Snow Rescue Vehicle	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC8 - Aerial Ladder
OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC17 - Rescue equipment	OC10 - Small Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC20 - PPE (SCBA)	OC12 - Snow Rescue Vehicle
OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC17 - Rescue equipment	OC32 - PC and IT equipment	OC15 - Structural Firefighting ensembles
OC17 - Rescue equipment	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	BS3 - EDG-5kW	OC17 - Rescue equipment
OC20 - PPE (SCBA)	OC21 - Tower - Type 1	OC21 - Tower - Type 1	BS5 - UPS 1000V	OC18 - Heavy Rescue Equip.
OC21 - Tower - Type 1	OC25 - Vehicle Extrication Pad	OC32 - PC and IT equipment	BS10 - Back-up communication	OC20 - PPE (SCBA)
OC25 - Vehicle Extrication Pad	OC26 - Forcibly entry training	BS2 - EDG - 10kW	BI3 - Area expansion	OC21 - Tower - Type 1
OC26 - Forcibly entry training	OC32 - PC and IT equipment	BS5 - UPS 1000V	BI4 - Vertical area expansion	OC23 - Tower - Type 3
OC27 - Confined spaces - Type 1	BS2 - EDG - 10kW	BS10 - Back-up communication	BI6 - Seismic retrofit - conventional	OC25 - Vehicle Extrication Pad
OC29 - Small USAR facility	BS5 - UPS 1000V	BI3 - Area expansion	BI12 - Walls - thermal insulation	OC26 - Forcibly entry training
OC32 - PC and IT equipment	BS6 - Water basin	BI4 - Vertical area expansion	BI13 - Energy efficient windows	OC28 - Confined spaces - Type 2

Class 1	Class 2	Class 3	Class 4	Class 0
BS1 - EDG - 15kW	BS10 - Back-up communication	BI6 - Seismic retrofit - conventional	BI14 - Interior remodelling	OC29 - Small USAR facility
BS4 - UPS 10kV	BI3 - Area expansion	BI12 - Walls - thermal insulation	BI15 - Inside cosmetic renovation	OC32 - PC and IT equipment
BS6 - Water basin	BI4 - Vertical area expansion	BI13 - Energy efficient windows	BI17 - Heating system - individual electric heaters	BS1 - EDG - 15kW
BS8 - Fuel storage with canisters	BI6 - Seismic retrofit - conventional	BI14 - Interior remodelling	BI20 - Garage heating devices	BS4 - UPS 10kV
BS10 - Back-up communication	BI12 - Walls - thermal insulation	BI15 - Inside cosmetic renovation	BI21 - El system replacement	BS6 - Water basin
BI3 - Area expansion	BI13 - Energy efficient windows	BI17 - Heating system - individual electric heaters	BI22 - Gas system replacement	BS8 - Fuel storage with canisters
BI4 - Vertical area expansion	BI14 - Interior remodelling	BI20 - Garage heating devices	BI23 - Replacing water pipes	BS10 - Back-up communication
BI6 - Seismic retrofit - conventional	BI15 - Inside cosmetic renovation	BI21 - El system replacement	BI24 - Remodelling sewage system (pipes)	BI3 - Area expansion
BI12 - Walls - thermal insulation	BI17 - Heating system - individual electric heaters	BI22 - Gas system replacement	BI25 - Garage - surface	BI4 - Vertical area expansion
BI13 - Energy efficient windows	BI20 - Garage heating devices	BI23 - Replacing water pipes	BI26 - Garage - non-slip epoxy surface	BI6 - Seismic retrofit - conventional
BI14 - Interior remodelling	BI21 - El system replacement	BI24 - Remodelling sewage system (pipes)	BI27 - Garage - drainage	BI12 - Walls - thermal insulation

Class 1	Class 2	Class 3	Class 4	Class 0
BI15 - Inside cosmetic renovation	BI22 - Gas system replacement	BI25 - Garage - surface	BI29 - Garage - improving doors	BI13 - Energy efficient windows
BI16 - Heating system - central heating system	BI23 - Replacing water pipes	BI26 - Garage - non-slip epoxy surface	BI30 - Fume exhaust system - source capture	BI14 - Interior remodelling
BI18 - Central HVAC	BI24 - Remodelling sewage system (pipes)	BI27 - Garage - drainage	BI31 - Fume exhaust system - ventilation system	BI15 - Inside cosmetic renovation
BI20 - Garage heating devices	BI25 - Garage - surface	BI29 - Garage - improving doors	BI32 - Fire extinguisher system	BI17 - Heating system - individual electric heaters
BI21 - El system replacement	BI26 - Garage - non-slip epoxy surface	BI30 - Fume exhaust system - source capture	BI35 - Cleaning and decontamination room	BI18 - Central HVAC
BI22 - Gas system replacement	BI27 - Garage - drainage	BI31 - Fume exhaust system - ventilation system	BI36 - Hose wash cleaning machine	BI20 - Garage heating devices
BI23 - Replacing water pipes	BI28 - Garage - new doors	BI32 - Fire extinguisher system	BI37 - Laundering equipment for FRS	BI21 - El system replacement
BI24 - Remodelling sewage system (pipes)	BI30 - Fume exhaust system - source capture	BI35 - Cleaning and decontamination room	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI22 - Gas system replacement
BI25 - Garage - surface	BI31 - Fume exhaust system - ventilation system	BI36 - Hose wash cleaning machine	BI39 - Office furniture - desks, chairs, shelves	BI23 - Replacing water pipes
BI26 - Garage - non-slip epoxy surface	BI32 - Fire extinguisher system	BI37 - Laundering equipment for FRS	BI40 - Kitchen & dayroom - furniture	BI24 - Remodelling sewage system (pipes)
BI27 - Garage - drainage	BI33 - Fire detectors	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI41 - Dormitory - furniture	BI25 - Garage - surface

Class 1	Class 2	Class 3	Class 4	Class 0
BI28 - Garage - new doors	BI35 - Cleaning and decontamination room	BI39 - Office furniture - desks, chairs, shelves	BI42 - Meeting/training room - furniture & equipment	BI26 - Garage - non-slip epoxy surface
BI30 - Fume exhaust system - source capture	BI36 - Hose wash cleaning machine	BI40 - Kitchen & dayroom - furniture	BI43 - Communication room - furniture	BI27 - Garage - drainage
BI31 - Fume exhaust system - ventilation system	BI37 - Laundering equipment for FRS	BI41 - Dormitory - furniture	BI44 - Communication room - ICT equipment	BI28 - Garage - new doors
BI32 - Fire extinguisher system	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI42 - Meeting/training room - furniture & equipment	BI45 - Passive lightning protection	BI30 - Fume exhaust system - source capture
BI33 - Fire detectors	BI39 - Office furniture - desks, chairs, shelves	BI43 - Communication room - furniture	BI46 - Storage racks	BI31 - Fume exhaust system - ventilation system
BI35 - Cleaning and decontamination room	BI40 - Kitchen & dayroom - furniture	BI44 - Communication room - ICT equipment	BI48 - Electrical boiler	BI32 - Fire extinguisher system
BI36 - Hose wash cleaning machine	BI41 - Dormitory - furniture	BI45 - Passive lightning protection	BI51 - Fitness equipment	BI33 - Fire detectors
BI37 - Laundering equipment for FRS	BI42 - Meeting/training room - furniture & equipment	BI46 - Storage racks	BI52 - Outside fitness area	BI34 - Automatic fire suppression system
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI43 - Communication room - furniture	BI48 - Electrical boiler	BI53 - Roof repair	BI35 - Cleaning and decontamination room
BI39 - Office furniture - desks, chairs, shelves	BI44 - Communication room - ICT equipment	BI51 - Fitness equipment	BI54 - Solar water heater	BI36 - Hose wash cleaning machine

Class 1	Class 2	Class 3	Class 4	Class 0
BI40 - Kitchen & dayroom - furniture	BI45 - Passive lightning protection	BI52 - Outside fitness area	SI1 - Yard pavement	BI37 - Laundering equipment for FRS
BI41 - Dormitory - furniture	BI46 - Storage racks	BI53 - Roof repair	SI2 - Yard asphalt	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI42 - Meeting/training room - furniture & equipment	BI49 - Gas boiler	BI54 - Solar water heater	SI6 - Retaining wall	BI39 - Office furniture - desks, chairs, shelves
BI43 - Communication room - furniture	BI51 - Fitness equipment	SI1 - Yard pavement	SI7 - Drainage system	BI40 - Kitchen & dayroom - furniture
BI44 - Communication room - ICT equipment	BI52 - Outside fitness area	SI2 - Yard asphalt	SI8 - Surveillance system	BI41 - Dormitory - furniture
BI45 - Passive lightning protection	BI53 - Roof repair	SI6 - Retaining wall	SI9 - Cable Internet access	BI42 - Meeting/training room - furniture & equipment
BI46 - Storage racks	BI54 - Solar water heater	SI7 - Drainage system	SI10 - Back-up cable Internet access	BI43 - Communication room - furniture
BI49 - Gas boiler	SI1 - Yard pavement	SI8 - Surveillance system		BI44 - Communication room - ICT equipment
BI51 - Fitness equipment	SI2 - Yard asphalt	SI9 - Cable Internet access		BI45 - Passive lightning protection
BI52 - Outside fitness area	SI4 - Automatic barrier	SI10 - Back-up cable Internet access		BI46 - Storage racks
BI53 - Roof repair	SI6 - Retaining wall			BI49 - Gas boiler
BI54 - Solar water heater	SI7 - Drainage system			BI51 - Fitness equipment

Class 1	Class 2	Class 3	Class 4	Class 0
SI1 - Yard pavement	SI8 - Surveillance system			BI52 - Outside fitness area
SI2 - Yard asphalt	SI9 - Cable Internet access			BI53 - Roof repair
SI3 - Automatic gate	SI10 - Back-up cable Internet access			BI54 - Solar water heater
SI4 - Automatic barrier				SI1 - Yard pavement
SI5 - Traffic light system				SI2 - Yard asphalt
SI6 - Retaining wall				SI3 - Automatic gate
SI7 - Drainage system				SI4 - Automatic barrier
SI8 - Surveillance system				SI5 - Traffic light system
SI9 - Cable Internet access				SI6 - Retaining wall
SI10 - Back-up cable Internet access				SI7 - Drainage system
				SI8 - Surveillance system
				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

Table B.18: Sets of interventions for Option 2, Group 5

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC4 - Emergency Tender - Type 2

Class 1	Class 2	Class 3	Class 4	Class 0
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC7 - Tanker Pumper Apparatus
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC8 - Aerial Ladder
OC14 - Command Vehicle	OC14 - Command Vehicle	OC14 - Command Vehicle	OC15 - Structural Firefighting Eq.	OC10 - Small Rescue Vehicle
OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC17 - Rescue equipment	OC12 - Snow Rescue Vehicle
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE	OC14 - Command Vehicle
OC20 - PPE	OC20 - PPE	OC20 - PPE	BS3 - EDG-5kW	OC15 - Structural Firefighting Eq.
OC21 - Tower - Type 1	OC21 - Tower - Type 1	OC21 - Tower - Type 1	BS5 - UPS 1000V	OC17 - Rescue equipment
BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS10 - Back-up communication	OC20 - PPE
BS5 - UPS 1000V	BS5 - UPS 1000V	BS5 - UPS 1000V	BI3 - Area expansion	OC21 - Tower - Type 1
BS10 - Back-up communication	BS10 - Back-up communication	BS10 - Back-up communication	BI4 - Vertical area expansion	BS1 - EDG - 15kW
BI3 - Area expansion	BI3 - Area expansion	BI3 - Area expansion	BI6 - Seismic retrofit - conventional	BS4 - UPS 10kV
BI4 - Vertical area expansion	BI4 - Vertical area expansion	BI4 - Vertical area expansion	BI12 - Walls - thermal insulation	BS7 - Closed water basin
BI6 - Seismic retrofit - conventional	BI6 - Seismic retrofit - conventional	BI6 - Seismic retrofit - conventional	BI13 - Energy efficient windows	BS10 - Back-up communication
BI12 - Walls - thermal insulation	BI12 - Walls - thermal insulation	BI12 - Walls - thermal insulation	BI14 - Interior remodelling	BI3 - Area expansion
BI13 - Energy efficient windows	BI13 - Energy efficient windows	BI13 - Energy efficient windows	BI15 - Inside cosmetic renovation	BI4 - Vertical area expansion
BI14 - Interior remodelling	BI14 - Interior remodelling	BI14 - Interior remodelling	BI17 - Heating system - individual electric heaters	BI6 - Seismic retrofit - conventional
BI15 - Inside cosmetic renovation	BI15 - Inside cosmetic renovation	BI15 - Inside cosmetic renovation	BI20 - Garage heating devices	BI12 - Walls - thermal insulation
BI17 - Heating system - individual electric heaters	BI17 - Heating system - individual electric heaters	BI17 - Heating system - individual electric heaters	BI21 - El system replacement	BI13 - Energy efficient windows
BI20 - Garage heating devices	BI20 - Garage heating devices	BI20 - Garage heating devices	BI22 - Gas system replacement	BI14 - Interior remodelling
BI21 - El system replacement	BI21 - El system replacement	BI21 - El system replacement	BI23 - Replacing water pipes	BI15 - Inside cosmetic renovation
BI22 - Gas system replacement	BI22 - Gas system replacement	BI22 - Gas system replacement	BI24 - Remodelling sewage system (pipes)	BI17 - Heating system - individual electric heaters
BI23 - Replacing water pipes	BI23 - Replacing water pipes	BI23 - Replacing water pipes	BI25 - Garage - surface	BI18 - Central HVAC
BI24 - Remodelling sewage system (pipes)	BI24 - Remodelling sewage system (pipes)	BI24 - Remodelling sewage system (pipes)	BI26 - Garage - non-slip epoxy surface	BI20 - Garage heating devices
BI25 - Garage - surface	BI25 - Garage - surface	BI25 - Garage - surface	BI27 - Garage - drainage	BI21 - El system replacement

Class 1	Class 2	Class 3	Class 4	Class 0
BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI29 - Garage - improving doors	BI22 - Gas system replacement
BI27 - Garage - drainage	BI27 - Garage - drainage	BI27 - Garage - drainage	BI30 - Fume exhaust system - source capture	BI23 - Replacing water pipes
BI29 - Garage - improving doors	BI29 - Garage - improving doors	BI29 - Garage - improving doors	BI31 - Fume exhaust system - ventilation system	BI24 - Remodelling sewage system (pipes)
BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI32 - Fire extinguisher system	BI25 - Garage - surface
BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI26 - Garage - non-slip epoxy surface
BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI27 - Garage - drainage
BI33 - Fire detectors	BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI37 - Cl. & decont. equipm. for PPE	BI29 - Garage - improving doors
BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI30 - Fume exhaust system - source capture
BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	BI37 - Cl. & decont. equipm. for PPE	BI39 - Office furniture - desks, chairs, shelves	BI31 - Fume exhaust system - ventilation system
BI37 - Cl. & decont. equipm. for PPE	BI37 - Cl. & decont. equipm. for PPE	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI40 - Kitchen & dayroom - furniture	BI32 - Fire extinguisher system
BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI38 - Bathroom (finishing materials, sinks, showers, etc)	BI39 - Office furniture - desks, chairs, shelves	BI41 - Dormitory - furniture	BI33 - Fire detectors
BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI42 - Meeting/training room - furniture & equipment	BI34 - automatic fire suppression system
BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI43 - Communication room - furniture	BI35 - Cleaning and decontamination room
BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI44 - Communication room - ITC equipment	BI36 - Hose wash cleaning machine
BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI45 - Passive lightning protection	BI37 - Cl. & decont. equipm. for PPE
BI43 - Communication room - furniture	BI43 - Communication room - furniture	BI44 - Communication room - ITC equipment	BI46 - Storage racks	BI38 - Bathroom (finishing materials, sinks, showers, etc)
BI44 - Communication room - ITC equipment	BI44 - Communication room - ITC equipment	BI45 - Passive lightning protection	BI48 - Electrical boiler	BI39 - Office furniture - desks, chairs, shelves
BI45 - Passive lightning protection	BI45 - Passive lightning protection	BI46 - Storage racks	BI51 - Fitness equipment	BI40 - Kitchen & dayroom - furniture
BI46 - Storage racks	BI46 - Storage racks	BI48 - Electrical boiler	BI53 - Roof repair	BI41 - Dormitory - furniture
BI49 - Gas boiler	BI49 - Gas boiler	BI51 - Fitness equipment	SI1 - Yard pavement	BI42 - Meeting/training room - furniture & equipment

Class 1	Class 2	Class 3	Class 4	Class 0
BI51 - Fitness equipment	BI51 - Fitness equipment	BI53 - Roof repair	SI2 - Yard asphalt	BI43 - Communication room - furniture
BI53 - Roof repair	BI53 - Roof repair	SI1 - Yard pavement	SI6 - Retaining wall	BI44 - Communication room - ITC equipment
SI1 - Yard pavement	SI1 - Yard pavement	SI2 - Yard asphalt	SI7 - Drainage system	BI45 - Passive lightning protection
SI2 - Yard asphalt	SI2 - Yard asphalt	SI6 - Retaining wall	SI8 - Surveillance system	BI46 - Storage racks
SI4 - Automatic barrier	SI4 - Automatic barrier	SI7 - Drainage system	SI9 - Cable Internet access	BI49 - Gas boiler
SI6 - Retaining wall	SI6 - Retaining wall	SI8 - Surveillance system	SI10 - Back-up cable Internet access	BI51 - Fitness equipment
SI7 - Drainage system	SI7 - Drainage system	SI9 - Cable Internet access		BI53 - Roof repair
SI8 - Surveillance system	SI8 - Surveillance system	SI10 - Back-up cable Internet access		SI1 - Yard pavement
SI9 - Cable Internet access	SI9 - Cable Internet access			SI2 - Yard asphalt
SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access			SI3 - Automatic gate
				SI4 - Automatic barrier
				SI5 - Traffic light system
				SI6 - Retaining wall
				SI7 - Drainage system
				SI8 - Surveillance system
				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

B.1.3 Sets of Interventions for Option 3

Table B.19: Sets of interventions for Option 3, Group 1

3_1_1	3_1_2	3_1_3	3_1_4	3_1_0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC4 - Emergency Tender - Type 2
OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC5 - Triple Combination Pumper
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC8 - Aerial Ladder
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC10 - Small Rescue Vehicle
OC11 - Heavy Rescue Vehicle	OC11 - Heavy Rescue Vehicle	OC14 - Command Vehicle	OC14 - Command Vehicle	OC11 - Heavy Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC12 - Snow Rescue Vehicle
OC14 - Command Vehicle	OC14 - Command Vehicle	OC17 - Rescue equipment	OC17 - Rescue equipment	OC14 - Command Vehicle
OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC20 - PPE	OC20 - PPE	OC15 - Structural Firefighting Eq.
OC17 - Rescue equipment	OC17 - Rescue equipment	BS2 - EDG - 10kW	BS2 - EDG - 10kW	OC17 - Rescue equipment
OC18 - Heavy Rescue Equip.	OC18 - Heavy Rescue Equip.	BS5 - UPS 1000V	BS5 - UPS 1000V	OC18 - Heavy Rescue Equip.
OC20 - PPE	OC20 - PPE	BS6 - Water basin	BS6 - Water basin	OC20 - PPE
OC23 - Tower - Type 3	OC23 - Tower - Type 3	BS10 - Back-up communication	BS10 - Back-up communication	OC23 - Tower - Type 3
OC25 - Vehicle Extrication Pad	OC25 - Vehicle Extrication Pad	BI2 - Building replacement	BI2 - Building replacement	OC25 - Vehicle Extrication Pad
OC26 - Forcibly entry training	OC26 - Forcibly entry training	BI18 - Central HVAC	BI18 - Central HVAC	OC26 - Forcibly entry training
OC28 - Confined spaces - Type 2	OC28 - Confined spaces - Type 2	BI20 - Garage heating devices	BI20 - Garage heating devices	OC28 - Confined spaces - Type 2
OC29 - Small USAR facility	OC29 - Small USAR facility	BI25 - Garage - surface	BI25 - Garage - surface	OC29 - Small USAR facility
OC31 - Training centre	OC31 - Training centre	BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	OC31 - Training centre
BS1 - EDG - 15kW	BS2 - EDG - 10kW	BI27 - Garage - drainage	BI27 - Garage - drainage	BS1 - EDG - 15kW
BS4 - UPS 10kV	BS5 - UPS 1000V	BI28 - Garage - new doors	BI28 - Garage - new doors	BS4 - UPS 10kV
BS6 - Water basin	BS6 - Water basin	BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BS6 - Water basin
BS8 - Fuel storage with canisters	BS8 - Fuel storage with canisters	BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BS8 - Fuel storage with canisters

3_1_1	3_1_2	3_1_3	3_1_4	3_1_0
BS10 - Back-up communication	BS10 - Back-up communication	BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BS10 - Back-up communication
BI2 - Building replacement	BI2 - Building replacement	BI33 - Fire detectors	BI33 - Fire detectors	BI2 - Building replacement
BI18 - Central HVAC	BI18 - Central HVAC	BI34 - automatic fire suppression system	BI34 - automatic fire suppression system	BI18 - Central HVAC
BI20 - Garage heating devices	BI20 - Garage heating devices	BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	BI20 - Garage heating devices
BI25 - Garage - surface	BI25 - Garage - surface	BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	BI25 - Garage - surface
BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI37 - Cl. & decont. equipm. for PPE	BI37 - Cl. & decont. equipm. for PPE	BI26 - Garage - non-slip epoxy surface
BI27 - Garage - drainage	BI27 - Garage - drainage	BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks, chairs, shelves	BI27 - Garage - drainage
BI28 - Garage - new doors	BI28 - Garage - new doors	BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	BI28 - Garage - new doors
BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	BI30 - Fume exhaust system - source capture
BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	BI31 - Fume exhaust system - ventilation system
BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI43 - Communication room - furniture	BI43 - Communication room - furniture	BI32 - Fire extinguisher system
BI33 - Fire detectors	BI33 - Fire detectors	BI44 - Communication room - ITC equipment	BI44 - Communication room - ITC equipment	BI33 - Fire detectors
BI34 - automatic fire suppression system	BI34 - automatic fire suppression system	BI46 - Storage racks	BI46 - Storage racks	BI34 - automatic fire suppression system
BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	BI47 - Maintenance workshop	BI47 - Maintenance workshop	BI35 - Cleaning and decontamination room
BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	BI49 - Gas boiler	BI49 - Gas boiler	BI36 - Hose wash cleaning machine
BI37 - Cl. & decont. equipm. for PPE	BI37 - Cl. & decont. equipm. for PPE	BI51 - Fitness equipment	BI51 - Fitness equipment	BI37 - Cl. & decont. equipm. for PPE
BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks chairs, shelves	BI52 - Outside fitness area	BI52 - Outside fitness area	BI39 - Office furniture - desks, chairs, shelves
BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	SI1 - Yard pavement	SI1 - Yard pavement	BI40 - Kitchen & dayroom - furniture
BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	SI2 - Yard asphalt	SI2 - Yard asphalt	BI41 - Dormitory - furniture
BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	SI8 - Surveillance system	SI8 - Surveillance system	BI42 - Meeting/training room - furniture & equipment
BI43 - Communication room - furniture	BI43 - Communication room - furniture	SI9 - Cable Internet access	SI9 - Cable Internet access	BI43 - Communication room - furniture
BI44 - Communication room - ITC equipment	BI44 - Communication room - ITC equipment	SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access	BI44 - Communication room - ITC equipment
BI46 - Storage racks	BI46 - Storage racks			BI46 - Storage racks
BI47 - Maintenance workshop	BI47 - Maintenance workshop			BI47 - Maintenance workshop
BI49 - Gas boiler	BI49 - Gas boiler			BI49 - Gas boiler

3_1_1	3_1_2	3_1_3	3_1_4	3_1_0
BI51 - Fitness equipment	BI51 - Fitness equipment			BI51 - Fitness equipment
BI52 - Outside fitness area	BI52 - Outside fitness area			BI52 - Outside fitness area
SI1 - Yard pavement	SI1 - Yard pavement			SI1 - Yard pavement
SI2 - Yard asphalt	SI2 - Yard asphalt			SI2 - Yard asphalt
SI3 - Automatic gate	SI4 - Automatic barrier			SI3 - Automatic gate
SI4 - Automatic barrier	SI8 - Surveillance system			SI4 - Automatic barrier
SI5 - Traffic light system	SI9 - Cable Internet access			SI5 - Traffic light system
SI8 - Surveillance system	SI10 - Back-up cable Internet access			SI8 - Surveillance system
SI9 - Cable Internet access				SI9 - Cable Internet access
SI10 - Back-up cable Internet access				SI10 - Back-up cable Internet access

Table B.20: Sets of interventions for Option 3, Group 2

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC7 - Tanker Pumper Apparatus	OC4 - Emergency Tender - Type 2
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC12 - Snow Rescue Vehicle	OC5 - Triple Combination Pumper
OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC15 - Structural Firefighting Eq.	OC7 - Tanker Pumper Apparatus
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC17 - Rescue equipment	OC8 - Aerial Ladder
OC11 - Heavy Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC20 - PPE	OC10 - Small Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC14 - Command Vehicle	OC14 - Command Vehicle	BS3 - EDG-5kW	OC11 - Heavy Rescue Vehicle
OC14 - Command Vehicle	OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	BS5 - UPS 1000V	OC12 - Snow Rescue Vehicle
OC15 - Structural Firefighting Eq.	OC17 - Rescue equipment	OC17 - Rescue equipment	BS6 - Water basin	OC14 - Command Vehicle
OC17 - Rescue equipment	OC20 - PPE	OC20 - PPE	BS10 - Back-up communication	OC15 - Structural Firefighting Eq.
OC18 - Heavy Rescue Equip.	OC23 - Tower - Type 3	BS2 - EDG - 10kW	BI2 - Building replacement	OC17 - Rescue equipment
OC20 - PPE	OC25 - Vehicle Extrication Pad	BS5 - UPS 1000V	BI18 - Central HVAC	OC18 - Heavy Rescue Equip.
OC23 - Tower - Type 3	OC26 - Forcibly entry training	BS6 - Water basin	BI20 - Garage heating devices	OC20 - PPE

Class 1	Class 2	Class 3	Class 4	Class 0
OC25 - Vehicle Extrication Pad	OC28 - Confined spaces - Type 2	BS10 - Back-up communication	BI25 - Garage - surface	OC23 - Tower - Type 3
OC26 - Forcibly entry training	OC29 - Small USAR facility	BI2 - Building replacement	BI26 - Garage - non-slip epoxy surface	OC25 - Vehicle Extrication Pad
OC28 - Confined spaces - Type 2	OC31 - Training centre	BI18 - Central HVAC	BI27 - Garage - drainage	OC26 - Forcibly entry training
OC29 - Small USAR facility	BS2 - EDG - 10kW	BI20 - Garage heating devices	BI28 - Garage - new doors	OC28 - Confined spaces - Type 2
OC31 - Training centre	BS5 - UPS 1000V	BI25 - Garage - surface	BI30 - Fume exhaust system - source capture	OC29 - Small USAR facility
BS1 - EDG - 15kW	BS6 - Water basin	BI26 - Garage - non-slip epoxy surface	BI31 - Fume exhaust system - ventilation system	OC31 - Training centre
BS4 - UPS 10kV	BS8 - Fuel storage with canisters	BI27 - Garage - drainage	BI32 - Fire extinguisher system	BS1 - EDG - 15kW
BS6 - Water basin	BS10 - Back-up communication	BI28 - Garage - new doors	BI33 - Fire detectors	BS4 - UPS 10kV
BS8 - Fuel storage with canisters	BI2 - Building replacement	BI30 - Fume exhaust system - source capture	BI34 - automatic fire suppression system	BS6 - Water basin
BS10 - Back-up communication	BI18 - Central HVAC	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BS8 - Fuel storage with canisters
BI2 - Building replacement	BI20 - Garage heating devices	BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BS10 - Back-up communication
BI18 - Central HVAC	BI25 - Garage - surface	BI33 - Fire detectors	BI37 - Cl. & decont. equipm. for PPE	BI2 - Building replacement
BI20 - Garage heating devices	BI26 - Garage - non-slip epoxy surface	BI34 - automatic fire suppression system	BI39 - Office furniture - desks, chairs, shelves	BI18 - Central HVAC
BI25 - Garage - surface	BI27 - Garage - drainage	BI35 - Cleaning and decontamination room	BI40 - Kitchen & dayroom - furniture	BI20 - Garage heating devices
BI26 - Garage - non-slip epoxy surface	BI28 - Garage - new doors	BI36 - Hose wash cleaning machine	BI41 - Dormitory - furniture	BI25 - Garage - surface
BI27 - Garage - drainage	BI30 - Fume exhaust system - source capture	BI37 - Cl. & decont. equipm. for PPE	BI42 - Meeting/training room - furniture & equipment	BI26 - Garage - non-slip epoxy surface
BI28 - Garage - new doors	BI31 - Fume exhaust system - ventilation system	BI39 - Office furniture - desks, chairs, shelves	BI43 - Communication room - furniture	BI27 - Garage - drainage
BI30 - Fume exhaust system - source capture	BI32 - Fire extinguisher system	BI40 - Kitchen & dayroom - furniture	BI44 - Communication room - ITC equipment	BI28 - Garage - new doors
BI31 - Fume exhaust system - ventilation system	BI33 - Fire detectors	BI41 - Dormitory - furniture	BI46 - Storage racks	BI30 - Fume exhaust system - source capture
BI32 - Fire extinguisher system	BI34 - automatic fire suppression system	BI42 - Meeting/training room - furniture & equipment	BI47 - Maintenance workshop	BI31 - Fume exhaust system - ventilation system
BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI43 - Communication room - furniture	BI49 - Gas boiler	BI32 - Fire extinguisher system

Class 1	Class 2	Class 3	Class 4	Class 0
BI34 - automatic fire suppression system	BI36 - Hose wash cleaning machine	BI44 - Communication room - ITC equipment	BI51 - Fitness equipment	BI33 - Fire detectors
BI35 - Cleaning and decontamination room	BI37 - Cl. & decont. equipm. for PPE	BI46 - Storage racks	BI52 - Outside fitness area	BI34 - automatic fire suppression system
BI36 - Hose wash cleaning machine	BI39 - Office furniture - desks, chairs, shelves	BI47 - Maintenance workshop	SI1 - Yard pavement	BI35 - Cleaning and decontamination room
BI37 - Cl. & decont. equipm. for PPE	BI40 - Kitchen & dayroom - furniture	BI49 - Gas boiler	SI2 - Yard asphalt	BI36 - Hose wash cleaning machine
BI39 - Office furniture - desks, chairs, shelves	BI41 - Dormitory - furniture	BI51 - Fitness equipment	SI8 - Surveillance system	BI37 - Cl. & decont. equipm. for PPE
BI40 - Kitchen & dayroom - furniture	BI42 - Meeting/training room - furniture & equipment	BI52 - Outside fitness area	SI9 - Cable Internet access	BI39 - Office furniture - desks, chairs, shelves
BI41 - Dormitory - furniture	BI43 - Communication room - furniture	SI1 - Yard pavement	SI10 - Back-up cable Internet access	BI40 - Kitchen & dayroom - furniture
BI42 - Meeting/training room - furniture & equipment	BI44 - Communication room - ITC equipment	SI2 - Yard asphalt		BI41 - Dormitory - furniture
BI43 - Communication room - furniture	BI46 - Storage racks	SI8 - Surveillance system		BI42 - Meeting/training room - furniture & equipment
BI44 - Communication room - ITC equipment	BI47 - Maintenance workshop	SI9 - Cable Internet access		BI43 - Communication room - furniture
BI46 - Storage racks	BI49 - Gas boiler	SI10 - Back-up cable Internet access		BI44 - Communication room - ITC equipment
BI47 - Maintenance workshop	BI51 - Fitness equipment			BI46 - Storage racks
BI49 - Gas boiler	BI52 - Outside fitness area			BI47 - Maintenance workshop
BI51 - Fitness equipment	SI1 - Yard pavement			BI49 - Gas boiler
BI52 - Outside fitness area	SI2 - Yard asphalt			BI51 - Fitness equipment
SI1 - Yard pavement	SI4 - Automatic barrier			BI52 - Outside fitness area
SI2 - Yard asphalt	SI8 - Surveillance system			SI1 - Yard pavement
SI3 - Automatic gate	SI9 - Cable Internet access			SI2 - Yard asphalt
SI4 - Automatic barrier	SI10 - Back-up cable Internet access			SI3 - Automatic gate
SI5 - Traffic light system				SI4 - Automatic barrier
SI8 - Surveillance system				SI5 - Traffic light system
SI9 - Cable Internet access				SI8 - Surveillance system
SI10 - Back-up cable Internet access				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

Table B.21: Sets of interventions for Option 3, Group 4

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC5 - Triple Combination Pumper	OC7 - Tanker Pumper Apparatus	OC4 - Emergency Tender - Type 2
OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC7 - Tanker Pumper Apparatus	OC12 - Snow Rescue Vehicle	OC5 - Triple Combination Pumper
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC8 - Aerial Ladder	OC15 - Structural Firefighting Eq.	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC10 - Small Rescue Vehicle	OC17 - Rescue equipment	OC8 - Aerial Ladder
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC20 - PPE	OC10 - Small Rescue Vehicle
OC11 - Heavy Rescue Vehicle	OC11 - Heavy Rescue Vehicle	OC14 - Command Vehicle	BS3 - EDG-5kW	OC11 - Heavy Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting Eq.	BS5 - UPS 1000V	OC12 - Snow Rescue Vehicle
OC14 - Command Vehicle	OC14 - Command Vehicle	OC17 - Rescue equipment	BS6 - Water basin	OC14 - Command Vehicle
OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC20 - PPE	BS10 - Back-up communication	OC15 - Structural Firefighting Eq.
OC17 - Rescue equipment	OC17 - Rescue equipment	OC23 - Tower - Type 3	BI2 - Building replacement	OC17 - Rescue equipment
OC18 - Heavy Rescue Equip.	OC18 - Heavy Rescue Equip.	OC25 - Vehicle Extrication Pad	BI18 - Central HVAC	OC18 - Heavy Rescue Equip.
OC20 - PPE	OC20 - PPE	OC26 - Forcibly entry training	BI20 - Garage heating devices	OC20 - PPE
OC23 - Tower - Type 3	OC23 - Tower - Type 3	OC28 - Confined spaces - Type 2	BI25 - Garage - surface	OC23 - Tower - Type 3
OC25 - Vehicle Extrication Pad	OC25 - Vehicle Extrication Pad	OC29 - Small USAR facility	BI26 - Garage - non-slip epoxy surface	OC25 - Vehicle Extrication Pad
OC26 - Forcibly entry training	OC26 - Forcibly entry training	OC31 - Training centre	BI27 - Garage - drainage	OC26 - Forcibly entry training
OC28 - Confined spaces - Type 2	OC28 - Confined spaces - Type 2	BS2 - EDG - 10kW	BI28 - Garage - new doors	OC28 - Confined spaces - Type 2
OC29 - Small USAR facility	OC29 - Small USAR facility	BS5 - UPS 1000V	BI30 - Fume exhaust system - source capture	OC29 - Small USAR facility
OC31 - Training centre	OC31 - Training centre	BS6 - Water basin	BI31 - Fume exhaust system - ventilation system	OC31 - Training centre
BS1 - EDG - 15kW	BS2 - EDG - 10kW	BS10 - Back-up communication	BI32 - Fire extinguisher system	BS1 - EDG - 15kW
BS4 - UPS 10kV	BS5 - UPS 1000V	BI2 - Building replacement	BI33 - Fire detectors	BS4 - UPS 10kV
BS6 - Water basin	BS6 - Water basin	BI18 - Central HVAC	BI34 - automatic fire suppression system	BS6 - Water basin
BS8 - Fuel storage with canisters	BS8 - Fuel storage with canisters	BI20 - Garage heating devices	BI35 - Cleaning and decontamination room	BS8 - Fuel storage with canisters

Class 1	Class 2	Class 3	Class 4	Class 0
BS10 - Back-up communication	BS10 - Back-up communication	BI25 - Garage - surface	BI36 - Hose wash cleaning machine	BS10 - Back-up communication
BI2 - Building replacement	BI2 - Building replacement	BI26 - Garage - non-slip epoxy surface	BI37 - Cl. & decont. equipm. for PPE	BI2 - Building replacement
BI18 - Central HVAC	BI18 - Central HVAC	BI27 - Garage - drainage	BI39 - Office furniture - desks, chairs, shelves	BI18 - Central HVAC
BI20 - Garage heating devices	BI20 - Garage heating devices	BI28 - Garage - new doors	BI40 - Kitchen & dayroom - furniture	BI20 - Garage heating devices
BI25 - Garage - surface	BI25 - Garage - surface	BI30 - Fume exhaust system - source capture	BI41 - Dormitory - furniture	BI25 - Garage - surface
BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI31 - Fume exhaust system - ventilation system	BI42 - Meeting/training room - furniture & equipment	BI26 - Garage - non-slip epoxy surface
BI27 - Garage - drainage	BI27 - Garage - drainage	BI32 - Fire extinguisher system	BI43 - Communication room - furniture	BI27 - Garage - drainage
BI28 - Garage - new doors	BI28 - Garage - new doors	BI33 - Fire detectors	BI44 - Communication room - ITC equipment	BI28 - Garage - new doors
BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI34 - automatic fire suppression system	BI46 - Storage racks	BI30 - Fume exhaust system - source capture
BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI47 - Maintenance workshop	BI31 - Fume exhaust system - ventilation system
BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI36 - Hose wash cleaning machine	BI49 - Gas boiler	BI32 - Fire extinguisher system
BI33 - Fire detectors	BI33 - Fire detectors	BI37 - Cl. & decont. equipm. for PPE	BI51 - Fitness equipment	BI33 - Fire detectors
BI34 - automatic fire suppression system	BI34 - automatic fire suppression system	BI39 - Office furniture - desks, chairs, shelves	BI52 - Outside fitness area	BI34 - automatic fire suppression system
BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	BI40 - Kitchen & dayroom - furniture	SI1 - Yard pavement	BI35 - Cleaning and decontamination room
BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	BI41 - Dormitory - furniture	SI2 - Yard asphalt	BI36 - Hose wash cleaning machine
BI37 - Cl. & decont. equipm. for PPE	BI37 - Cl. & decont. equipm. for PPE	BI42 - Meeting/training room - furniture & equipment	SI6 - Retaining wall	BI37 - Cl. & decont. equipm. for PPE
BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks, chairs, shelves	BI43 - Communication room - furniture	SI7 - Drainage system	BI39 - Office furniture - desks, chairs, shelves
BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	BI44 - Communication room - ITC equipment	SI8 - Surveillance system	BI40 - Kitchen & dayroom - furniture
BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	BI46 - Storage racks	SI9 - Cable Internet access	BI41 - Dormitory - furniture
BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	BI47 - Maintenance workshop	SI10 - Back-up cable Internet access	BI42 - Meeting/training room - furniture & equipment
BI43 - Communication room - furniture	BI43 - Communication room - furniture	BI49 - Gas boiler		BI43 - Communication room - furniture
BI44 - Communication room - ITC equipment	BI44 - Communication room - ITC equipment	BI51 - Fitness equipment		BI44 - Communication room - ITC equipment
BI46 - Storage racks	BI46 - Storage racks	BI52 - Outside fitness area		BI46 - Storage racks

Class 1	Class 2	Class 3	Class 4	Class 0
BI47 - Maintenance workshop	BI47 - Maintenance workshop	SI1 - Yard pavement		BI47 - Maintenance workshop
BI49 - Gas boiler	BI49 - Gas boiler	SI2 - Yard asphalt		BI49 - Gas boiler
BI51 - Fitness equipment	BI51 - Fitness equipment	SI6 - Retaining wall		BI51 - Fitness equipment
BI52 - Outside fitness area	BI52 - Outside fitness area	SI7 - Drainage system		BI52 - Outside fitness area
SI1 - Yard pavement	SI1 - Yard pavement	SI8 - Surveillance system		SI1 - Yard pavement
SI2 - Yard asphalt	SI2 - Yard asphalt	SI9 - Cable Internet access		SI2 - Yard asphalt
SI3 - Automatic gate	SI4 - Automatic barrier	SI10 - Back-up cable Internet access		SI3 - Automatic gate
SI4 - Automatic barrier	SI6 - Retaining wall			SI4 - Automatic barrier
SI5 - Traffic light system	SI7 - Drainage system			SI5 - Traffic light system
SI6 - Retaining wall	SI8 - Surveillance system			SI6 - Retaining wall
SI7 - Drainage system	SI9 - Cable Internet access			SI7 - Drainage system
SI8 - Surveillance system	SI10 - Back-up cable Internet access			SI8 - Surveillance system
SI9 - Cable Internet access				SI9 - Cable Internet access
SI10 - Back-up cable Internet access				SI10 - Back-up cable Internet access

Table B.22: Sets of interventions for Option 3, Group 5

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC4 - Emergency Tender - Type 2
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC7 - Tanker Pumper Apparatus
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC8 - Aerial Ladder
OC14 - Command Vehicle	OC14 - Command Vehicle	OC14 - Command Vehicle	OC15 - Structural Firefighting Eq.	OC10 - Small Rescue Vehicle
OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC17 - Rescue equipment	OC12 - Snow Rescue Vehicle
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE	OC14 - Command Vehicle
OC20 - PPE	OC20 - PPE	OC20 - PPE	BS3 - EDG-5kW	OC15 - Structural Firefighting Eq.
OC23 - Tower - Type 3	OC23 - Tower - Type 3	BS2 - EDG - 10kW	BS5 - UPS 1000V	OC17 - Rescue equipment

Class 1	Class 2	Class 3	Class 4	Class 0
OC25 - Vehicle Extrication Pad	OC25 - Vehicle Extrication Pad	BS5 - UPS 1000V	BS10 - Back-up communication	OC20 - PPE
OC26 - Forcibly entry training	OC26 - Forcibly entry training	BS10 - Back-up communication	BI2 - Building replacement	BS1 - EDG - 15kW
OC28 - Confined spaces - Type 2	OC28 - Confined spaces - Type 2	BI2 - Building replacement	BI18 - Central HVAC	BS4 - UPS 10kV
OC29 - Small USAR facility	OC29 - Small USAR facility	BI18 - Central HVAC	BI20 - Garage heating devices	BS7 - Closed water basin
OC31 - Training centre	OC31 - Training centre	BI20 - Garage heating devices	BI25 - Garage - surface	BS10 - Back-up communication
BS2 - EDG - 10kW	BS2 - EDG - 10kW	BI25 - Garage - surface	BI26 - Garage - non-slip epoxy surface	BI2 - Building replacement
BS5 - UPS 1000V	BS5 - UPS 1000V	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BI18 - Central HVAC
BS10 - Back-up communication	BS10 - Back-up communication	BI27 - Garage - drainage	BI28 - Garage - new doors	BI20 - Garage heating devices
BI2 - Building replacement	BI2 - Building replacement	BI28 - Garage - new doors	BI30 - Fume exhaust system - source capture	BI25 - Garage - surface
BI18 - Central HVAC	BI18 - Central HVAC	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI26 - Garage - non-slip epoxy surface
BI20 - Garage heating devices	BI20 - Garage heating devices	BI31 - Fume exhaust system - ventilation system	BI32 - Fire extinguisher system	BI27 - Garage - drainage
BI25 - Garage - surface	BI25 - Garage - surface	BI32 - Fire extinguisher system	BI33 - Fire detectors	BI28 - Garage - new doors
BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI33 - Fire detectors	BI34 - automatic fire suppression system	BI30 - Fume exhaust system - source capture
BI27 - Garage - drainage	BI27 - Garage - drainage	BI34 - automatic fire suppression system	BI35 - Cleaning and decontamination room	BI31 - Fume exhaust system - ventilation system
BI28 - Garage - new doors	BI28 - Garage - new doors	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI32 - Fire extinguisher system
BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI36 - Hose wash cleaning machine	BI37 - Cl. & decont. equipm. for PPE	BI33 - Fire detectors
BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI37 - Cl. & decont. equipm. for PPE	BI39 - Office furniture - desks, chairs, shelves	BI34 - automatic fire suppression system
BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI35 - Cleaning and decontamination room
BI33 - Fire detectors	BI33 - Fire detectors	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI36 - Hose wash cleaning machine
BI34 - automatic fire suppression system	BI34 - automatic fire suppression system	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI37 - Cl. & decont. equipm. for PPE
BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI39 - Office furniture - desks, chairs, shelves

Class 1	Class 2	Class 3	Class 4	Class 0
BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	BI43 - Communication room - furniture	BI44 - Communication room - ITC equipment	BI40 - Kitchen & dayroom - furniture
BI37 - Cl. & decont. equipm. for PPE	BI37 - Cl. & decont. equipm. for PPE	BI44 - Communication room - ITC equipment	BI46 - Storage racks	BI41 - Dormitory - furniture
BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks, chairs, shelves	BI46 - Storage racks	BI47 - Maintenance workshop	BI42 - Meeting/training room - furniture & equipment
BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	BI47 - Maintenance workshop	BI49 - Gas boiler	BI43 - Communication room - furniture
BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	BI49 - Gas boiler	BI51 - Fitness equipment	BI44 - Communication room - ITC equipment
BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	BI51 - Fitness equipment	BI52 - Outside fitness area	BI46 - Storage racks
BI43 - Communication room - furniture	BI43 - Communication room - furniture	BI52 - Outside fitness area	SI1 - Yard pavement	BI47 - Maintenance workshop
BI44 - Communication room - ITC equipment	BI44 - Communication room - ITC equipment	SI1 - Yard pavement	SI2 - Yard asphalt	BI49 - Gas boiler
BI46 - Storage racks	BI46 - Storage racks	SI2 - Yard asphalt	SI6 - Retaining wall	BI51 - Fitness equipment
BI47 - Maintenance workshop	BI47 - Maintenance workshop	SI6 - Retaining wall	SI7 - Drainage system	BI52 - Outside fitness area
BI49 - Gas boiler	BI49 - Gas boiler	SI7 - Drainage system	SI8 - Surveillance system	SI1 - Yard pavement
BI51 - Fitness equipment	BI51 - Fitness equipment	SI8 - Surveillance system	SI9 - Cable Internet access	SI2 - Yard asphalt
BI52 - Outside fitness area	BI52 - Outside fitness area	SI9 - Cable Internet access	SI10 - Back-up cable Internet access	SI3 - Automatic gate
SI1 - Yard pavement	SI1 - Yard pavement	SI10 - Back-up cable Internet access		SI4 - Automatic barrier
SI2 - Yard asphalt	SI2 - Yard asphalt			SI5 - Traffic light system
SI4 - Automatic barrier	SI4 - Automatic barrier			SI6 - Retaining wall
SI6 - Retaining wall	SI6 - Retaining wall			SI7 - Drainage system
SI7 - Drainage system	SI7 - Drainage system			SI8 - Surveillance system
SI8 - Surveillance system	SI8 - Surveillance system			SI9 - Cable Internet access
SI9 - Cable Internet access	SI9 - Cable Internet access			SI10 - Back-up cable Internet access
SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access			

Table B.23: Sets of interventions for Option 3, Group 6

3_6_1	3_6_2	3_6_3	3_6_4	3_6_0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	
OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC8 - Aerial Ladder	
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	
OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	
OC14 - Command Vehicle	OC14 - Command Vehicle	OC14 - Command Vehicle	OC15 - Structural Firefighting Eq.	
OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC15 - Structural Firefighting Eq.	OC17 - Rescue equipment	
OC17 - Rescue equipment	OC17 - Rescue equipment	OC17 - Rescue equipment	OC20 - PPE	
OC20 - PPE	OC20 - PPE	OC20 - PPE	OC21 - Tower - Type 1	
BS1 - EDG - 15kW	BS1 - EDG - 15kW	BS2 - EDG - 10kW	BS3 - EDG-5kW	
BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS5 - UPS 1000V	BS5 - UPS 1000V	
BS4 - UPS 10kV	BS4 - UPS 10kV	BS10 - Back-up communication	BS10 - Back-up communication	
BS7 - Closed water basin	BS7 - Closed water basin	BI2 - Building replacement	BI2 - Building replacement	
BS10 - Back-up communication	BS10 - Back-up communication	BI18 - Central HVAC	BI18 - Central HVAC	
BI2 - Building replacement	BI2 - Building replacement	BI20 - Garage heating devices	BI20 - Garage heating devices	
BI18 - Central HVAC	BI18 - Central HVAC	BI25 - Garage - surface	BI25 - Garage - surface	
BI20 - Garage heating devices	BI20 - Garage heating devices	BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	
BI25 - Garage - surface	BI25 - Garage - surface	BI27 - Garage - drainage	BI27 - Garage - drainage	
BI26 - Garage - non-slip epoxy surface	BI26 - Garage - non-slip epoxy surface	BI28 - Garage - new doors	BI28 - Garage - new doors	
BI27 - Garage - drainage	BI27 - Garage - drainage	BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	
BI28 - Garage - new doors	BI28 - Garage - new doors	BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	
BI30 - Fume exhaust system - source capture	BI30 - Fume exhaust system - source capture	BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	
BI31 - Fume exhaust system - ventilation system	BI31 - Fume exhaust system - ventilation system	BI33 - Fire detectors	BI33 - Fire detectors	
BI32 - Fire extinguisher system	BI32 - Fire extinguisher system	BI34 - automatic fire suppression system	BI34 - automatic fire suppression system	
BI33 - Fire detectors	BI33 - Fire detectors	BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	
BI34 - automatic fire suppression system	BI34 - automatic fire suppression system	BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	
BI35 - Cleaning and decontamination room	BI35 - Cleaning and decontamination room	BI37 - Cl. & decont. equipm. for PPE	BI37 - Cl. & decont. equipm. for PPE	

3_6_1	3_6_2	3_6_3	3_6_4	3_6_0
BI36 - Hose wash cleaning machine	BI36 - Hose wash cleaning machine	BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks, chairs, shelves	
BI37 - Cl. & decont. equipm. for PPE	BI37 - Cl. & decont. equipm. for PPE	BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	
BI39 - Office furniture - desks, chairs, shelves	BI39 - Office furniture - desks, chairs, shelves	BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	
BI40 - Kitchen & dayroom - furniture	BI40 - Kitchen & dayroom - furniture	BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	
BI41 - Dormitory - furniture	BI41 - Dormitory - furniture	BI43 - Communication room - furniture	BI43 - Communication room - furniture	
BI42 - Meeting/training room - furniture & equipment	BI42 - Meeting/training room - furniture & equipment	BI44 - Communication room - ITC equipment	BI44 - Communication room - ITC equipment	
BI43 - Communication room - furniture	BI43 - Communication room - furniture	BI46 - Storage racks	BI46 - Storage racks	
BI44 - Communication room - ITC equipment	BI44 - Communication room - ITC equipment	BI47 - Maintenance workshop	BI47 - Maintenance workshop	
BI46 - Storage racks	BI46 - Storage racks	BI49 - Gas boiler	BI49 - Gas boiler	
BI47 - Maintenance workshop	BI47 - Maintenance workshop	BI51 - Fitness equipment	BI51 - Fitness equipment	
BI49 - Gas boiler	BI49 - Gas boiler	BI52 - Outside fitness area	BI52 - Outside fitness area	
BI51 - Fitness equipment	BI51 - Fitness equipment	SI9 - Cable Internet access	SI9 - Cable Internet access	
BI52 - Outside fitness area	BI52 - Outside fitness area	SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access	
SI9 - Cable Internet access	SI9 - Cable Internet access			
SI10 - Back-up cable Internet access	SI10 - Back-up cable Internet access			

B.1.4 Sets of Interventions for Option 4

Table B.24: Sets of interventions for Option 4, Group 1, 2, 3, 4, 5, 6

Class 1	Class 2	Class 3	Class 4	Class 0
OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle	OC1 - Brigade Response Vehicle
OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus	OC2 - Wildland Apparatus
OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1	OC3 - Emergency Tender - Type 1

Class 1	Class 2	Class 3	Class 4	Class 0
OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2	OC4 - Emergency Tender - Type 2
OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper	OC5 - Triple Combination Pumper
OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus	OC7 - Tanker Pumper Apparatus
OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC8 - Aerial Ladder	OC8 - Aerial Ladder
OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC10 - Small Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC10 - Small Rescue Vehicle
OC11 - Heavy Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC11 - Heavy Rescue Vehicle
OC12 - Snow Rescue Vehicle	OC15 - Structural Firefighting ensembles	OC15 - Structural Firefighting ensembles	OC17 - Rescue equipment	OC12 - Snow Rescue Vehicle
OC13 - Swap body vehicles	OC17 - Rescue equipment	OC17 - Rescue equipment	OC18 - Heavy Rescue Equip.	OC13 - Swap body vehicles
OC14 - Command Vehicle	OC18 - Heavy Rescue Equip.	OC18 - Heavy Rescue Equip.	OC20 - PPE (SCBA)	OC14 - Command Vehicle
OC15 - Structural Firefighting ensembles	OC20 - PPE (SCBA)	OC20 - PPE (SCBA)	OC23 - Tower - Type 3	OC15 - Structural Firefighting ensembles
OC17 - Rescue equipment	OC23 - Tower - Type 3	OC23 - Tower - Type 3	OC24 - Mobile Tower	OC17 - Rescue equipment
OC18 - Heavy Rescue Equip.	OC24 - Mobile Tower	OC24 - Mobile Tower	OC25 - Vehicle Extrication Pad	OC18 - Heavy Rescue Equip.
OC20 - PPE (SCBA)	OC25 - Vehicle Extrication Pad	OC25 - Vehicle Extrication Pad	OC26 - Forcibly entry training	OC19 - Water rescue equip.
OC23 - Tower - Type 3	OC26 - Forcibly entry training	OC26 - Forcibly entry training	OC27 - Confined spaces - Type 1	OC20 - PPE (SCBA)
OC24 - Mobile Tower	OC27 - Confined spaces - Type 1	OC27 - Confined spaces - Type 1	OC29 - Small USAR facility	OC23 - Tower - Type 3
OC25 - Vehicle Extrication Pad	OC29 - Small USAR facility	OC29 - Small USAR facility	OC30 - Large USAR facility	OC24 - Mobile Tower

Class 1	Class 2	Class 3	Class 4	Class 0
OC26 - Forcibly entry training	OC30 - Large USAR facility	OC30 - Large USAR facility	OC32 - PC and IT equipment	OC25 - Vehicle Extrication Pad
OC28 - Confined spaces - Type 2	OC32 - PC and IT equipment	OC32 - PC and IT equipment	BS2 - EDG - 10kW	OC26 - Forcibly entry training
OC29 - Small USAR facility	BS2 - EDG - 10kW	BS2 - EDG - 10kW	BS5 - UPS 1000V	OC28 - Confined spaces - Type 2
OC30 - Large USAR facility	BS5 - UPS 1000V	BS5 - UPS 1000V	BS6 - Water basin	OC29 - Small USAR facility
OC32 - PC and IT equipment	BS6 - Water basin	BS6 - Water basin	BS10 - Back-up communication	OC30 - Large USAR facility
BS1 - EDG - 15kW	BS8 - Fuel storage with canisters	BS10 - Back-up communication	BI1 - Building replacement with relocation	OC32 - PC and IT equipment
BS4 - UPS 10kV	BS10 - Back-up communication	BI1 - Building replacement with relocation	BI20 - Garage heating devices	BS1 - EDG - 15kW
BS6 - Water basin	BI1 - Building replacement with relocation	BI20 - Garage heating devices	BI26 - Garage - non-slip epoxy surface	BS4 - UPS 10kV
BS8 - Fuel storage with canisters	BI20 - Garage heating devices	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BS6 - Water basin
BS10 - Back-up communication	BI26 - Garage - non-slip epoxy surface	BI27 - Garage - drainage	BI28 - Garage - new doors	BS8 - Fuel storage with canisters
BI1 - Building replacement with relocation	BI27 - Garage - drainage	BI28 - Garage - new doors	BI30 - Fume exhaust system - source capture	BS10 - Back-up communication
BI20 - Garage heating devices	BI28 - Garage - new doors	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI1 - Building replacement with relocation
BI26 - Garage - non-slip epoxy surface	BI30 - Fume exhaust system - source capture	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and decontamination room	BI20 - Garage heating devices
BI27 - Garage - drainage	BI31 - Fume exhaust system - ventilation system	BI35 - Cleaning and	BI36 - Hose wash cleaning machine	BI26 - Garage - non-slip epoxy surface

Class 1	Class 2	Class 3	Class 4	Class 0
		decontamination room		
BI28 - Garage - new doors	BI35 - Cleaning and decontamination room	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI27 - Garage - drainage
BI30 - Fume exhaust system - source capture	BI36 - Hose wash cleaning machine	BI37 - Laundering equipment for FRS	BI39 - Office furniture - desks, chairs, shelves	BI28 - Garage - new doors
BI31 - Fume exhaust system - ventilation system	BI37 - Laundering equipment for FRS	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI30 - Fume exhaust system - source capture
BI35 - Cleaning and decontamination room	BI39 - Office furniture - desks, chairs, shelves	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI31 - Fume exhaust system - ventilation system
BI36 - Hose wash cleaning machine	BI40 - Kitchen & dayroom - furniture	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI35 - Cleaning and decontamination room
BI37 - Laundering equipment for FRS	BI41 - Dormitory - furniture	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI36 - Hose wash cleaning machine
BI39 - Office furniture - desks, chairs, shelves	BI42 - Meeting/training room - furniture & equipment	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI37 - Laundering equipment for FRS
BI40 - Kitchen & dayroom - furniture	BI43 - Communication room - furniture	BI44 - Communication room - ICT equipment	BI46 - Storage racks	BI39 - Office furniture - desks, chairs, shelves
BI41 - Dormitory - furniture	BI44 - Communication room - ICT equipment	BI46 - Storage racks	BI47 - Maintenance workshop	BI40 - Kitchen & dayroom - furniture
BI42 - Meeting/training	BI46 - Storage racks	BI47 - Maintenance workshop	BI51 - Fitness equipment	BI41 - Dormitory - furniture

Class 1	Class 2	Class 3	Class 4	Class 0
room - furniture & equipment				
BI43 - Communication room - furniture	BI47 - Maintenance workshop	BI51 - Fitness equipment	BI52 - Outside fitness area	BI42 - Meeting/training room - furniture & equipment
BI44 - Communication room - ICT equipment	BI51 - Fitness equipment	BI52 - Outside fitness area	BI54 - Solar water heater	BI43 - Communication room - furniture
BI46 - Storage racks	BI52 - Outside fitness area	BI54 - Solar water heater	BI55 - Intensive cleaing and repair centre	BI44 - Communication room - ICT equipment
BI47 - Maintenance workshop	BI54 - Solar water heater	BI55 - Intensive cleaing and repair centre	SI1 - Yard pavement	BI46 - Storage racks
BI51 - Fitness equipment	BI55 - Intensive cleaing and repair centre	SI1 - Yard pavement	SI2 - Yard asphalt	BI47 - Maintenance workshop
BI52 - Outside fitness area	SI1 - Yard pavement	SI2 - Yard asphalt	SI3 - Automatic gate	BI51 - Fitness equipment
BI54 - Solar water heater	SI2 - Yard asphalt	SI3 - Automatic gate	SI4 - Automatic barrier	BI52 - Outside fitness area
BI55 - Intensive cleaing and repair centre	SI3 - Automatic gate	SI4 - Automatic barrier	SI8 - Surveillance system	BI54 - Solar water heater
SI1 - Yard pavement	SI4 - Automatic barrier	SI8 - Surveillance system	SI9 - Cable Internet access	BI55 - Intensive cleaing and repair centre
SI2 - Yard asphalt	SI5 - Traffic light system	SI9 - Cable Internet access	SI10 - Back-up cable Internet access	SI1 - Yard pavement
SI3 - Automatic gate	SI8 - Surveillance system	SI10 - Back-up cable Internet access		SI2 - Yard asphalt
SI4 - Automatic barrier	SI9 - Cable Internet access			SI3 - Automatic gate

Class 1	Class 2	Class 3	Class 4	Class 0
SI5 - Traffic light system	SI10 - Back-up cable Internet access			SI4 - Automatic barrier
SI8 - Surveillance system				SI5 - Traffic light system
SI9 - Cable Internet access				SI6 - Retaining wall
SI10 - Back-up cable Internet access				SI7 - Drainage system
				SI8 - Surveillance system
				SI9 - Cable Internet access
				SI10 - Back-up cable Internet access

B.2 Expected improvement in FRS after intervention

The expected potential for improvement of each option when applied on stations in each group is presented in Table B.25. The expected potential for improvement presented in Table B.25 is initially based on the descriptions for the upgrade options and the deficiency. For example: for a station with infrastructure without any major issues hindering its operation only repair and renovation works will be sufficient improvement.

Table B.25: Expected potential for improvement

	Intervention option	**Option 1 Repair**	**Option 2 Expansion**	**Option 3 Replacement**	**Option 4 Relocation**
Deficiency group	**Definitions**	**Intervention in the existing building and site,**	**Increasing the building area or rebuying shared parts and interventions in the existing building and site**	**New building on the same site**	**Relocating the FRS in a new building**
Group 1 Without remarks	**FRS with sufficient size of the infrastructure and no major issues**	Great potential the FRS can reach a level compatible with the international best practices	Great potential the FRS can reach a level compatible with the international best practices	Great potential the FRS can reach a level compatible with the international best practices	Great potential the FRS can reach a level compatible with the international best practices
Group 2 Small-sized infrastructure	**FRS with insufficient size of the infrastructure and no major issues**	Some potential the FRS can meet basic requirements for the firefighters health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated	Good potential the FRS can meet basic requirements for the firefighters health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be met. All back-up systems can be implemented. At least four of the functional zones can be obtained (with less area than the tolerable defined in SP...) and clean and contaminated areas can be separated	Great potential the FRS can reach a level compatible with the international best practices	Great potential the FRS can reach a level compatible with the international best practices

	Intervention option	Option 1 Repair	Option 2 Expansion	Option 3 Replacement	Option 4 Relocation
Group 3 Shared ownership	**FRS with shared ownership**	Only minor partial interventions will be possible, until the FRS has full ownership on the building	Good potential the FRS can meet basic requirements for the firefighters health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be met. All back-up systems can be implemented. At least four of the functional zones can be obtained (with less area than the tolerable defined in SP...) and clean and contaminated areas can be separated	Not applicable	Great potential the FRS can reach a level compatible with the international best practices
Group 4 Poor building infrastructure	**FRS with insufficient size of the infrastructure, in bad state and hazards expected on the site**	Limited potential the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be partially met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated	Some potential the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated	Great potential the FRS can reach a level compatible with the international best practices	Great potential the FRS can reach a level compatible with the international best practices

	Intervention option	**Option 1** **Repair**	**Option 2** **Expansion**	**Option 3** **Replacement**	**Option 4** **Relocation**
Group 5 **Poor building and site infrastructure**	**FRS with insufficient size of the infrastructure, in bad state and expected hazards and additional problems on the site**	Limited potential the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be partially met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated	Limited potential the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be partially met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated	Some potential the FRS can meet basic requirements for the firefighters' health and safety, the equipment level can be improved, smaller new vehicles can be added, basic requirement for maintenance and storage can be met. Electricity and communication back-up systems can be implemented. Clean and contaminated areas can be partially separated	Great potential the FRS can reach a level compatible with the international best practices
Group 6 **For relocation**	**FRS known to be planned for replacement**	No potential Only measures that are with high impact and low cost, vital for the FRS operation, and can be transferred are to be applied. No further investments are justifiable. This means any present inside hazards have to be removed. New vehicles, special equipment, electricity and communication back-ups, communication lines on site (internet and phone connection, computer for the communication room) can be applied	Not justifiable	Not justifiable	Great potential the FRS can reach a level compatible with the international best practices

A further justification of the expected improvement was provided with the relative qualitative procedure [P1] The definitions of the criteria for scoring the parameters described in [P1] are such that a direct unambiguous relation between a single measure and a single parameter can't be defined. For this reason the expected increase in the parameter's value is logically assumed based on the definitions of the criteria for scoring the parameters [P1] and the sets of measures. The assumed increase in the parameters values after applying the intervention sets (B.1.1 to B.1.4) are presented in detail in B.2.1, B.2.2, B.2.3, B.2.4

The expected improvement of each station with each applicable upgrade option is then calculated according to the relative scoring procedure in [P1]. The results are presented on Figure B.2, Figure B.3, Figure B.4, Figure B.5.

Figure B.2: Possible improvement in operational capacity, depending on the chosen intervention option for each FRS

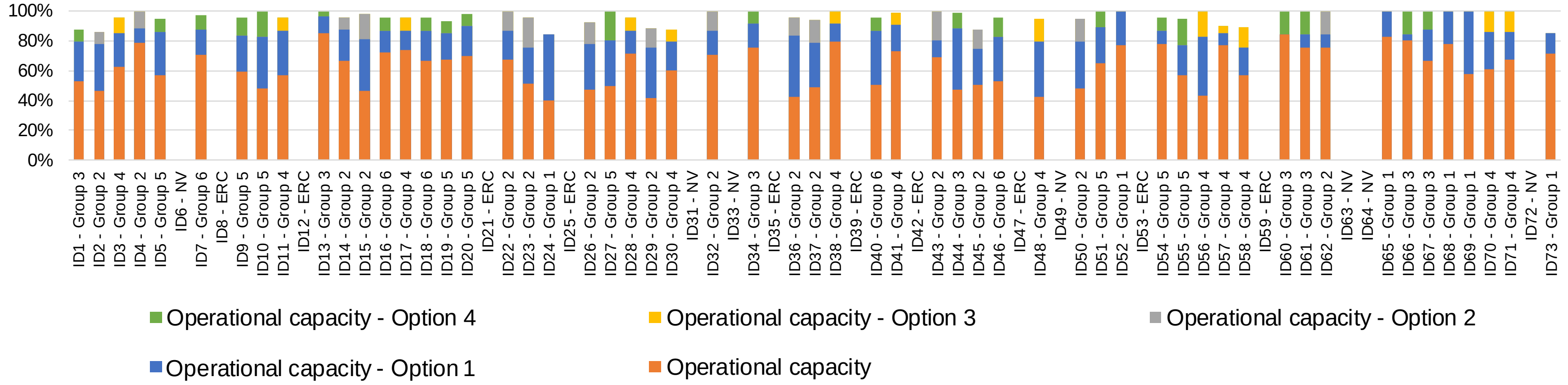


Figure B.3: Possible improvement in back-up systems, depending on the chosen intervention option for each FRS

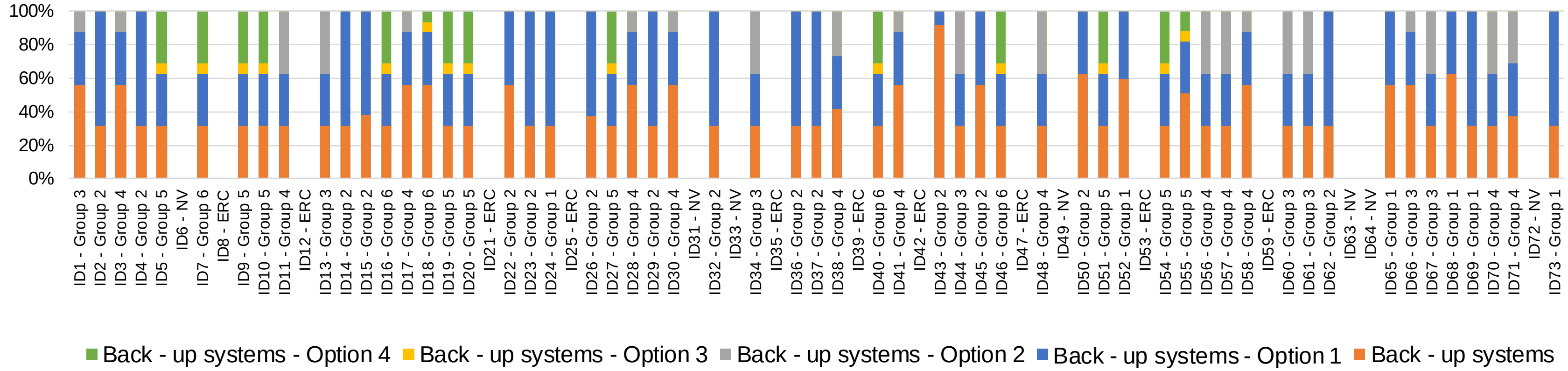


Figure B.4: Possible improvement in building infrastructure, depending on the chosen intervention option for each FRS

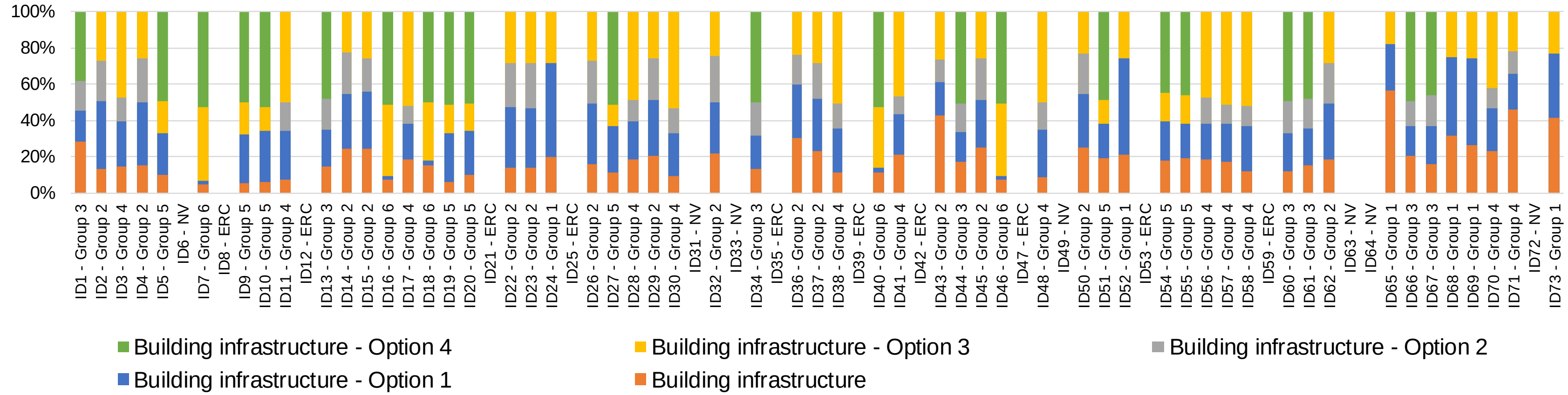
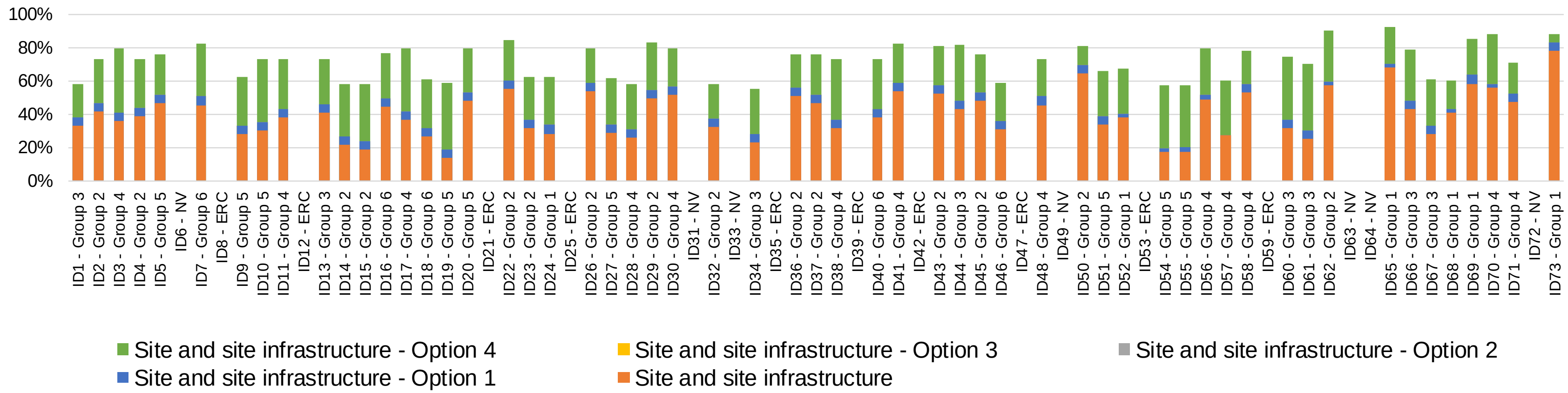


Figure B.5: Possible improvement in site infrastructure, depending on the chosen intervention option for each FRS



B.2.1 Option 1: Repair - Increase in the values of the parameters

Table B.26: Option 1: Repair

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Staff number	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Shift Size	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Large fire trucks	Po	unchanged	unchanged	unchanged	unchanged	unchanged
Ladder trucks	Po	unchanged	unchanged	unchanged	unchanged	unchanged
Large Rescue Trucks	Po	unchanged	unchanged	unchanged	unchanged	unchanged
Off-road fire trucks	Po	unchanged	unchanged	unchanged	unchanged	unchanged
Small off-road fire trucks	Po	Pt	Pt	Pt	Pt	Pt
Small off-road rescue vehicles	Po	Pt	Pt	Pt	Pt	Pt
Special cars for deep snow	Po	Pt	Pt	Pt	Pt	Pt
Average age of fire vehicles	some improvement	some improvement	some improvement	some improvement	some improvement	some improvement
Average age of rescue vehicles	some improvement	some improvement	some improvement	some improvement	some improvement	some improvement
Specialist Equipment	Po	Po	Po	Po	Po	Po
Training facilities	Po	Pt	unchanged	Pt	Pt	unchanged
Electricity (hrs)	Po	Po	Po	Po	Po	Po
water (m3)	Po	Po	unchanged	unchanged	unchanged	unchanged
fuel (l)	Po	Po	unchanged	unchanged	unchanged	unchanged
Communication (hrs)	Po	Po	Po	Po	Po	Po
Equipment (outside of building)	Po	Po	unchanged	unchanged	unchanged	unchanged
Building age	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Garage area	Po	Pt	unchanged	unchanged	unchanged	unchanged
Bays (number)	Po	unchanged	unchanged	unchanged	unchanged	unchanged
Garage height	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Structure	Pt	Pt	unchanged	Pt	Pt	unchanged
Building envelope / Facades	between Pt and Po	between Pt and Po	unchanged	between Pt and Po	between Pt and Po	unchanged
Roof	between Pt and Po	between Pt and Po	unchanged	between Pt and Po	between Pt and Po	unchanged
Foundation	Pt	Pt	unchanged	unchanged	unchanged	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Surface & drainage	Po	Po	Po	Po	Po	unchanged
Natural light	Po	Po	Po	Po	Po	unchanged
Doors	Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Fume/exhaust extraction systems	Po	Po	Po	Po	Po	unchanged
Internal hazards (gas, el cables, heavy eq)	Po	Po	Po	Po	Po	Po
Fire suppression system	Po	Po	Po	Po	Po	unchanged
Garage winter temp (deg C)	Po	Po	Po	Po	Po	unchanged
Lightning Protection	Po	Po	Po	Po	Po	unchanged
Energy Efficiency	Po	Po	between Pt and Po	Po	Po	unchanged
Internal Storage Space	Pt	unchanged	unchanged	unchanged	unchanged	unchanged
Maintenance area	Pt	unchanged	unchanged	unchanged	unchanged	unchanged
Cleaning and decontamination area (trucks)	Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Hose-wash area and drying tower	Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Building age	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Total area, m2	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Functional Zones, count	Po	Pt	unchanged	unchanged	unchanged	unchanged
Architectural layout	Po	between Pt and Po	Pt	Pt	Pt	unchanged
Structure (1 to 5)	Pt	Pt	unchanged	Pt	Pt	unchanged
Building envelope / Facades	between Pt and Po	between Pt and Po	unchanged	between Pt and Po	between Pt and Po	unchanged
Partition walls	Pt	Pt	unchanged	Pt	Pt	unchanged
Roof	between Pt and Po	between Pt and Po	unchanged	between Pt and Po	between Pt and Po	unchanged
Foundation	Pt	Pt	unchanged	Pt	Pt	unchanged
Administration zone	Po	Pt	unchanged	unchanged	unchanged	unchanged
Communication room	Po	Pt	unchanged	unchanged	unchanged	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Dinning and Recreational	Po	Pt	unchanged	unchanged	unchanged	unchanged
Training/meeting room	Po	Pt	unchanged	unchanged	unchanged	unchanged
Sleeping quarters	Po	Pt	unchanged	unchanged	unchanged	unchanged
Support, Storage and Cleaning	Po	Pt	unchanged	unchanged	unchanged	unchanged
Fitness	Po	Pt	unchanged	unchanged	unchanged	unchanged
Lightning Protection System	Po	Po	Po	Po	Po	unchanged
Energy Efficiency	Po	Po	between Pt and Po	Po	Po	unchanged
Fire Suppression System	Po	Po	Po	Po	Po	unchanged
Internal hazards (gas, el cables, heavy eq)	Po	Po	between Pt and Po	Po	Po	Po
running water	Po	Po	Pt	Pt	Pt	unchanged
canalisation	Po	Po	Pt	Pt	Pt	unchanged
hot water	Po	Po	Pt	Pt	Pt	unchanged
showers (numbers)	Po	Po	Pt	Pt	Pt	unchanged
Washrooms (numbers)	Po	Po	Pt	Pt	Pt	unchanged
Bathrooms	Po	Po	Pt	Pt	Pt	unchanged
Toilets	Po	Po	Pt	Pt	Pt	unchanged
Heating	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Cooling	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Management and administration	Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Communication room	Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	Pt
Sleeping quarters	Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Kitchen, dining and day room	Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Meeting and training room	Po	Pt	unchanged	unchanged	unchanged	unchanged
Fitness room	Po	Pt	unchanged	unchanged	unchanged	unchanged
Shared ownership	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Location	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Site hazards	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Access road	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Number of exits	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Exit to access road	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Electricity	Pt	unchanged	unchanged	unchanged	unchanged	unchanged
Gas or district heating	Pt	unchanged	unchanged	unchanged	unchanged	unchanged
Water (for fire trucks)	Pt	unchanged	unchanged	unchanged	unchanged	unchanged
Communications	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po
Average Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Average Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Site Size	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged

B.2.2 Option 2: Expansion – Increase in the Values of the Parameters

Table B.27: Option 2: Expansion

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Staff number	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Shift Size	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Large fire trucks	Po	Po	unchanged	unchanged	unchanged	unchanged
Ladder trucks	Po	Po	unchanged	unchanged	unchanged	unchanged
Large Rescue Trucks	Po	Po	unchanged	unchanged	unchanged	unchanged
Off-road fire trucks	Po	Po	unchanged	unchanged	unchanged	unchanged
Small off-road fire trucks	Po	Po	Pt	Pt	Pt	unchanged
Small off-road rescue vehicles	Po	Po	Pt	Pt	Pt	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Special cars for deep snow	Po	Po	Pt	Pt	Pt	unchanged
Average age of fire vehicles	some improvement	some improvement	some improvement	some improvement	some improvement	unchanged
Average age of rescue vehicles	some improvement	some improvement	some improvement	some improvement	some improvement	unchanged
Specialist Equipment	Po	Po	Po	Po	Po	unchanged
Training facilities	Po	Po	Pt	Pt	unchanged	unchanged
Electricity (hrs)	Po	Po	Po	Po	Po	unchanged
water (m3)	Po	Po	Po	Po	unchanged	unchanged
fuel (l)	Po	Po	Po	Po	unchanged	unchanged
Communication (hrs)	Po	Po	Po	Po	Po	unchanged
Equipment (outside of building)	Po	Po	Po	Po	unchanged	unchanged
Building age	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Garage area	Po	Po	Pt	Pt	unchanged	unchanged
Bays (number)	Po	Po	unchanged	unchanged	unchanged	unchanged
Garage height	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Structure	Pt	Pt	Pt	Pt	Pt	unchanged
Building envelope / Facades	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Roof	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Foundation	Pt	Pt	Pt	Pt	unchanged	unchanged
Surface & drainage	Po	Po	Po	Po	Po	unchanged
Natural light	Po	Po	Po	Po	Po	unchanged
Doors	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Fume/exhaust extraction systems	Po	Po	Po	Po	Po	unchanged
Internal hazards (gas, el cables, heavy eq)	Po	Po	Po	Po	Po	unchanged
Fire suppression system	Po	Po	Po	Po	Po	unchanged
Garage winter temp (deg C)	Po	Po	Po	Po	Po	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Lightning Protection	Po	Po	Po	Po	Po	unchanged
Energy Efficiency	Po	Po	Po	Po	Po	unchanged
Internal Storage Space	Po	Pt	unchanged	unchanged	unchanged	unchanged
Maintenance area	Po	Pt	unchanged	unchanged	unchanged	unchanged
Cleaning and decontamination area (trucks)	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Hose-wash area and drying tower	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Building age	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Total area, m2	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Functional Zones, count	Po	Po	Pt	Pt	unchanged	unchanged
Architectural layout	Po	Po	between Pt and Po	between Pt and Po	Pt	unchanged
Structure	Pt	Pt	Pt	Pt	Pt	unchanged
Building envelope / Facades	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Partition walls	Pt	Pt	Pt	Pt	Pt	unchanged
Roof	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Foundation	Pt	Pt	Pt	Pt	Pt	unchanged
Administration zone	Po	Po	Pt	Pt	unchanged	unchanged
Communication room	Po	Po	Pt	Pt	unchanged	unchanged
Dinning and Recreational	Po	Po	Pt	Pt	unchanged	unchanged
Training/meeting room	Po	Po	Pt	Pt	unchanged	unchanged
Sleeping quarters	Po	Po	Pt	Pt	unchanged	unchanged
Support, Storage and Cleaning	Po	Po	Pt	Pt	unchanged	unchanged
Fitness	Po	Po	Pt	Pt	unchanged	unchanged
Lightning Protection System	Po	Po	Po	Po	Po	unchanged
Energy Efficiency	Po	Po	Po	Po	Po	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Fire Suppression System	Po	Po	Po	Po	Po	unchanged
Internal hazards (gas, el cables, heavy eq)	Po	Po	Po	Po	Po	unchanged
running water	Po	Po	Po	Po	Pt	unchanged
canalisation	Po	Po	Po	Po	Pt	unchanged
hot water	Po	Po	Po	Po	Pt	unchanged
showers (numbers)	Po	Po	Po	Po	Pt	unchanged
Washrooms (numbers)	Po	Po	Po	Po	Pt	unchanged
Bathrooms	Po	Po	Po	Po	Pt	unchanged
Toilets	Po	Po	Po	Po	Pt	unchanged
Heating	Po	Po	Po	Po	between Pt and Po	unchanged
Cooling	Po	Po	Po	Po	between Pt and Po	unchanged
Management and administration	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Communication room	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Sleeping quarters	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Kitchen, dining and day room	Po	Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged
Meeting and training room	Po	Po	Pt	Pt	unchanged	unchanged
Fitness room	Po	Po	Pt	Pt	unchanged	unchanged
Shared ownership	unchanged	unchanged	Po	unchanged	unchanged	unchanged
Location	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Site hazards	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Access road	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Number of exits	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Exit to access road	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Electricity	Pt	Pt	unchanged	unchanged	unchanged	unchanged
Gas or district heating	Pt	Pt	unchanged	unchanged	unchanged	unchanged
Water (for fire trucks)	Pt	Pt	unchanged	unchanged	unchanged	unchanged
Communications	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	between Pt and Po	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Average Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Average Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Site Size	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged

B.2.3 Option 3: Replacement – Increase in the Values of the Parameters

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Staff number	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Shift Size	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Large fire trucks	Po	Po	unchanged	Po	unchanged	unchanged
Ladder trucks	Po	Po	unchanged	Po	unchanged	unchanged
Large Rescue Trucks	Po	Po	unchanged	Po	unchanged	unchanged
Off-road fire trucks	Po	Po	unchanged	Po	unchanged	unchanged
Small off-road fire trucks	Po	Po	unchanged	Po	Pt	Pt
Small off-road rescue vehicles	Po	Po	unchanged	Po	Pt	Pt
Special cars for deep snow	Po	Po	unchanged	Po	Pt	Pt
Average age of fire vehicles	some improvement	some improvement	unchanged	some improvement	some improvement	some improvement
Average age of rescue vehicles	some improvement	some improvement	unchanged	some improvement	some improvement	some improvement
Specialist Equipment	Po	Po	unchanged	Po	Po	Po
Training facilities	Po	Po	unchanged	Po	Pt	Pt
Electricity (hrs)	Po	Po	unchanged	Po	Po	Po
water (m3)	Po	Po	unchanged	Po	unchanged	unchanged
fuel (l)	Po	Po	unchanged	Po	unchanged	unchanged
Communication (hrs)	Po	Po	unchanged	Po	Po	Po

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Equipment (outside of building)	Po	Po	unchanged	Po	unchanged	unchanged
Building age	Po	Po	unchanged	Po	Po	Po
Garage area	Po	Po	unchanged	Po	Pt	Pt
Bays (number)	Po	Po	unchanged	Po	Pt	Pt
Garage height	Po	Po	unchanged	Po	Po	Po
Structure	Po	Po	unchanged	Po	Po	Po
Building envelope / Facades	Po	Po	unchanged	Po	Po	Po
Roof	Po	Po	unchanged	Po	Po	Po
Foundation	Po	Po	unchanged	Po	Po	Po
Surface & drainage	Po	Po	unchanged	Po	Po	Po
Natural light	Po	Po	unchanged	Po	Po	Po
Doors	Po	Po	unchanged	Po	Po	Po
Fume/exhaust extraction systems	Po	Po	unchanged	Po	Po	Po
Internal hazards (gas, el cables, heavy eq)	Po	Po	unchanged	Po	Po	Po
Fire suppression system	Po	Po	unchanged	Po	Po	Po
Garage winter temp (deg C)	Po	Po	unchanged	Po	Po	Po
Lightning Protection	Po	Po	unchanged	Po	Po	Po
Energy Efficiency	Po	Po	unchanged	Po	Po	Po
Internal Storage Space	Po	Po	unchanged	Po	Pt	Pt
Maintenance area	Po	Po	unchanged	Po	Pt	Pt
Cleaning and decontamination area (trucks)	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po
Hose-wash area and drying tower	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po
Building age	Po	Po	unchanged	Po	Po	Po
Total area, m2	Po	Po	unchanged	Po	min(Pt, Pa*2)	min(Pt, Pa*2)
Functional Zones, count	Po	Po	unchanged	Po	Pt	Pt
Architectural layout	Po	Po	unchanged	Po	Pt	Pt
Structure (1 to 5)	Po	Po	unchanged	Po	Po	Po

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Building envelope / Facades	Po	Po	unchanged	Po	Po	Po
Partition walls	Po	Po	unchanged	Po	Po	Po
Roof	Po	Po	unchanged	Po	Po	Po
Foundation	Po	Po	unchanged	Po	Po	Po
Administration zone	Po	Po	unchanged	Po	Pt	Pt
Communication room	Po	Po	unchanged	Po	Pt	Pt
Dinning and Recreational	Po	Po	unchanged	Po	Pt	Pt
Training/meeting room	Po	Po	unchanged	Po	unchanged	unchanged
Sleeping quarters	Po	Po	unchanged	Po	Pt	Pt
Support, Storage and Cleaning	Po	Po	unchanged	Po	Pt	Pt
Fitness	Po	Po	unchanged	Po	unchanged	unchanged
Lightning Protection System	Po	Po	unchanged	Po	Po	Po
Energy Efficiency	Po	Po	unchanged	Po	Po	Po
Fire Suppression System	Po	Po	unchanged	Po	Po	Po
Internal hazards (gas, el cables, heavy eq)	Po	Po	unchanged	Po	Po	Po
running water	Po	Po	unchanged	Po	Po	Po
canalisation	Po	Po	unchanged	Po	Pt	Pt
hot water	Po	Po	unchanged	Po	Pt	Pt
showers (numbers)	Po	Po	unchanged	Po	Pt	Pt
Washrooms (numbers)	Po	Po	unchanged	Po	Pt	Pt
Bathrooms	Po	Po	unchanged	Po	Pt	Pt
Toilets	Po	Po	unchanged	Po	Pt	Pt
Heating	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po
Cooling	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po
Management and administration	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po
Communication room	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po
Sleeping quarters	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Kitchen, dining and day room	Po	Po	unchanged	Po	between Pt and Po	between Pt and Po
Meeting and training room	Po	Po	unchanged	Po	unchanged	unchanged
Fitness room	Po	Po	unchanged	Po	unchanged	unchanged
Shared ownership	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Location	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Site hazards	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Access road	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Number of exits	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Exit to access road	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Electricity	Pt	Pt	unchanged	Pt	unchanged	unchanged
Gas or district heating	Pt	Pt	unchanged	Pt	unchanged	unchanged
Water (for fire trucks)	Pt	Pt	unchanged	Pt	unchanged	unchanged
Communications	between Pt and Po	between Pt and Po	unchanged	between Pt and Po	between Pt and Po	between Pt and Po
Average Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Average Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Site Size	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged

B.2.4 Option 4: Relocation – Increase in the Values of the Parameters

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Staff number	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Shift Size	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Large fire trucks	Po	Po	Po	Po	Po	Po
Ladder trucks	Po	Po	Po	Po	Po	Po
Large Rescue Trucks	Po	Po	Po	Po	Po	Po

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Off-road fire trucks	Po	Po	Po	Po	Po	Po
Small off-road fire trucks	Po	Po	Po	Po	Po	Po
Small off-road rescue vehicles	Po	Po	Po	Po	Po	Po
Special cars for deep snow	Po	Po	Po	Po	Po	Po
Average age of fire vehicles	some improvement	some improvement	some improvement	some improvement	some improvement	some improvement
Average age of rescue vehicles	some improvement	some improvement	some improvement	some improvement	some improvement	some improvement
Specialist Equipment	Po	Po	Po	Po	Po	Po
Training facilities	Po	Po	Po	Po	Po	Po
Electricity (hrs)	Po	Po	Po	Po	Po	Po
water (m3)	Po	Po	Po	Po	Po	Po
fuel (l)	Po	Po	Po	Po	Po	Po
Communication (hrs)	Po	Po	Po	Po	Po	Po
Equipment (outside of building)	Po	Po	Po	Po	Po	Po
Building age	Po	Po	Po	Po	Po	Po
Garage area	Po	Po	Po	Po	Po	Po
Bays (number)	Po	Po	Po	Po	Po	Po
Garage height	Po	Po	Po	Po	Po	Po
Structure	Po	Po	Po	Po	Po	Po
Building envelope / Facades	Po	Po	Po	Po	Po	Po
Roof	Po	Po	Po	Po	Po	Po
Foundation	Po	Po	Po	Po	Po	Po
Surface & drainage	Po	Po	Po	Po	Po	Po
Natural light	Po	Po	Po	Po	Po	Po
Doors	Po	Po	Po	Po	Po	Po
Fume/exhaust extraction systems	Po	Po	Po	Po	Po	Po
Internal hazards (gas, el cables, heavy eq)	Po	Po	Po	Po	Po	Po
Fire suppression system	Po	Po	Po	Po	Po	Po

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Garage winter temp (deg C)	Po	Po	Po	Po	Po	Po
Lightning Protection	Po	Po	Po	Po	Po	Po
Energy Efficiency	Po	Po	Po	Po	Po	Po
Internal Storage Space	Po	Po	Po	Po	Po	Po
Maintenance area	Po	Po	Po	Po	Po	Po
Cleaning and decontamination area (trucks)	Po	Po	Po	Po	Po	Po
Hose-wash area and drying tower	Po	Po	Po	Po	Po	Po
Building age	Po	Po	Po	Po	Po	Po
Total area, m2	Po	Po	Po	Po	Po	Po
Functional Zones, count	Po	Po	Po	Po	Po	Po
Architectural layout	Po	Po	Po	Po	Po	Po
Structure (1 to 5)	Po	Po	Po	Po	Po	Po
Building envelope / Facades	Po	Po	Po	Po	Po	Po
Partition walls	Po	Po	Po	Po	Po	Po
Roof	Po	Po	Po	Po	Po	Po
Foundation	Po	Po	Po	Po	Po	Po
Administration zone	Po	Po	Po	Po	Po	Po
Communication room	Po	Po	Po	Po	Po	Po
Dinning and Recreational	Po	Po	Po	Po	Po	Po
Training/meeting room	Po	Po	Po	Po	Po	Po
Sleeping quarters	Po	Po	Po	Po	Po	Po
Support, Storage and Cleaning	Po	Po	Po	Po	Po	Po
Fitness	Po	Po	Po	Po	Po	Po
Lightning Protection System	Po	Po	Po	Po	Po	Po
Energy Efficiency	Po	Po	Po	Po	Po	Po

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Fire Supression System	Po	Po	Po	Po	Po	Po
Internal hazards (gas, el cables, heavy eq)	Po	Po	Po	Po	Po	Po
running water	Po	Po	Po	Po	Po	Po
canalisation	Po	Po	Po	Po	Po	Po
hot water	Po	Po	Po	Po	Po	Po
showers (numbers)	Po	Po	Po	Po	Po	Po
Washrooms (numbers)	Po	Po	Po	Po	Po	Po
Bathrooms	Po	Po	Po	Po	Po	Po
Toilets	Po	Po	Po	Po	Po	Po
Heating	Po	Po	Po	Po	Po	Po
Cooling	Po	Po	Po	Po	Po	Po
Management and administration	Po	Po	Po	Po	Po	Po
Communication room	Po	Po	Po	Po	Po	Po
Sleeping quarters	Po	Po	Po	Po	Po	Po
Kitchen, dining and day room	Po	Po	Po	Po	Po	Po
Meeting and training room	Po	Po	Po	Po	Po	Po
Fitness room	Po	Po	Po	Po	Po	Po
Shared ownership	Po	Po	Po	Po	Po	Po
Location	Po	Po	Po	Po	Po	Po
Site hazards	Po	Po	Po	Po	Po	Po
Access road	Po	Po	Po	Po	Po	Po
Number of exits	Po	Po	Po	Po	Po	Po
Exit to access road	Po	Po	Po	Po	Po	Po
Electricity	Pt	Pt	Pt	Pt	Pt	Pt
Gas or district heating	Pt	Pt	Pt	Pt	Pt	Pt
Water (for fire trucks)	Pt	Pt	Pt	Pt	Pt	Pt
Communications	Po	Po	Po	Po	Po	Po
Average Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged

Parameter	Group 1 Without remarks	Group 2 Small sized	Group 3 Shared ownership	Group 4 Poor building infrastructure	Group 5 Poor building and site infrastructure	Group 6 For replacement
Average Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (town)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Maximum Drive Time (service area)	unchanged	unchanged	unchanged	unchanged	unchanged	unchanged
Site Size	Po	Po	Po	Po	Po	Po

B.3 Quantifying the Interventions for Individual FRS

Each intervention from the 4 sets applicable to the group and class of individual FRS is quantified as described in Section 4.3

Based on the definitions for the groups and the options the variant with greater impact will be as presented on Table B.28. However, the aim of this study is not to define the wanted level of improvement for the Armenian fire and rescue services, but only to provide guidance and information for possible improvement strategies. For this reason, four different variants were developed (presented on Table B.29 to Table B.32) to grasp a range of improvement strategies and needed budgets for all visited stations.

Table B.28: Variant 0

	Option 1 Repair	Option 2 Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 Without remarks	**6 FRS Great potential**			
Group 2 Small sized area		**15 FRS Good potential**		
Group 3 Shared ownership				**11 FRS Great potential**
Group 4 Poor building infrastructure			**11 FRS Great potential**	
Group 5 Poor building and site infrastructure				**8 FRS Great potential**
Group 6 For replacement				**5 FRS Great potential**

- Variant 1, presented on Table B.29: all FRS classified in group 1 – without remarks are repaired and vehicles on more than 25 years are replaced and equipment is upgraded (Option1 - repair), all FRS in group 6 – for replacement, are relocated on a proper site in a new building and the equipment and vehicles are upgraded (Option 4 - relocation), all other FRS are upgraded with option 2 – expansion, vehicles and equipment are upgraded.

Table B.29: Variant 1

	Option 1 Repair	Option 2 Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 Without remarks	6 FRS Great potential			
Group 2 Small sized area		15 FRS Good potential		
Group 3 Shared ownership		11 FRS Good potential		
Group 4 Poor building infrastructure		11 FRS Some potential		
Group 5 Poor building and site infrastructure		8 FRS Limited potential		
Group 6 For replacement				5 FRS Great potential

- Variant 2, presented on : all FRS not planned for replacement are repaired and vehicles on more than 25 years are replaced and equipment is upgraded (Option1 - repair), all FRS in group 6 – for replacement, are relocated on a proper site in a new building and the equipment and vehicles are upgraded (Option 4 - relocation). The potential for improvement between the stations is limited to great (Table B.25: Expected potential for improvement)

Table B.30: Variant 2

	Option 1 Repair	Option 2 Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 Without remarks	6 FRS Great potential			
Group 2 Small sized area	15 FRS Some potential			
Group 3 Shared ownership	11 FRS Limited potential			
Group 4 Poor building infrastructure	11 FRS Limited potential			
Group 5 Poor building and site infrastructure	8 FRS Limited potential			
Group 6 For replacement				5 FRS Great potential

- Variant 3, presented on : all FRS not planned for replacement are repaired and vehicles on more than 25 years are replaced and equipment is upgraded (Option1 - repair), all FRS in group 6 – for replacement, are relocated on a proper site in a new building and the equipment and vehicles are upgraded (Option 4 - relocation). The potential for improvement between the stations is limited to great (Table B.25: Expected potential for improvement)

Table B.31: Variant 3

	Option 1 Repair	Option 2 Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 Without remarks	6 FRS Great potential			
Group 2 Small sized area			15 FRS Great potential	
Group 3 Shared ownership				11 FRS Great potential
Group 4 Poor building infrastructure			11 FRS Great potential	
Group 5 Poor building and site infrastructure			8 FRS Some potential	
Group 6 For replacement				5 FRS Great potential

Table B.32: Variant 4

	Option 1 Repair	Option 2 Expansion	Option 3 Replacement	Option 4 Relocation
Group 1 Without remarks			6 FRS Great potential	
Group 2 Small sized area			15 FRS Great potential	
Group 3 Shared ownership				11 FRS Great potential
Group 4 Poor building infrastructure				11 FRS Great potential
Group 5 Poor building and site infrastructure				8 FRS Great potential
Group 6 For replacement				5 FRS Great potential

B.4 Results

Detailed results for all visited FRSs for variant 1 are accessible in the following link:

Link to SharePoint Document

Fire Service Optimisation Strategy

C. Estimated Investments

C.1 Estimated Investments per FRS

The investment needs per FRS were estimated as explained in Section 4.3. The results from the different variant are presented next

C.1.1 Variant 1: Investments per FRS

Table C.33: Variant 1: Estimated investment per FRS

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
1	Talin	$ 1,085,000	$ 8,500	$ 600,000	$ 22,000	$ 1,715,500	Group 3	Option 2
2	Tsaghkahovit	$ 780,000	$ 6,000	$ 450,000	$ 29,000	$ 1,265,000	Group 2	Option 2
3	Aparan	$ 1,085,000	$ 8,500	$ 735,000	$ 29,000	$ 1,857,500	Group 3	Option 2
4	Ashtarak	$ 165,000	$ 8,500	$ 420,000	$ 22,000	$ 615,500	Group 2	Option 2
5	Maralik	$ 1,080,000	$ 8,500	$ 330,000	$ 74,000	$ 1,492,500	Group 5	Option 2
6	Artik	$ -	$ -	$ -	$ -	$ -	NV	NV
7	Gyumri	$ 2,215,000	$ 25,000	$ 2,640,000	$ 500	$ 4,880,500	Group 6	Option 4
8	Gyumri	$ -	$ -	$ -	$ -	$ -	ERC	ERC
9	Gyumri, Akhuryan	$ 280,000	$ 8,500	$ 305,000	$ 76,000	$ 669,500	Group 5	Option 2
10	Amasia	$ 430,000	$ 8,500	$ 270,000	$ 70,000	$ 778,500	Group 5	Option 2
11	Ashotsk	$ 430,000	$ 8,500	$ 525,000	$ 72,500	$ 1,036,000	Group 4	Option 2
12	Vanadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC
13	Vanadzor	$ 460,000	$ 18,500	$ 1,160,000	$ 147,500	$ 1,786,000	Group 3	Option 2
14	Vanadzor, Gugark	$ 640,000	$ 6,500	$ 345,000	$ 22,000	$ 1,013,500	Group 2	Option 2
15	Alaverdi	$ 800,000	$ 6,000	$ 295,000	$ 22,000	$ 1,123,000	Group 2	Option 2
16	Stepanavan	$ 1,760,000	$ 10,000	$ 1,590,000	$ 500	$ 3,360,500	Group 6	Option 4

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
17	Tashir	$ 280,000	$ 8,500	$ 390,000	$ 87,500	$ 766,000	Group 4	Option 2
18	Spitak	$ 280,000	$ 8,500	$ 1,215,000	$ 500	$ 1,504,000	Group 6	Option 4
19	Odzun	$ 70,000	$ 5,500	$ 505,000	$ 72,000	$ 652,500	Group 5	Option 2
20	Ijevan	$ 1,095,000	$ 17,500	$ 1,030,000	$ 159,500	$ 2,302,000	Group 5	Option 2
21	Ijevan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
22	Dilijan	$ 820,000	$ 8,500	$ 570,000	$ 29,000	$ 1,427,500	Group 2	Option 2
23	Noyemberyan	$ 1,345,000	$ 9,500	$ 775,000	$ 29,000	$ 2,158,500	Group 2	Option 2
24	Berd	$ 2,145,000	$ 13,000	$ 750,000	$ 29,500	$ 2,937,500	Group 1	Option 1
25	Gavar	$ -	$ -	$ -	$ -	$ -	ERC	ERC
26	Gavar	$ 2,025,000	$ 9,000	$ 1,200,000	$ 36,500	$ 3,270,500	Group 2	Option 2
27	Martuni	$ 1,200,000	$ 8,500	$ 440,000	$ 65,500	$ 1,714,000	Group 5	Option 2
28	Vardenis	$ 280,000	$ 8,500	$ 530,000	$ 68,000	$ 886,500	Group 4	Option 2
29	Chambarak	$ 965,000	$ 9,500	$ 695,000	$ 29,000	$ 1,698,500	Group 2	Option 2
30	Sevan	$ 1,090,000	$ 8,500	$ 415,000	$ 81,000	$ 1,594,500	Group 4	Option 2
31	Sevan	$ -	$ -	$ -	$ -	$ -	NV	NV
32	Hrazdan	$ 1,730,000	$ 21,500	$ 550,000	$ 81,500	$ 2,383,000	Group 2	Option 2
33	Hrazdan	$ -	$ -	$ -	$ -	$ -	NV	NV
34	Abovyan	$ 510,000	$ 22,000	$ 500,000	$ 132,500	$ 1,164,500	Group 3	Option 2
35	Abovyan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
36	Yeghvard	$ 795,000	$ 8,500	$ 495,000	$ 15,000	$ 1,313,500	Group 2	Option 2
37	Charentsavan	$ 1,285,000	$ 9,000	$ 505,000	$ 15,000	$ 1,814,000	Group 2	Option 2
38	Armavir	$ 1,475,000	$ 20,500	$ 845,000	$ 146,500	$ 2,487,000	Group 4	Option 2
39	Armavir	$ -	$ -	$ -	$ -	$ -	ERC	ERC

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
40	Myasnikyan	$ 1,620,000	$ 9,000	$ 940,000	$ 500	$ 2,569,500	Group 6	Option 4
41	Vagharshapat	$ 1,085,000	$ 8,500	$ 345,000	$ 87,500	$ 1,526,000	Group 4	Option 2
42	Artashat	$ -	$ -	$ -	$ -	$ -	ERC	ERC
43	Artashat	$ 2,540,000	$ 18,000	$ 620,000	$ 74,500	$ 3,252,500	Group 2	Option 2
44	Masis	$ 1,085,000	$ 8,500	$ 555,000	$ 15,000	$ 1,663,500	Group 3	Option 2
45	Vedi	$ 940,000	$ 8,500	$ 685,000	$ 29,000	$ 1,662,500	Group 2	Option 2
46	Surenavan	$ 1,890,000	$ 9,000	$ 1,085,000	$ 500	$ 2,984,500	Group 6	Option 4
47	Yeghegnadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC
48	Yeghegnadzor	$ 1,335,000	$ 10,000	$ 1,370,000	$ 98,500	$ 2,813,500	Group 4	Option 2
49	Khacik	$ -	$ -	$ -	$ -	$ -	NV	NV
50	Jermuk	$ 945,000	$ 8,500	$ 445,000	$ 22,000	$ 1,420,500	Group 2	Option 2
51	Vayk	$ 1,120,000	$ 8,500	$ 585,000	$ 56,000	$ 1,769,500	Group 5	Option 2
52	Kapan	$ 2,065,000	$ 25,500	$ 1,785,000	$ 109,500	$ 3,985,000	Group 1	Option 1
53	Kapan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
54	Goris	$ 370,000	$ 9,000	$ 875,000	$ 15,500	$ 1,269,500	Group 3	Option 2
55	Meghri	$ 1,090,000	$ 5,500	$ 280,000	$ 73,000	$ 1,448,500	Group 5	Option 2
56	Agarak	$ 215,000	$ 5,500	$ 490,000	$ 64,500	$ 775,000	Group 4	Option 2
57	Sisian	$ 350,000	$ 9,000	$ 365,000	$ 76,500	$ 800,500	Group 4	Option 2
58	Kajaran	$ 285,000	$ 5,500	$ 640,000	$ 87,500	$ 1,018,000	Group 4	Option 2
59	Ashtarak	$ -	$ -	$ -	$ -	$ -	ERC	ERC
60	Vanadzor	$ 270,000	$ 9,000	$ 520,000	$ 15,500	$ 814,500	Group 3	Option 2
61	Yerevan	$ 365,000	$ 18,500	$ 640,000	$ 74,500	$ 1,098,000	Group 3	Option 2

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
62	Yerevan	$ 2,270,000	$ 22,000	$ 875,000	$ 81,500	$ 3,248,500	Group 2	Option 2
63	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
64	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
65	Yerevan	$ 1,810,000	$ 21,000	$ 730,000	$ 81,500	$ 2,642,500	Group 1	Option 1
66	Yerevan	$ 305,000	$ 8,500	$ 825,000	$ 29,500	$ 1,168,000	Group 3	Option 2
67	Yerevan	$ 335,000	$ 18,000	$ 885,000	$ 81,500	$ 1,319,500	Group 3	Option 2
68	Yerevan	$ 815,000	$ 12,000	$ 965,000	$ 22,500	$ 1,814,500	Group 1	Option 1
69	Yerevan	$ 2,270,000	$ 20,000	$ 565,000	$ 67,500	$ 2,922,500	Group 1	Option 1
70	Yerevan	$ 460,000	$ 18,000	$ 735,000	$ 81,500	$ 1,294,500	Group 3	Option 2
71	Yerevan	$ 135,000	$ 5,500	$ 345,000	$ 98,000	$ 583,500	Group 4	Option 2
72	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
73	Yerevan	$ 1,190,000	$ 9,000	$ 765,000	$ 15,000	$ 1,979,000	Group 1	Option 1

C.1.2 Variant 2: Investments per FRS

Table C.34: Variant 2: Estimated investment per FRS

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
1	Talin	$ 1,085,000	$ 8,500	$ 315,000	$ 3,500	$ 1,412,000	Group 3	Option 1
2	Tsaghkahovit	$ 780,000	$ 6,000	$ 225,000	$ 22,000	$ 1,033,000	Group 2	Option 1
3	Aparan	$ 1,085,000	$ 8,500	$ 245,000	$ 4,500	$ 1,343,000	Group 3	Option 1
4	Ashtarak	$ 165,000	$ 8,500	$ 220,000	$ 22,000	$ 415,500	Group 2	Option 1
5	Maralik	$ 1,080,000	$ 8,500	$ 200,000	$ 67,000	$ 1,355,500	Group 5	Option 1

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
6	Artik	$ -	$ -	$ -	$ -	$ -	NV	NV
7	Gyumri	$ 2,215,000	$ 25,000	$ 2,640,000	$ 500	$ 4,880,500	Group 6	Option 4
8	Gyumri	$ -	$ -	$ -	$ -	$ -	ERC	ERC
9	Gyumri, Akhuryan	$ 280,000	$ 8,500	$ 215,000	$ 65,500	$ 569,000	Group 5	Option 1
10	Amasia	$ 430,000	$ 8,500	$ 165,000	$ 59,500	$ 663,000	Group 5	Option 1
11	Ashotsk	$ 430,000	$ 8,500	$ 265,000	$ 72,500	$ 776,000	Group 4	Option 1
12	Vanadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC
13	Vanadzor	$ 300,000	$ 17,500	$ 690,000	$ 6,500	$ 1,014,000	Group 3	Option 1
14	Vanadzor, Gugark	$ 140,000	$ 6,500	$ 340,000	$ 15,000	$ 501,500	Group 2	Option 1
15	Alaverdi	$ 800,000	$ 6,000	$ 250,000	$ 22,000	$ 1,078,000	Group 2	Option 1
16	Stepanavan	$ 1,760,000	$ 10,000	$ 1,590,000	$ 500	$ 3,360,500	Group 6	Option 4
17	Tashir	$ 280,000	$ 8,500	$ 325,000	$ 87,500	$ 701,000	Group 4	Option 1
18	Spitak	$ 280,000	$ 8,500	$ 1,215,000	$ 500	$ 1,504,000	Group 6	Option 4
19	Odzun	$ 70,000	$ 5,500	$ 175,000	$ 61,500	$ 312,000	Group 5	Option 1
20	Ijevan	$ 1,095,000	$ 17,500	$ 400,000	$ 138,500	$ 1,651,000	Group 5	Option 1
21	Ijevan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
22	Dilijan	$ 320,000	$ 8,500	$ 310,000	$ 15,000	$ 653,500	Group 2	Option 1
23	Noyemberyan	$ 1,125,000	$ 9,500	$ 215,000	$ 22,000	$ 1,371,500	Group 2	Option 1
24	Berd	$ 2,145,000	$ 13,000	$ 750,000	$ 29,500	$ 2,937,500	Group 1	Option 1
25	Gavar	$ -	$ -	$ -	$ -	$ -	ERC	ERC

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
26	Gavar	$ 1,170,000	$ 9,000	$ 325,000	$ 22,500	$ 1,526,500	Group 2	Option 1
27	Martuni	$ 395,000	$ 8,500	$ 195,000	$ 58,500	$ 657,000	Group 5	Option 1
28	Vardenis	$ 280,000	$ 8,500	$ 145,000	$ 68,000	$ 501,500	Group 4	Option 1
29	Chambarak	$ 1,240,000	$ 9,500	$ 235,000	$ 15,000	$ 1,499,500	Group 2	Option 1
30	Sevan	$ 1,090,000	$ 8,500	$ 390,000	$ 81,000	$ 1,569,500	Group 4	Option 1
31	Sevan	$ -	$ -	$ -	$ -	$ -	NV	NV
32	Hrazdan	$ 275,000	$ 18,000	$ 205,000	$ 74,500	$ 572,500	Group 2	Option 1
33	Hrazdan	$ -	$ -	$ -	$ -	$ -	NV	NV
34	Abovyan	$ 420,000	$ 17,500	$ 250,000	$ 4,500	$ 692,000	Group 3	Option 1
35	Abovyan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
36	Yeghvard	$ 1,070,000	$ 8,500	$ 205,000	$ 22,000	$ 1,305,500	Group 2	Option 1
37	Charentsavan	$ 1,065,000	$ 9,000	$ 185,000	$ 15,000	$ 1,274,000	Group 2	Option 1
38	Armavir	$ 595,000	$ 17,500	$ 810,000	$ 146,500	$ 1,569,000	Group 4	Option 1
39	Armavir	$ -	$ -	$ -	$ -	$ -	ERC	ERC
40	Myasnikyan	$ 1,620,000	$ 9,000	$ 940,000	$ 500	$ 2,569,500	Group 6	Option 4
41	Vagharshapat	$ 280,000	$ 8,500	$ 290,000	$ 87,500	$ 666,000	Group 4	Option 1
42	Artashat	$ -	$ -	$ -	$ -	$ -	ERC	ERC
43	Artashat	$ 485,000	$ 18,000	$ 525,000	$ 81,500	$ 1,109,500	Group 2	Option 1
44	Masis	$ 280,000	$ 8,500	$ 215,000	$ 2,500	$ 506,000	Group 3	Option 1
45	Vedi	$ 1,105,000	$ 8,500	$ 195,000	$ 15,000	$ 1,323,500	Group 2	Option 1

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
46	Surenavan	$ 1,890,000	$ 9,000	$ 1,085,000	$ 500	$ 2,984,500	Group 6	Option 4
47	Yeghegnadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC
48	Yeghegnadzor	$ 1,325,000	$ 8,500	$ 400,000	$ 98,500	$ 1,832,000	Group 4	Option 1
49	Khacik	$ -	$ -	$ -	$ -	$ -	NV	NV
50	Jermuk	$ 1,110,000	$ 8,500	$ 270,000	$ 15,000	$ 1,403,500	Group 2	Option 1
51	Vayk	$ 315,000	$ 8,500	$ 100,000	$ 52,500	$ 476,000	Group 5	Option 1
52	Kapan	$ 2,065,000	$ 25,500	$ 1,785,000	$ 109,500	$ 3,985,000	Group 1	Option 1
53	Kapan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
54	Goris	$ 330,000	$ 8,500	$ 205,000	$ 2,500	$ 546,000	Group 3	Option 1
55	Meghri	$ 1,090,000	$ 5,500	$ 130,000	$ 62,500	$ 1,288,000	Group 5	Option 1
56	Agarak	$ 215,000	$ 5,500	$ 130,000	$ 64,500	$ 415,000	Group 4	Option 1
57	Sisian	$ 340,000	$ 8,500	$ 220,000	$ 76,500	$ 645,000	Group 4	Option 1
58	Kajaran	$ 285,000	$ 5,500	$ 355,000	$ 87,500	$ 733,000	Group 4	Option 1
59	Ashtarak	$ -	$ -	$ -	$ -	$ -	ERC	ERC
60	Vanadzor	$ 235,000	$ 8,500	$ 220,000	$ 2,500	$ 466,000	Group 3	Option 1
61	Yerevan	$ 280,000	$ 17,500	$ 195,000	$ 3,500	$ 496,000	Group 3	Option 1
62	Yerevan	$ 350,000	$ 18,500	$ 410,000	$ 81,500	$ 860,000	Group 2	Option 1
63	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
64	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
65	Yerevan	$ 1,810,000	$ 21,000	$ 730,000	$ 81,500	$ 2,642,500	Group 1	Option 1

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
66	Yerevan	$ 265,000	$ 8,500	$ 200,000	$ 4,500	$ 478,000	Group 3	Option 1
67	Yerevan	$ 285,000	$ 17,500	$ 265,000	$ 4,500	$ 572,000	Group 3	Option 1
68	Yerevan	$ 815,000	$ 12,000	$ 965,000	$ 22,500	$ 1,814,500	Group 1	Option 1
69	Yerevan	$ 2,270,000	$ 20,000	$ 565,000	$ 67,500	$ 2,922,500	Group 1	Option 1
70	Yerevan	$ 300,000	$ 17,500	$ 420,000	$ 4,500	$ 742,000	Group 3	Option 1
71	Yerevan	$ 135,000	$ 5,500	$ 305,000	$ 98,000	$ 543,500	Group 4	Option 1
72	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
73	Yerevan	$ 1,190,000	$ 9,000	$ 765,000	$ 15,000	$ 1,979,000	Group 1	Option 1

C.1.3 Variant 3: Investments per FRS

Table C.35: Variant 3: Estimated investment per FRS

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
1	Talin	$ 2,450,000	$ 8,500	$ 1,165,000	$ 26,500	$ 3,650,000	Group 3	Option 4
2	Tsaghkahovit	$ 1,150,000	$ 6,000	$ 1,910,000	$ 29,000	$ 3,095,000	Group 2	Option 3
3	Aparan	$ 2,565,000	$ 8,500	$ 1,320,000	$ 31,500	$ 3,925,000	Group 3	Option 4
4	Ashtarak	$ 165,000	$ 8,500	$ 1,690,000	$ 22,000	$ 1,885,500	Group 2	Option 3
5	Maralik	$ 1,080,000	$ 8,500	$ 2,480,000	$ 88,000	$ 3,656,500	Group 5	Option 3
6	Artik	$ -	$ -	$ -	$ -	$ -	NV	NV
7	Gyumri	$ 2,215,000	$ 25,000	$ 2,640,000	$ 500	$ 4,880,500	Group 6	Option 4

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
8	Gyumri	$ -	$ -	$ -	$ -	$ -	ERC	ERC
9	Gyumri, Akhuryan	$ 1,080,000	$ 8,500	$ 1,890,000	$ 76,000	$ 3,054,500	Group 5	Option 3
10	Amasia	$ 430,000	$ 8,500	$ 1,440,000	$ 56,000	$ 1,934,500	Group 5	Option 3
11	Ashotsk	$ 480,000	$ 9,000	$ 1,915,000	$ 86,500	$ 2,490,500	Group 4	Option 3
12	Vanadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC
13	Vanadzor	$ 2,775,000	$ 24,000	$ 2,130,000	$ 147,500	$ 5,076,500	Group 3	Option 4
14	Vanadzor, Gugark	$ 145,000	$ 6,500	$ 1,685,000	$ 22,000	$ 1,858,500	Group 2	Option 3
15	Alaverdi	$ 1,170,000	$ 6,000	$ 1,685,000	$ 22,000	$ 2,883,000	Group 2	Option 3
16	Stepanavan	$ 1,760,000	$ 10,000	$ 1,590,000	$ 500	$ 3,360,500	Group 6	Option 4
17	Tashir	$ 330,000	$ 8,500	$ 1,915,000	$ 101,500	$ 2,355,000	Group 4	Option 3
18	Spitak	$ 280,000	$ 8,500	$ 1,215,000	$ 500	$ 1,504,000	Group 6	Option 4
19	Odzun	$ 600,000	$ 5,500	$ 1,665,000	$ 65,000	$ 2,335,500	Group 5	Option 3
20	Ijevan	$ 3,240,000	$ 17,500	$ 4,080,000	$ 159,500	$ 7,497,000	Group 5	Option 3
21	Ijevan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
22	Dilijan	$ 1,995,000	$ 8,500	$ 1,915,000	$ 29,000	$ 3,947,500	Group 2	Option 3
23	Noyemberyan	$ 1,990,000	$ 9,500	$ 1,915,000	$ 29,000	$ 3,943,500	Group 2	Option 3
24	Berd	$ 2,145,000	$ 13,000	$ 750,000	$ 29,500	$ 2,937,500	Group 1	Option 1
25	Gavar	$ -	$ -	$ -	$ -	$ -	ERC	ERC
26	Gavar	$ 2,090,000	$ 9,000	$ 2,510,000	$ 36,500	$ 4,645,500	Group 2	Option 3
27	Martuni	$ 1,200,000	$ 8,500	$ 1,440,000	$ 58,500	$ 2,707,000	Group 5	Option 3

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
28	Vardenis	$ 1,135,000	$ 8,500	$ 1,915,000	$ 82,000	$ 3,140,500	Group 4	Option 3
29	Chambarak	$ 1,610,000	$ 9,500	$ 1,915,000	$ 29,000	$ 3,563,500	Group 2	Option 3
30	Sevan	$ 1,140,000	$ 8,500	$ 1,915,000	$ 95,000	$ 3,158,500	Group 4	Option 3
31	Sevan	$ -	$ -	$ -	$ -	$ -	NV	NV
32	Hrazdan	$ 3,775,000	$ 21,500	$ 1,925,000	$ 81,500	$ 5,803,000	Group 2	Option 3
33	Hrazdan	$ -	$ -	$ -	$ -	$ -	NV	NV
34	Abovyan	$ 2,650,000	$ 22,000	$ 1,345,000	$ 146,500	$ 4,163,500	Group 3	Option 4
35	Abovyan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
36	Yeghvard	$ 1,440,000	$ 8,500	$ 1,465,000	$ 15,000	$ 2,928,500	Group 2	Option 3
37	Charentsavan	$ 1,935,000	$ 9,000	$ 1,465,000	$ 15,000	$ 3,424,000	Group 2	Option 3
38	Armavir	$ 3,760,000	$ 20,500	$ 1,935,000	$ 153,500	$ 5,869,000	Group 4	Option 3
39	Armavir	$ -	$ -	$ -	$ -	$ -	ERC	ERC
40	Myasnikyan	$ 1,620,000	$ 9,000	$ 940,000	$ 500	$ 2,569,500	Group 6	Option 4
41	Vagharshapat	$ 1,135,000	$ 8,500	$ 1,690,000	$ 87,500	$ 2,921,000	Group 4	Option 3
42	Artashat	$ -	$ -	$ -	$ -	$ -	ERC	ERC
43	Artashat	$ 4,150,000	$ 18,000	$ 1,710,000	$ 74,500	$ 5,952,500	Group 2	Option 3
44	Masis	$ 2,450,000	$ 9,000	$ 1,165,000	$ 24,500	$ 3,648,500	Group 3	Option 4
45	Vedi	$ 1,585,000	$ 8,500	$ 1,915,000	$ 29,000	$ 3,537,500	Group 2	Option 3
46	Surenavan	$ 1,890,000	$ 9,000	$ 1,085,000	$ 500	$ 2,984,500	Group 6	Option 4
47	Yeghegnadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
48	Yeghegnadzor	$ 1,920,000	$ 15,500	$ 3,095,000	$ 105,500	$ 5,136,000	Group 4	Option 3
49	Khacik	$ -	$ -	$ -	$ -	$ -	NV	NV
50	Jermuk	$ 1,595,000	$ 8,500	$ 1,690,000	$ 22,000	$ 3,315,500	Group 2	Option 3
51	Vayk	$ 1,120,000	$ 8,500	$ 1,875,000	$ 63,000	$ 3,066,500	Group 5	Option 3
52	Kapan	$ 2,065,000	$ 25,500	$ 1,785,000	$ 109,500	$ 3,985,000	Group 1	Option 1
53	Kapan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
54	Goris	$ 2,500,000	$ 13,500	$ 2,125,000	$ 95,500	$ 4,734,000	Group 3	Option 4
55	Meghri	$ 815,000	$ 5,500	$ 1,865,000	$ 66,000	$ 2,751,500	Group 5	Option 3
56	Agarak	$ 215,000	$ 6,500	$ 1,455,000	$ 64,500	$ 1,741,000	Group 4	Option 3
57	Sisian	$ 435,000	$ 12,000	$ 1,700,000	$ 83,500	$ 2,230,500	Group 4	Option 3
58	Kajaran	$ 290,000	$ 5,500	$ 2,495,000	$ 101,500	$ 2,892,000	Group 4	Option 3
59	Ashtarak	$ -	$ -	$ -	$ -	$ -	ERC	ERC
60	Vanadzor	$ 1,420,000	$ 12,000	$ 1,170,000	$ 74,500	$ 2,676,500	Group 3	Option 4
61	Yerevan	$ 3,140,000	$ 22,000	$ 1,335,000	$ 81,500	$ 4,578,500	Group 3	Option 4
62	Yerevan	$ 2,760,000	$ 22,000	$ 1,930,000	$ 81,500	$ 4,793,500	Group 2	Option 3
63	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
64	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
65	Yerevan	$ 1,810,000	$ 21,000	$ 730,000	$ 81,500	$ 2,642,500	Group 1	Option 1
66	Yerevan	$ 1,455,000	$ 12,000	$ 1,325,000	$ 81,500	$ 2,873,500	Group 3	Option 4
67	Yerevan	$ 4,130,000	$ 21,000	$ 1,180,000	$ 74,500	$ 5,405,500	Group 3	Option 4

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
68	Yerevan	$ 815,000	$ 12,000	$ 965,000	$ 22,500	$ 1,814,500	Group 1	Option 1
69	Yerevan	$ 2,270,000	$ 20,000	$ 565,000	$ 67,500	$ 2,922,500	Group 1	Option 1
70	Yerevan	$ 3,270,000	$ 21,000	$ 1,180,000	$ 74,500	$ 4,545,500	Group 3	Option 4
71	Yerevan	$ 135,000	$ 6,000	$ 1,440,000	$ 77,000	$ 1,658,000	Group 4	Option 3
72	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
73	Yerevan	$ 1,190,000	$ 9,000	$ 765,000	$ 15,000	$ 1,979,000	Group 1	Option 1

C.1.4 Variant 4: Investments per FRS

Table C.36: Variant 4: Estimated investment per FRS

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
1	Talin	$ 2,450,000	$ 8,500	$ 1,165,000	$ 26,500	$ 3,650,000	Group 3	Option 4
2	Tsaghkahovit	$ 1,150,000	$ 6,000	$ 1,910,000	$ 29,000	$ 3,095,000	Group 2	Option 3
3	Aparan	$ 2,565,000	$ 8,500	$ 1,320,000	$ 31,500	$ 3,925,000	Group 3	Option 4
4	Ashtarak	$ 165,000	$ 8,500	$ 1,690,000	$ 22,000	$ 1,885,500	Group 2	Option 3
5	Maralik	$ 2,450,000	$ 10,000	$ 1,715,000	$ 38,500	$ 4,213,500	Group 5	Option 4
6	Artik	$ -	$ -	$ -	$ -	$ -	NV	NV
7	Gyumri	$ 2,215,000	$ 25,000	$ 2,640,000	$ 500	$ 4,880,500	Group 6	Option 4
8	Gyumri	$ -	$ -	$ -	$ -	$ -	ERC	ERC
9	Gyumri, Akhuryan	$ 2,945,000	$ 9,500	$ 1,320,000	$ 31,500	$ 4,306,000	Group 5	Option 4

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
10	Amasia	$ 1,120,000	$ 9,000	$ 1,005,000	$ 17,500	$ 2,151,500	Group 5	Option 4
11	Ashotsk	$ 1,120,000	$ 9,000	$ 1,320,000	$ 31,500	$ 2,480,500	Group 4	Option 4
12	Vanadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC
13	Vanadzor	$ 2,775,000	$ 24,000	$ 2,130,000	$ 147,500	$ 5,076,500	Group 3	Option 4
14	Vanadzor, Gugark	$ 145,000	$ 6,500	$ 1,685,000	$ 22,000	$ 1,858,500	Group 2	Option 3
15	Alaverdi	$ 1,170,000	$ 6,000	$ 1,685,000	$ 22,000	$ 2,883,000	Group 2	Option 3
16	Stepanavan	$ 1,760,000	$ 10,000	$ 1,590,000	$ 500	$ 3,360,500	Group 6	Option 4
17	Tashir	$ 970,000	$ 8,500	$ 1,325,000	$ 31,500	$ 2,335,000	Group 4	Option 4
18	Spitak	$ 280,000	$ 8,500	$ 1,215,000	$ 500	$ 1,504,000	Group 6	Option 4
19	Odzun	$ 2,240,000	$ 6,000	$ 1,155,000	$ 24,500	$ 3,425,500	Group 5	Option 4
20	Ijevan	$ 4,175,000	$ 26,000	$ 2,830,000	$ 109,500	$ 7,140,500	Group 5	Option 4
21	Ijevan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
22	Dilijan	$ 1,995,000	$ 8,500	$ 1,915,000	$ 29,000	$ 3,947,500	Group 2	Option 3
23	Noyemberyan	$ 1,990,000	$ 9,500	$ 1,915,000	$ 29,000	$ 3,943,500	Group 2	Option 3
24	Berd	$ 2,260,000	$ 13,000	$ 1,920,000	$ 29,500	$ 4,222,500	Group 1	Option 3
25	Gavar	$ -	$ -	$ -	$ -	$ -	ERC	ERC
26	Gavar	$ 2,090,000	$ 9,000	$ 2,510,000	$ 36,500	$ 4,645,500	Group 2	Option 3
27	Martuni	$ 2,565,000	$ 8,500	$ 1,005,000	$ 17,500	$ 3,596,000	Group 5	Option 4
28	Vardenis	$ 2,450,000	$ 8,500	$ 1,320,000	$ 31,500	$ 3,810,000	Group 4	Option 4
29	Chambarak	$ 1,610,000	$ 9,500	$ 1,915,000	$ 29,000	$ 3,563,500	Group 2	Option 3

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
30	Sevan	$ 2,455,000	$ 8,500	$ 1,320,000	$ 31,500	$ 3,815,000	Group 4	Option 4
31	Sevan	$ -	$ -	$ -	$ -	$ -	NV	NV
32	Hrazdan	$ 3,775,000	$ 21,500	$ 1,925,000	$ 81,500	$ 5,803,000	Group 2	Option 3
33	Hrazdan	$ -	$ -	$ -	$ -	$ -	NV	NV
34	Abovyan	$ 2,650,000	$ 22,000	$ 1,345,000	$ 146,500	$ 4,163,500	Group 3	Option 4
35	Abovyan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
36	Yeghvard	$ 1,440,000	$ 8,500	$ 1,465,000	$ 15,000	$ 2,928,500	Group 2	Option 3
37	Charentsavan	$ 1,935,000	$ 9,000	$ 1,465,000	$ 15,000	$ 3,424,000	Group 2	Option 3
38	Armavir	$ 4,240,000	$ 20,500	$ 1,345,000	$ 153,500	$ 5,759,000	Group 4	Option 4
39	Armavir	$ -	$ -	$ -	$ -	$ -	ERC	ERC
40	Myasnikyan	$ 1,620,000	$ 9,000	$ 940,000	$ 500	$ 2,569,500	Group 6	Option 4
41	Vagharshapat	$ 2,450,000	$ 8,500	$ 1,165,000	$ 24,500	$ 3,648,000	Group 4	Option 4
42	Artashat	$ -	$ -	$ -	$ -	$ -	ERC	ERC
43	Artashat	$ 4,150,000	$ 18,000	$ 1,710,000	$ 74,500	$ 5,952,500	Group 2	Option 3
44	Masis	$ 2,450,000	$ 9,000	$ 1,165,000	$ 24,500	$ 3,648,500	Group 3	Option 4
45	Vedi	$ 1,585,000	$ 8,500	$ 1,915,000	$ 29,000	$ 3,537,500	Group 2	Option 3
46	Surenavan	$ 1,890,000	$ 9,000	$ 1,085,000	$ 500	$ 2,984,500	Group 6	Option 4
47	Yeghegnadzor	$ -	$ -	$ -	$ -	$ -	ERC	ERC
48	Yeghegnadzor	$ 3,185,000	$ 15,500	$ 2,125,000	$ 95,500	$ 5,421,000	Group 4	Option 4
49	Khacik	$ -	$ -	$ -	$ -	$ -	NV	NV

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
50	Jermuk	$ 1,595,000	$ 8,500	$ 1,690,000	$ 22,000	$ 3,315,500	Group 2	Option 3
51	Vayk	$ 2,485,000	$ 8,500	$ 1,320,000	$ 31,500	$ 3,845,000	Group 5	Option 4
52	Kapan	$ 2,615,000	$ 25,500	$ 4,125,000	$ 109,500	$ 6,875,000	Group 1	Option 3
53	Kapan	$ -	$ -	$ -	$ -	$ -	ERC	ERC
54	Goris	$ 2,500,000	$ 13,500	$ 2,125,000	$ 95,500	$ 4,734,000	Group 3	Option 4
55	Meghri	$ 2,455,000	$ 6,000	$ 1,310,000	$ 31,500	$ 3,802,500	Group 5	Option 4
56	Agarak	$ 900,000	$ 6,500	$ 1,000,000	$ 17,500	$ 1,924,000	Group 4	Option 4
57	Sisian	$ 1,025,000	$ 12,000	$ 1,170,000	$ 74,500	$ 2,281,500	Group 4	Option 4
58	Kajaran	$ 975,000	$ 5,500	$ 1,710,000	$ 40,500	$ 2,731,000	Group 4	Option 4
59	Ashtarak	$ -	$ -	$ -	$ -	$ -	ERC	ERC
60	Vanadzor	$ 1,420,000	$ 12,000	$ 1,170,000	$ 74,500	$ 2,676,500	Group 3	Option 4
61	Yerevan	$ 3,140,000	$ 22,000	$ 1,335,000	$ 81,500	$ 4,578,500	Group 3	Option 4
62	Yerevan	$ 2,760,000	$ 22,000	$ 1,930,000	$ 81,500	$ 4,793,500	Group 2	Option 3
63	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
64	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
65	Yerevan	$ 2,210,000	$ 21,000	$ 1,925,000	$ 81,500	$ 4,237,500	Group 1	Option 3
66	Yerevan	$ 1,455,000	$ 12,000	$ 1,325,000	$ 81,500	$ 2,873,500	Group 3	Option 4
67	Yerevan	$ 4,130,000	$ 21,000	$ 1,180,000	$ 74,500	$ 5,405,500	Group 3	Option 4
68	Yerevan	$ 865,000	$ 12,000	$ 1,700,000	$ 22,500	$ 2,599,500	Group 1	Option 3
69	Yerevan	$ 2,670,000	$ 20,000	$ 1,475,000	$ 67,500	$ 4,232,500	Group 1	Option 3

ID	City	Investments				Total investment	Group	Selected option
		OC	BS	BI	SI			
70	Yerevan	$ 3,270,000	$ 21,000	$ 1,180,000	$ 74,500	$ 4,545,500	Group 3	Option 4
71	Yerevan	$ 1,320,000	$ 6,000	$ 980,000	$ 10,500	$ 2,316,500	Group 4	Option 4
72	Yerevan	$ -	$ -	$ -	$ -	$ -	NV	NV
73	Yerevan	$ 1,840,000	$ 9,000	$ 1,465,000	$ 15,000	$ 3,329,000	Group 1	Option 3

Summary of the proposed measures for all FRS in the different Variants is presented in Table C.37

Table C.37: Summary of the different upgrade variants for all FRS

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $
OC1 - Brigade Response Vehicle	medium	26	26	$ 3,432,000	21	21	$ 2,772,000	34	34	$ 4,488,000	34	34	$ 4,488,000
OC2 - Wildland Apparatus	low	18	18	$ 2,016,000	17	17	$ 1,904,000	18	18	$ 2,016,000	18	18	$ 2,016,000
OC3 - Emergency Tender - Type 1	medium	16	16	$ 4,424,000	18	18	$ 4,977,000	29	29	$ 8,018,500	32	32	$ 8,848,000
OC4 - Emergency Tender - Type 2	medium	6	6	$ 1,836,000	4	4	$ 1,224,000	12	12	$ 3,672,000	22	22	$ 6,732,000
OC5 - Triple Combination Pumper	medium	3	3	$ 1,110,000	3	3	$ 1,110,000	22	22	$ 8,140,000	34	34	$ 12,580,000
OC6 - Aerial Truck	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
OC7 - Tanker Pumper Apparatus	medium	26	26	$ 10,296,000	21	21	$ 8,316,000	34	34	$ 13,464,000	34	34	$ 13,464,000
OC8 - Aerial Ladder	medium	11	11	$ 5,467,000	4	4	$ 1,988,000	15	15	$ 7,455,000	17	17	$ 8,449,000
OC9 - Aerial Platform	low	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
OC10 - Small Rescue Vehicle	medium	29	29	$ 3,233,500	26	26	$ 2,899,000	31	31	$ 3,456,500	32	32	$ 3,568,000
OC11 - Heavy Rescue Vehicle	medium	7	7	$ 2,835,000	4	4	$ 1,620,000	14	14	$ 5,670,000	14	14	$ 5,670,000
OC12 - Snow Rescue Vehicle	low	17	17	$ 680,000	17	17	$ 680,000	17	17	$ 680,000	17	17	$ 680,000

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost , US $	Number of FRS	Quantity for all FRS	Total cost , US $	Number of FRS	Quantity for all FRS	Total cost , US $	Number of FRS	Quantity for all FRS	Total cost , US $
OC13 - Swap body vehicles	medium	7	7	$ 5,806,500	4	4	$ 3,318,000	14	14	$ 11,613,000	14	14	$ 11,613,000
OC14 - Command Vehicle	medium	1	1	$ 400,000	1	1	$ 400,000	11	11	$ 4,400,000	14	14	$ 5,600,000
OC15 - Structural Firefighting ensembles	low	56	1937	$ 6,779,500	56	1937	$ 6,779,500	56	1937	$ 6,779,500	56	1937	$ 6,779,500
OC16 - Wildland firefighting ensembles	low	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
OC17 - Rescue equipment	low	56	77	$ 1,925,000	56	77	$ 1,925,000	56	77	$ 1,925,000	56	77	$ 1,925,000
OC18 - Heavy Rescue Equip.	low	12	12	$ 600,000	4	4	$ 200,000	20	20	$ 1,000,000	38	38	$ 1,900,000
OC19 - Water rescue equip.	low	0	0	$ -	0	0	$ -	0	0	$ -	2	2	$ 50,000
OC20 - PPE (SCBA)	low	56	441	$ 2,205,000	56	441	$ 2,205,000	56	441	$ 2,205,000	56	441	$ 2,205,000
OC21 - Tower - Type 1	medium	9	9	$ 9,000	9	9	$ 9,000	2	2	$ 2,000	0	0	$ -
OC22 - Tower - Type 2	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
OC23 - Tower - Type 3	medium	13	13	$ 499,200	6	6	$ 230,400	27	27	$ 1,036,800	39	39	$ 1,497,600
OC24 - Mobile Tower	low	0	0	$ -	0	0	$ -	11	11	$ 550,000	30	30	$ 1,500,000
OC25 - Vehicle Extrication Pad	low	17	17	$ 85,000	14	14	$ 70,000	28	28	$ 140,000	39	39	$ 195,000

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $
OC26 - Forcibly entry training	medium	17	17	$ 85,000	14	14	$ 70,000	28	28	$ 140,000	39	39	$ 195,000
OC27 - Confined spaces - Type 1	low	10	10	$ 12,000	8	8	$ 9,600	35	35	$ 42,000	42	42	$ 50,400
OC28 - Confined spaces - Type 2	low	6	6	$ 324,000	5	5	$ 270,000	13	13	$ 702,000	14	14	$ 756,000
OC29 - Small USAR facility	low	6	6	$ 810,000	5	5	$ 675,000	18	18	$ 2,430,000	35	35	$ 4,725,000
OC30 - Large USAR facility	low	2	2	$ 810,000	1	1	$ 405,000	12	12	$ 4,860,000	31	31	$ 12,555,000
OC31 - Training centre	low	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
OC32 - PC and IT equipment	medium	56	154	$ 77,000	56	154	$ 77,000	56	154	$ 77,000	56	154	$ 77,000
BS1 - EDG - 15kW	medium	14	14	$ 161,070	14	14	$ 161,070	14	14	$ 161,070	14	14	$ 161,070
BS2 - EDG - 10kW	medium	34	34	$ 243,100	34	34	$ 243,100	34	34	$ 243,100	34	34	$ 243,100
BS3 - EDG-5kW	medium	8	8	$ 35,200	8	8	$ 35,200	8	8	$ 35,200	8	8	$ 35,200
BS4 - UPS 10kV	medium	14	14	$ 70,000	14	14	$ 70,000	14	14	$ 70,000	14	14	$ 70,000
BS5 - UPS 1000V	medium	42	42	$ 9,240	42	42	$ 9,240	42	42	$ 9,240	42	42	$ 9,240
BS6 - Water basin	low	29	448.5	$ 22,425	19	283.5	$ 14,175	33	492	$ 24,600	41	608.5	$ 30,425

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $
BS7 - Closed water basin	low	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BS8 - Fuel storage with canisters	medium	11	2670	$ 40,050	7	1770	$ 26,550	20	4890	$ 73,350	21	5370	$ 80,550
BS9 - Fuel storage with filling station	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BS10 - Back-up communication	low	56	56	$ 56,000	56	56	$ 56,000	56	56	$ 56,000	56	56	$ 56,000
BI1 - Building replacement with relocation	medium	5	8125	$ 7,312,500	5	8125	$ 7,312,500	16	23575	$ 21,217,500	35	50225	$ 45,202,500
BI2 - Building replacement	medium	0	0	$ -	0	0	$ -	34	45510	$ 61,438,500	21	27580	$ 37,233,000
BI3 - Area expansion	medium	24	8811.5	$ 7,930,350	0	0	$ -	0	0	$ -	0	0	$ -
BI4 - Vertical area expansion	medium	11	2745.5	$ 2,470,950	0	0	$ -	0	0	$ -	0	0	$ -
BI5 - Seismic retrofit - carbon fibre	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BI6 - Seismic retrofit - conventional	medium	51	38081.5	$ 5,141,003	40	29619	$ 3,998,565	6	9620	$ 1,298,700	0	0	$ -
BI7 - Seismic retrofit - RC walls	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BI8 - Roof repair - structure	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BI9 - Roof repair – hydro insulation	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $
BI10 - Roof repair - thermal insulation	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BI11 - Roof repair - cladding / tiles	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BI12 - Walls - thermal insulation	medium	51	27268.04	$ 272,680	51	25646	$ 256,460	6	7861	$ 78,610	0	0	$ -
BI13 - Energy efficient windows	medium	41	21360.9	$ 1,708,872	21	14469.7	$ 1,157,576	3	5156	$ 412,480	0	0	$ -
BI14 - Interior remodelling	medium	51	33951.2	$ 5,092,680	51	33951	$ 5,092,650	6	9485	$ 1,422,750	0	0	$ -
BI15 - Inside cosmetic renovation	medium	51	18178.55	$ 1,817,855	51	14783	$ 1,478,300	6	4294	$ 429,400	0	0	$ -
BI16 - Heating system - central heating system	medium	8	7591	$ 379,550	4	4841	$ 242,050	2	3581	$ 179,050	0	0	$ -
BI17 - Heating system - individual electric heaters	medium	18	7789	$ 38,945	22	8820	$ 44,100	1	1300	$ 6,500	0	0	$ -
BI18 - Central HVAC	medium	8	7591	$ 151,820	4	4841	$ 96,820	2	3581	$ 71,620	0	0	$ -
BI19 - Air Conditioning	medium	5	4093	$ 81,860	14	7194	$ 143,880	5	4093	$ 81,860	0	0	$ -
BI20 - Garage heating devices	medium	43	9126	$ 45,630	43	8722	$ 43,610	43	8854.7	$ 44,274	43	9059	$ 45,295
BI21 - El system replacement	medium	50	12711	$ 254,220	18	8194	$ 163,880	5	1780	$ 35,600	5	1780	$ 35,600
BI22 - Gas system replacement	medium	50	9343	$ 373,720	7	3699	$ 147,960	5	1780	$ 71,200	5	1780	$ 71,200

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost , US $	Number of FRS	Quantity for all FRS	Total cost , US $	Number of FRS	Quantity for all FRS	Total cost , US $	Number of FRS	Quantity for all FRS	Total cost , US $
BI23 - Replacing water pipes	medium	38	22297	$ 891,880	19	16300	$ 652,000	6	9485	$ 379,400	0	0	$ -
BI24 - Remodelling sewage system (pipes)	medium	9	3576.3	$ 143,052	8	3018	$ 120,720	0	0	$ -	0	0	$ -
BI25 - Garage - surface	medium	29	6621.75	$ 66,218	29	6187	$ 61,870	3	897	$ 8,970	0	0	$ -
BI26 - Garage - non-slip epoxy surface	medium	49	10218	$ 102,180	49	9921	$ 99,210	49	10125.95	$ 101,260	49	10379	$ 103,790
BI27 - Garage - drainage	medium	49	10218	$ 102,180	49	9921	$ 99,210	49	10125.95	$ 101,260	49	10379	$ 103,790
BI28 - Garage - new doors	low	21	76	$ 912,000	6	23	$ 276,000	51	179	$ 2,148,000	51	190	$ 2,280,000
BI29 - Garage - improving doors	medium	30	94	$ 188,000	42	124	$ 248,000	0	0	$ -	0	0	$ -
BI30 - Fume exhaust system - source capture	medium	51	164	$ 492,000	51	153	$ 459,000	51	179	$ 537,000	51	190	$ 570,000
BI31 - Fume exhaust system - ventilation system	medium	51	164	$ 492,000	51	153	$ 459,000	51	179	$ 537,000	51	190	$ 570,000
BI32 - Fire extinguisher system	medium	51	33951.2	$ 33,951	51	33951	$ 33,951	6	9485	$ 9,485	0	0	$ -
BI33 - Fire detectors	low	24	20870.7	$ 521,768	24	20871	$ 521,775	5	8185	$ 204,625	0	0	$ -
BI34 - Automatic fire suppression system	medium	5	5240.7	$ 157,221	5	5241	$ 157,230	1	2616	$ 78,480	0	0	$ -
BI35 - Cleaning and decontamination room	low	51	66.5	$ 99,750	51	66.5	$ 99,750	51	66.5	$ 99,750	51	66.5	$ 99,750

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	**Quantity for all FRS**	**Total cost , US $**	**Number of FRS**	**Quantity for all FRS**	**Total cost , US $**	**Number of FRS**	**Quantity for all FRS**	**Total cost , US $**	**Number of FRS**	**Quantity for all FRS**	**Total cost , US $**
BI36 - Hose wash cleaning machine	medium	51	66.5	$ 52,203	50	65.5	$ 51,418	51	66.5	$ 52,203	51	66.5	$ 52,203
BI37 - Laundering equipment for FRS	medium	51	51	$ 255,000	51	51	$ 255,000	51	51	$ 255,000	51	51	$ 255,000
BI38 - Bathroom (finishing materials, sinks, showers, etc)	medium	46	62	$ 44,020	28	37.5	$ 26,625	6	10.5	$ 7,455	0	0	$ -
BI39 - Office furniture - desks, chairs, shelves	medium	41	45.4	$ 18,614	34	14.9	$ 6,109	49	58.9	$ 24,149	51	66.5	$ 27,265
BI40 - Kitchen & dayroom - furniture	medium	50	63.2	$ 99,856	49	37.4	$ 59,092	51	63.7	$ 100,646	51	66.5	$ 105,070
BI41 - Dormitory - furniture	medium	41	51.7	$ 153,808	36	22.7	$ 67,533	49	61.2	$ 182,070	51	66.5	$ 197,838
BI42 - Meeting/training room - furniture & equipment	low	31	43	$ 34,615	10	13.5	$ 10,868	42	55.5	$ 44,678	50	64	$ 51,520
BI43 - Communication room - furniture	low	50	66	$ 24,420	49	65.5	$ 24,235	50	66	$ 24,420	51	66.5	$ 24,605
BI44 - Communication room - ICT equipment	low	56	72	$ 360,000	56	72	$ 360,000	56	72	$ 360,000	56	72	$ 360,000
BI45 - Passive lightning protection	medium	51	33951.59	$ 169,758	51	33951.59	$ 169,758	6	9485.39	$ 47,427	2	1230	$ 6,150
BI46 - Storage racks	medium	56	1937	$ 290,550	56	1937	$ 290,550	56	1937	$ 290,550	56	1937	$ 290,550
BI47 - Maintenance workshop	low	9	9	$ 18,000	5	5	$ 10,000	50	50	$ 100,000	51	51	$ 102,000
BI48 - Electrical boiler	medium	9	8.5	$ 2,125	9	8.5	$ 2,125	0	0	$ -	0	0	$ -

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $
BI49 - Gas boiler	medium	20	38	$ 21,470	20	38	$ 21,470	5	9.5	$ 5,368	0	0	$ -
BI50 - Instant heating boiler	medium	0	0	$ -	0	0	$ -	0	0	$ -	0	0	$ -
BI51 - Fitness equipment	medium	42	56.5	$ 50,285	21	28	$ 24,920	43	58	$ 51,620	51	66.5	$ 59,185
BI52 - Outside fitness area	medium	42	56.5	$ 84,750	21	28	$ 42,000	43	58	$ 87,000	51	66.5	$ 99,750
BI53 - Roof repair	medium	48	10747.83	$ 376,174	37	7436	$ 260,260	6	1412	$ 49,420	0	0	$ -
BI54 - Solar water heater	low	51	132	$ 316,800	51	132	$ 316,800	51	132	$ 316,800	51	132	$ 316,800
BI55 - Intensive cleaing and repair centre	low	17	17	$ 340,000	5	5	$ 100,000	50	50	$ 1,000,000	51	51	$ 1,020,000
SI1 - Yard pavement	medium	51	16400	$ 328,000	51	12450	$ 249,000	51	17900	$ 358,000	51	19000	$ 380,000
SI2 - Yard asphalt	medium	51	16400	$ 820,000	40	10550	$ 527,500	51	17900	$ 895,000	51	19000	$ 950,000
SI3 - Automatic gate	medium	13	14	$ 28,000	8	8	$ 16,000	19	21	$ 42,000	36	39	$ 78,000
SI4 - Automatic barrier	medium	21	23	$ 9,200	13	14	$ 5,600	24	27	$ 10,800	39	43	$ 17,200
SI5 - Traffic light system	low	13	14	$ 700,000	8	8	$ 400,000	16	17	$ 850,000	18	19	$ 950,000
SI6 - Retaining wall	medium	20	20	$ 524,800	19	19	$ 498,560	20	20	$ 524,800	2	2	$ 52,480

Measure	Reliability of the cost	Variant 1			Variant 2			Variant 3			Variant 4		
		Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $	Number of FRS	Quantity for all FRS	Total cost, US $
SI7 - Drainage system	medium	20	6625	$ 662,500	19	6233	$ 623,300	20	6625	$ 662,500	2	854	$ 85,400
SI8 - Surveillance system	medium	51	51	$ 20,400	40	40	$ 16,000	51	51	$ 20,400	51	51	$ 20,400
SI9 - Cable Internet access	medium	56	56	$ 13,440	56	56	$ 13,440	56	56	$ 13,440	56	56	$ 13,440
SI10 - Back-up cable Internet access	medium	56	56	$ 13,440	56	56	$ 13,440	56	56	$ 13,440	56	56	$ 13,440
SI11 - Rebuying shared parts	medium	10	10	$ 10	0	0	$ -	0	0	$ -	0	0	$ -

C.2 Investments per Region

The results per FRS were summed for region are presented next

C.2.1 Variant 1: Investments per Region

Table C.38: Variant 1: Estimated investments per region

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments: OC, million US $	Investments: BS, million US $	Investments: BI, million US $	Investments: SI, million US $	Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
Aragatsotn	132925	48	4	4	116	$ 3.12 M	$ 0.03 M	$ 2.21 M	$ 0.1 M	$ 5.46 M	$ 5.46 M	$ 47,100	$ 1.37 M	$ 40
Shirak	251941	94	6	5	196	$ 4.44 M	$ 0.06 M	$ 4.07 M	$ 0.3 M	$ 8.87 M	$ 10.64 M	$ 45,200	$ 1.77 M	$ 40
Lori	235537	62	8	8	237	$ 4.56 M	$ 0.08 M	$ 6.02 M	$ 0.37 M	$ 11.03 M	$ 11.03 M	$ 46,500	$ 1.38 M	$ 45
Tavush	128609	48	4	4	142	$ 5.41 M	$ 0.05 M	$ 3.13 M	$ 0.25 M	$ 8.84 M	$ 8.84 M	$ 62,200	$ 2.21 M	$ 70
Gegharkunik	235075	44	7	5	171	$ 5.56 M	$ 0.05 M	$ 3.28 M	$ 0.28 M	$ 9.17 M	$ 12.83 M	$ 53,600	$ 1.83 M	$ 55
Kotayk	254397	122	5	4	127	$ 4.32 M	$ 0.06 M	$ 2.05 M	$ 0.25 M	$ 6.68 M	$ 8.34 M	$ 52,600	$ 1.67 M	$ 35
Armavir	256770	207	3	3	98	$ 4.18 M	$ 0.04 M	$ 2.13 M	$ 0.24 M	$ 6.59 M	$ 6.59 M	$ 67,200	$ 2.2 M	$ 25

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments				Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
						OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Ararat	260367	125	4	4	126	$ 6.46 M	$ 0.05 M	$ 2.95 M	$ 0.12 M	$ 9.58 M	$ 9.58 M	$ 76,000	$ 2.39 M	$ 35
Vayots Dzor	53324	23	4	3	102	$ 3.4 M	$ 0.03 M	$ 2.4 M	$ 0.18 M	$ 6 M	$ 8 M	$ 58,800	$ 2 M	$ 150
Syunik	141771	31	6	6	177	$ 4.38 M	$ 0.06 M	$ 4.44 M	$ 0.43 M	$ 9.31 M	$ 9.31 M	$ 52,600	$ 1.55 M	$ 65
Yerevan	1060138	4754	13	10	445	$ 9.96 M	$ 0.16 M	$ 7.33 M	$ 0.64 M	$ 18.08 M	$ 23.5 M	$ 40,600	$ 1.81 M	$ 20
Total for Armenia	3010854	101	64	56	1937	$ 55.79 M	$ 0.65 M	$ 40.01 M	$ 3.13 M	$ 99.57 M	$ 113.79 M	$ 51,400	$ 1.78 M	$ 35

Notes:

(1) Likely total investments for all FRS stations in the region - based on the assumption that the not visited stations in the region would need investments equal to the average per FRS for the region
(2) Total investments per resident – estimated with the population data from Census 2011 and with the ikely total investments for all FRS

C.2.2 Variant 2: Investments per Region

Table C.39: Variant 2: Estimated investments per region

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments				Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
						OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Aragatsotn	132925	48	4	4	116	$ 3.12 M	$ 0.03 M	$ 1.01 M	$ 0.05 M	$ 4.21 M	$ 4.21 M	$ 36,300	$ 1.05 M	$ 30
Shirak	251941	94	6	5	196	$ 4.44 M	$ 0.06 M	$ 3.49 M	$ 0.27 M	$ 8.26 M	$ 9.91 M	$ 42,100	$ 1.65 M	$ 40
Lori	235537	62	8	8	237	$ 3.87 M	$ 0.07 M	$ 4.81 M	$ 0.2 M	$ 8.95 M	$ 8.95 M	$ 37,700	$ 1.12 M	$ 40
Tavush	128609	48	4	4	142	$ 4.69 M	$ 0.05 M	$ 1.68 M	$ 0.21 M	$ 6.63 M	$ 6.63 M	$ 46,700	$ 1.66 M	$ 50
Gegharkunik	235075	44	7	5	171	$ 4.18 M	$ 0.05 M	$ 1.29 M	$ 0.25 M	$ 5.76 M	$ 8.06 M	$ 33,700	$ 1.15 M	$ 35
Kotayk	254397	122	5	4	127	$ 2.83 M	$ 0.06 M	$ 0.85 M	$ 0.12 M	$ 3.85 M	$ 4.81 M	$ 30,300	$ 0.96 M	$ 20
Armavir	256770	207	3	3	98	$ 2.5 M	$ 0.04 M	$ 2.04 M	$ 0.24 M	$ 4.81 M	$ 4.81 M	$ 49,100	$ 1.6 M	$ 20
Ararat	260367	125	4	4	126	$ 3.76 M	$ 0.05 M	$ 2.02 M	$ 0.1 M	$ 5.93 M	$ 5.93 M	$ 47,000	$ 1.48 M	$ 25
Vayots Dzor	53324	23	4	3	102	$ 2.75 M	$ 0.03 M	$ 0.77 M	$ 0.17 M	$ 3.71 M	$ 4.95 M	$ 36,400	$ 1.24 M	$ 95

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments				Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
						OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Syunik	141771	31	6	6	177	$ 4.33 M	$ 0.06 M	$ 2.83 M	$ 0.41 M	$ 7.63 M	$ 7.63 M	$ 43,100	$ 1.27 M	$ 55
Yerevan	1060138	4754	13	10	445	$ 7.7 M	$ 0.15 M	$ 4.82 M	$ 0.39 M	$ 13.05 M	$ 16.97 M	$ 29,300	$ 1.31 M	$ 15
Total for Armenia	3010854	101	64	56	1937	$ 44.17 M	$ 0.62 M	$ 25.61 M	$ 2.37 M	$ 72.77 M	$ 83.16 M	$ 37,600	$ 1.3 M	$ 25

Notes:

(1) Likely total investments for all FRS stations in the region - based on the assumption that the not visited stations in the region would need investments equal to the average per FRS for the region

(2) Total investments per resident – estimated with the population data from Census 2011 and with the ikely total investments for all FRS

C.2.3 Variant 3: Investments per Region

Table C.40: Variant 3: Estimated investments per region

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments				Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
						OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Aragatsotn	132925	48	4	4	116	$ 6.33 M	$ 0.03 M	$ 6.09 M	$ 0.11 M	$ 12.56 M	$ 12.56 M	$ 108,300	$ 3.14 M	$ 95
Shirak	251941	94	6	5	196	$ 5.29 M	$ 0.06 M	$ 10.37 M	$ 0.31 M	$ 16.03 M	$ 19.23 M	$ 81,800	$ 3.21 M	$ 75
Lori	235537	62	8	8	237	$ 8.48 M	$ 0.08 M	$ 13.06 M	$ 0.44 M	$ 22.06 M	$ 22.06 M	$ 93,100	$ 2.76 M	$ 95
Tavush	128609	48	4	4	142	$ 9.37 M	$ 0.05 M	$ 8.66 M	$ 0.25 M	$ 18.33 M	$ 18.33 M	$ 129,000	$ 4.58 M	$ 140
Gegharkunik	235075	44	7	5	171	$ 7.18 M	$ 0.05 M	$ 9.7 M	$ 0.3 M	$ 17.23 M	$ 24.12 M	$ 100,700	$ 3.45 M	$ 105
Kotayk	254397	122	5	4	127	$ 9.8 M	$ 0.06 M	$ 6.2 M	$ 0.26 M	$ 16.32 M	$ 20.4 M	$ 128,500	$ 4.08 M	$ 80
Armavir	256770	207	3	3	98	$ 6.52 M	$ 0.04 M	$ 4.57 M	$ 0.24 M	$ 11.37 M	$ 11.37 M	$ 116,000	$ 3.79 M	$ 45
Ararat	260367	125	4	4	126	$ 10.08 M	$ 0.05 M	$ 5.88 M	$ 0.13 M	$ 16.14 M	$ 16.14 M	$ 128,100	$ 4.03 M	$ 60
Vayots Dzor	53324	23	4	3	102	$ 4.64 M	$ 0.04 M	$ 6.66 M	$ 0.19 M	$ 11.53 M	$ 15.37 M	$ 113,000	$ 3.84 M	$ 290

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments				Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
						OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Syunik	141771	31	6	6	177	$ 6.32 M	$ 0.07 M	$ 11.43 M	$ 0.52 M	$ 18.34 M	$ 18.34 M	$ 103,600	$ 3.06 M	$ 130
Yerevan	1060138	4754	13	10	445	$ 20.98 M	$ 0.17 M	$ 11.42 M	$ 0.66 M	$ 33.22 M	$ 43.19 M	$ 74,700	$ 3.32 M	$ 40
Total for Armenia	3010854	101	64	56	1937	$ 94.99 M	$ 0.68 M	$ 94.04 M	$ 3.39 M	$ 193.1 M	$ 220.69 M	$ 99,700	$ 3.45 M	$ 65

Notes:

(1) Likely total investments for all FRS stations in the region - based on the assumption that the not visited stations in the region would need investments equal to the average per FRS for the region
(2) Total investments per resident – estimated with the population data from Census 2011 and with the ikely total investments for all FRS

C.2.4 Variant 4: Investments per Region

Table C.41: Variant 4: Estimated investments per region

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments				Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
						OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Aragatsotn	132925	48	4	4	116	$ 6.33 M	$ 0.03 M	$ 6.09 M	$ 0.11 M	$ 12.56 M	$ 12.56 M	$ 108,300	$ 3.14 M	$ 95
Shirak	251941	94	6	5	196	$ 9.85 M	$ 0.07 M	$ 8 M	$ 0.12 M	$ 18.04 M	$ 21.64 M	$ 92,000	$ 3.61 M	$ 85
Lori	235537	62	8	8	237	$ 10.76 M	$ 0.08 M	$ 11.96 M	$ 0.33 M	$ 23.13 M	$ 23.13 M	$ 97,600	$ 2.89 M	$ 100
Tavush	128609	48	4	4	142	$ 10.42 M	$ 0.06 M	$ 8.58 M	$ 0.2 M	$ 19.25 M	$ 19.25 M	$ 135,600	$ 4.81 M	$ 150
Gegharkunik	235075	44	7	5	171	$ 11.17 M	$ 0.05 M	$ 8.07 M	$ 0.15 M	$ 19.43 M	$ 27.2 M	$ 113,600	$ 3.89 M	$ 115
Kotayk	254397	122	5	4	127	$ 9.8 M	$ 0.06 M	$ 6.2 M	$ 0.26 M	$ 16.32 M	$ 20.4 M	$ 128,500	$ 4.08 M	$ 80
Armavir	256770	207	3	3	98	$ 8.31 M	$ 0.04 M	$ 3.45 M	$ 0.18 M	$ 11.98 M	$ 11.98 M	$ 122,200	$ 3.99 M	$ 45
Ararat	260367	125	4	4	126	$ 10.08 M	$ 0.05 M	$ 5.88 M	$ 0.13 M	$ 16.14 M	$ 16.14 M	$ 128,100	$ 4.03 M	$ 60
Vayots Dzor	53324	23	4	3	102	$ 7.27 M	$ 0.04 M	$ 5.14 M	$ 0.15 M	$ 12.6 M	$ 16.79 M	$ 123,500	$ 4.2 M	$ 315

Region	Population	Population density	Total number of stations in a region	Number of visited stations in a region	firefighters in the visited stations in a region	Investments				Total investment for the visited FRS in the region, million US $	Likely total investment for all FRS in the region (1), million US $	Average total investment per firefighter	Average total investment per fire station, million US $	Total investment per resident (2), million US $
						OC, million US $	BS, million US $	BI, million US $	SI, million US $					
Syunik	141771	31	6	6	177	$ 10.47 M	$ 0.07 M	$ 11.44 M	$ 0.37 M	$ 22.35 M	$ 22.35 M	$ 126,300	$ 3.73 M	$ 160
Yerevan	1060138	4754	13	10	445	$ 23.66 M	$ 0.17 M	$ 14.5 M	$ 0.59 M	$ 38.92 M	$ 50.59 M	$ 87,400	$ 3.89 M	$ 50
Total for Armenia	3010854	101	64	56	1937	$ 118.12 M	$ 0.69 M	$ 89.31 M	$ 2.58 M	$ 210.7 M	$ 240.79 M	$ 108,800	$ 3.76 M	$ 70

Notes:

(1) Likely total investments for all FRS stations in the region - based on the assumption that the not visited stations in the region would need investments equal to the average per FRS for the region
(2) Total investments per resident – estimated with the population data from Census 2011 and with the ikely total investments for all FRS

C.3 Maps

C.3.1 Maps Presenting the Estimated Investments per FRS from Variant 1

Figure C.6: Total estimated investments in the visited FRS Variant 1

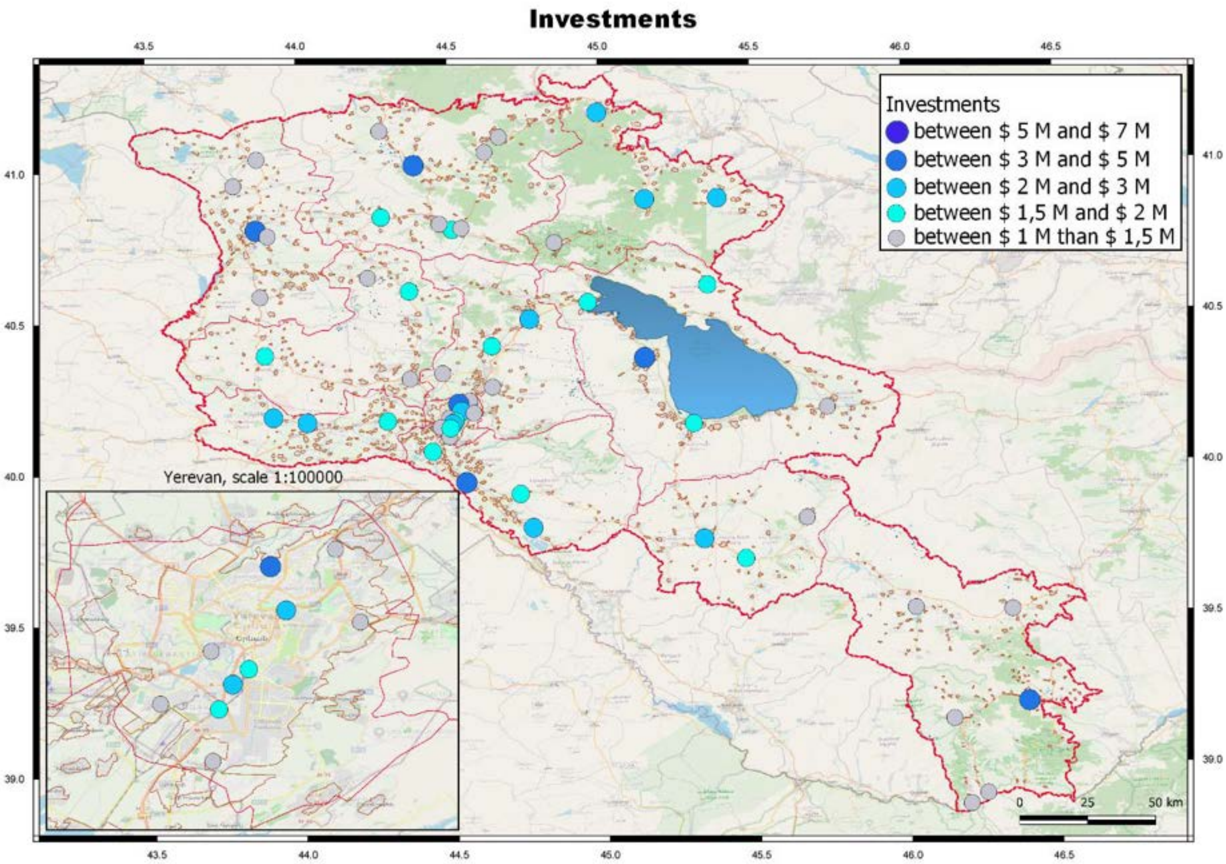


Figure C.7: Estimated investments in Operational Capacity in the visited FRS - Variant 1

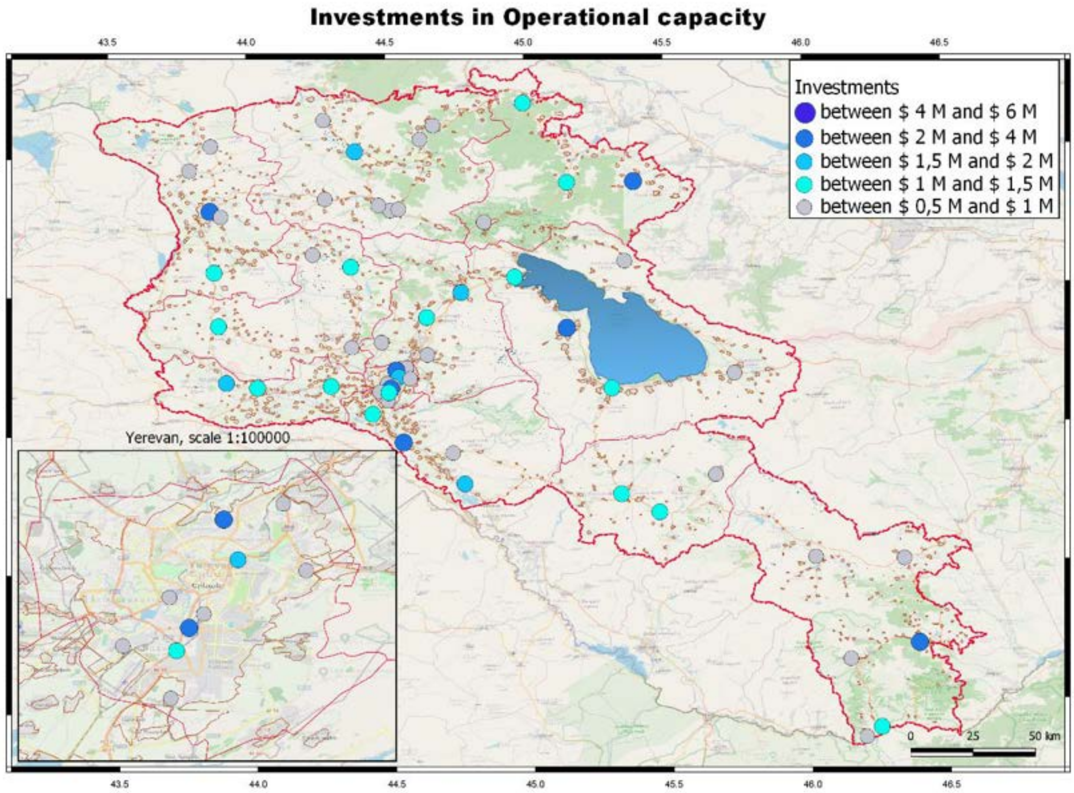


Figure C.8: Estimated investments in Back-up systems in the visited FRS – Variant 1

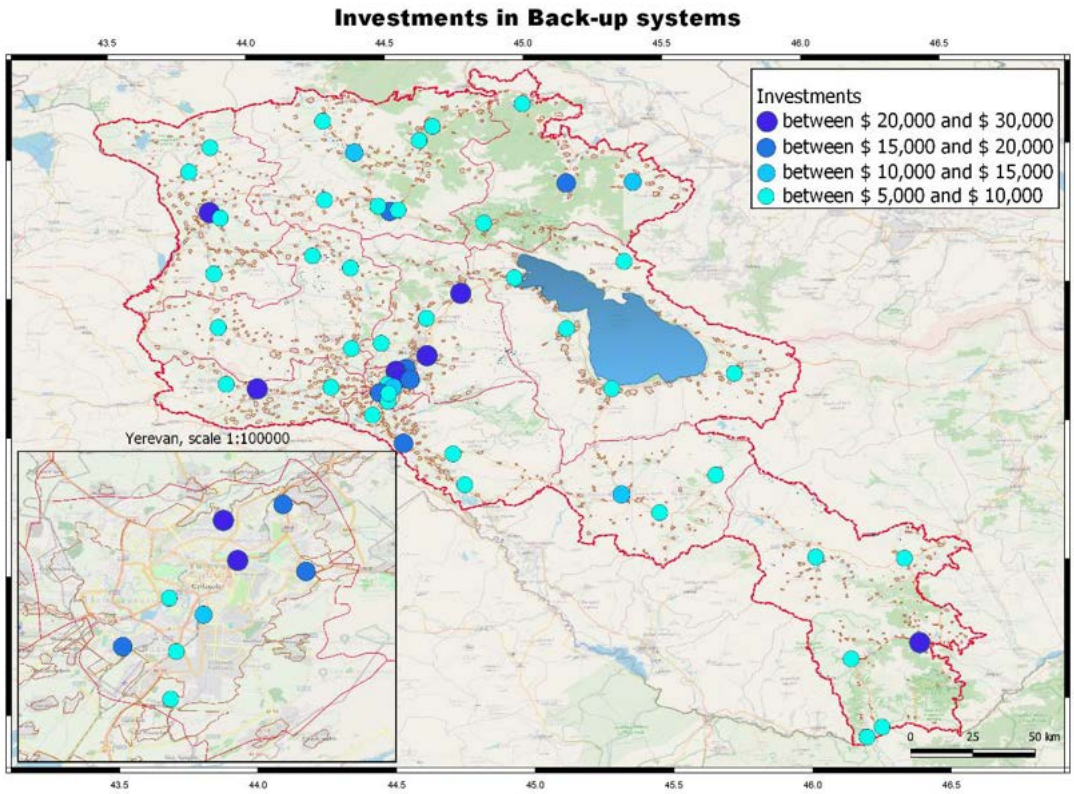


Figure C.9: Estimated investments in Building infrastructure in the visited FRS – Variant 1

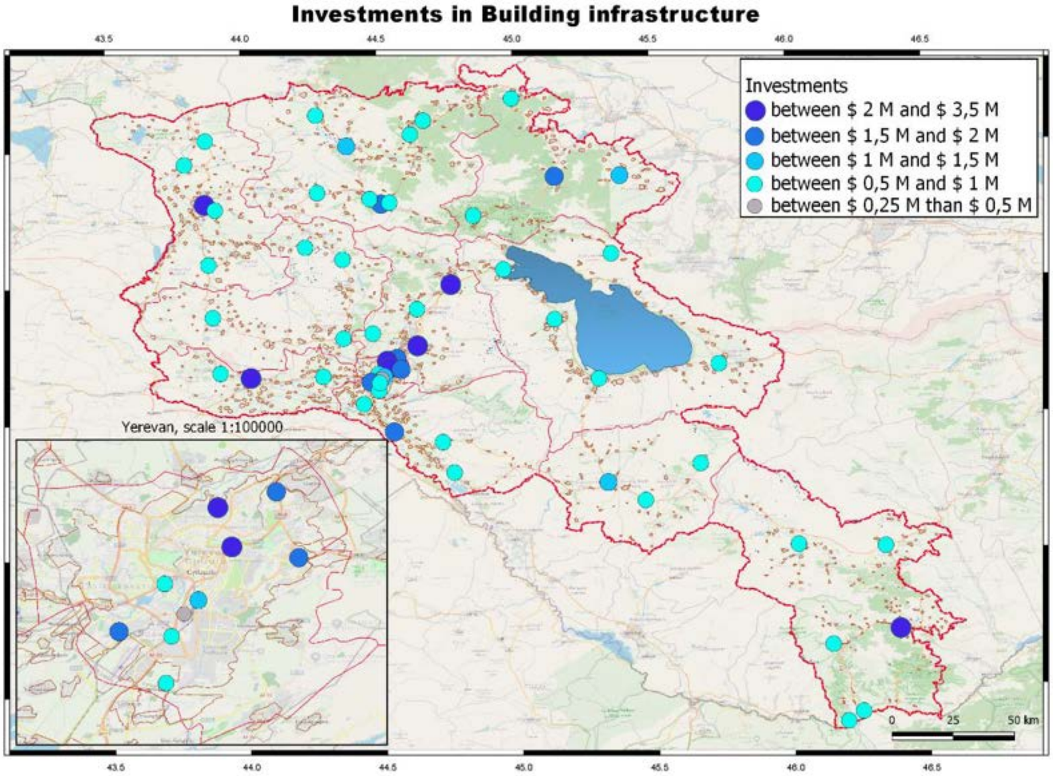
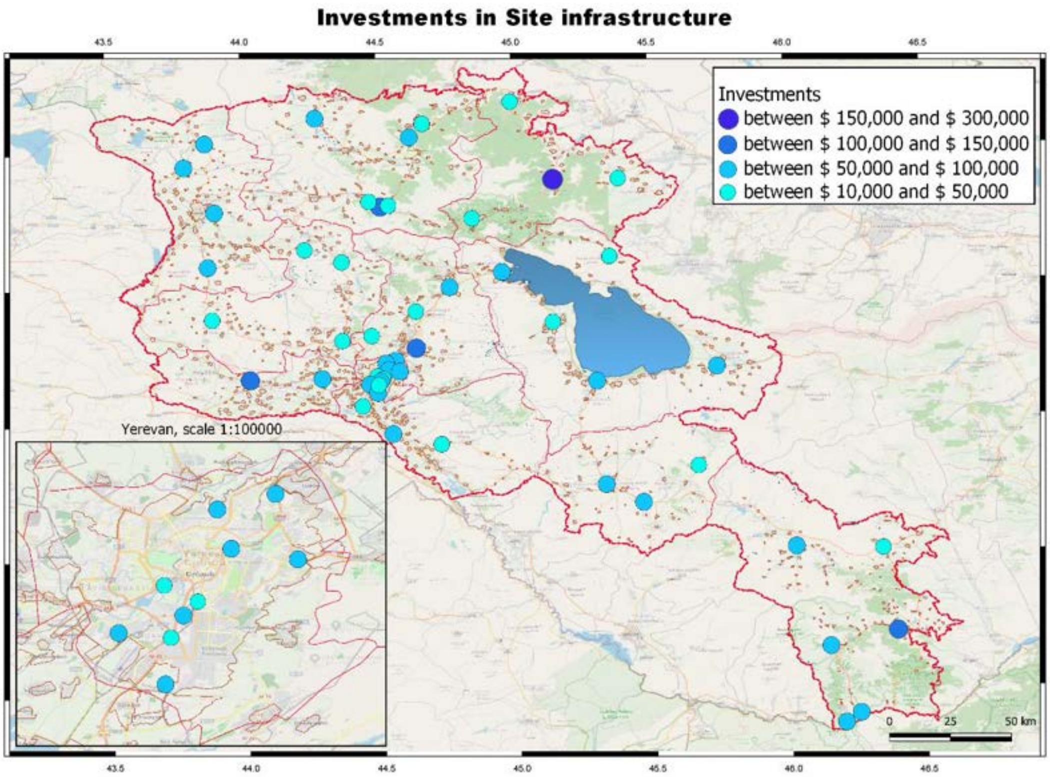


Figure C.10: Estimated investments in Site infrastructure in the visited FRS - Variant 1



C.3.2 Maps Presenting the Estimated Investments per Region

The values for the maps presenting the investments per region are obtained from the estimated values for the visited stations in a region and with the assumptions that the investments for the stations that were not visited are equal to the average value from the visited stations for the region.

Figure C.11: Likely investment in all FRS per region – Variant 1

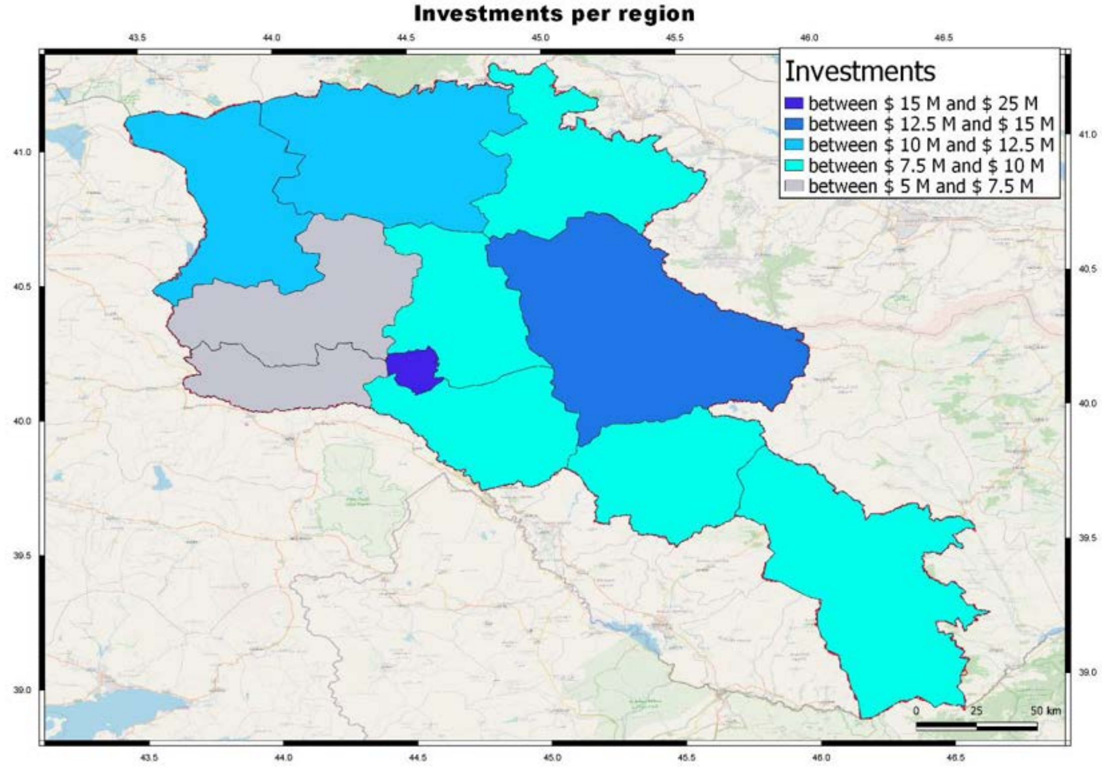


Figure C.12: Likely investment in all FRS per region – Variant 2

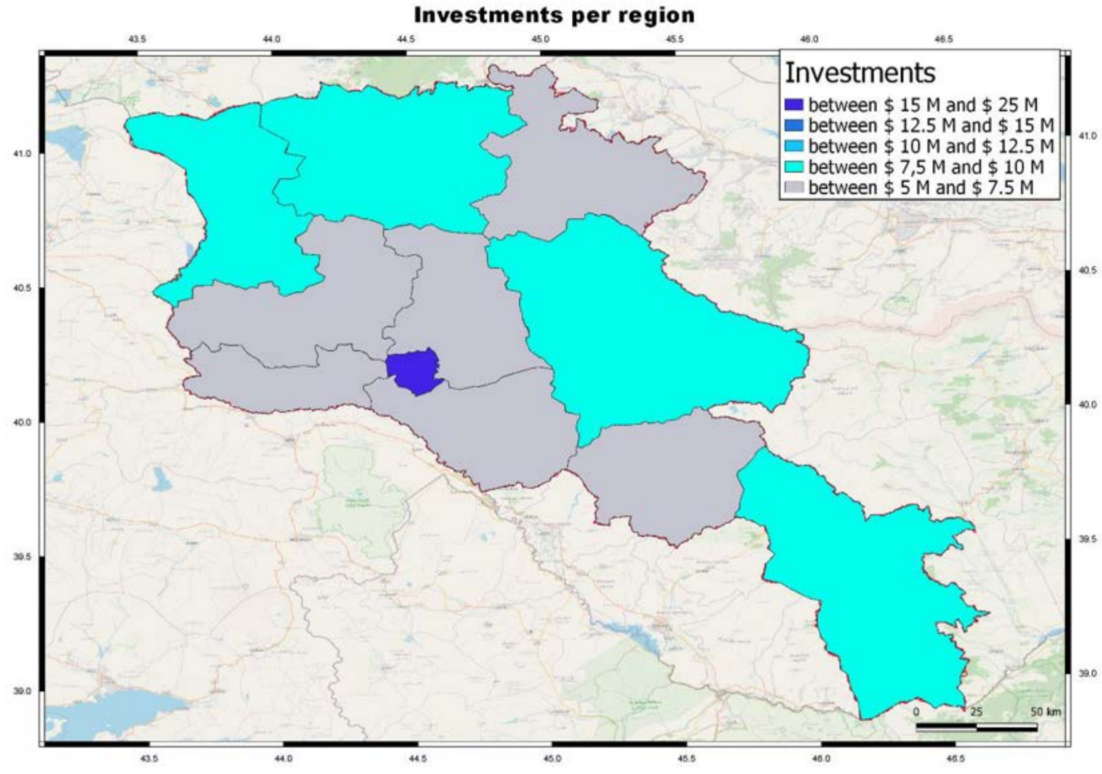


Figure C.13: Likely investment in all FRS per region – Variant 3

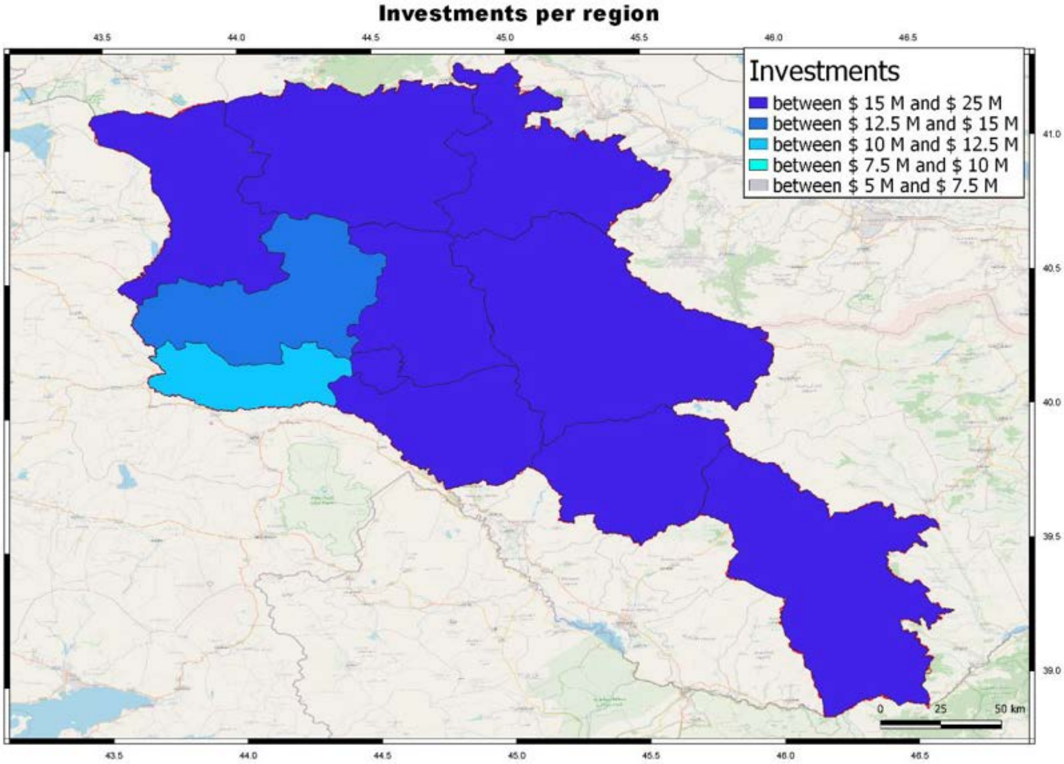


Figure C.14: Likely investment in all FRS per region – Variant 4

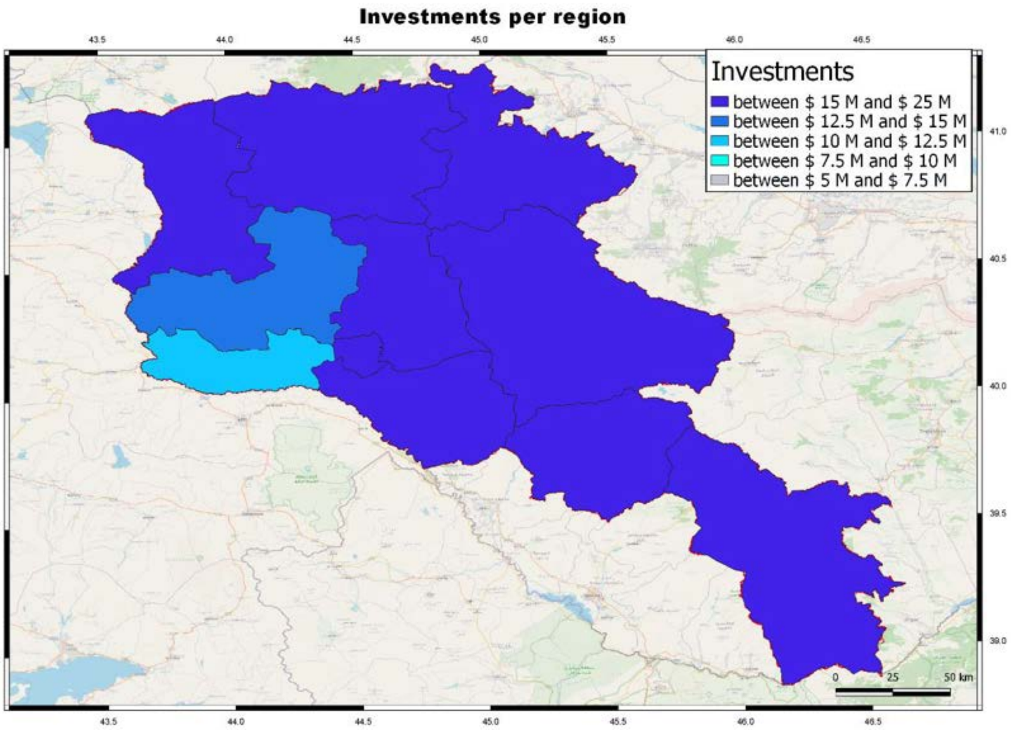


Figure C.15: Average investment per FRS in a region - Variant 1

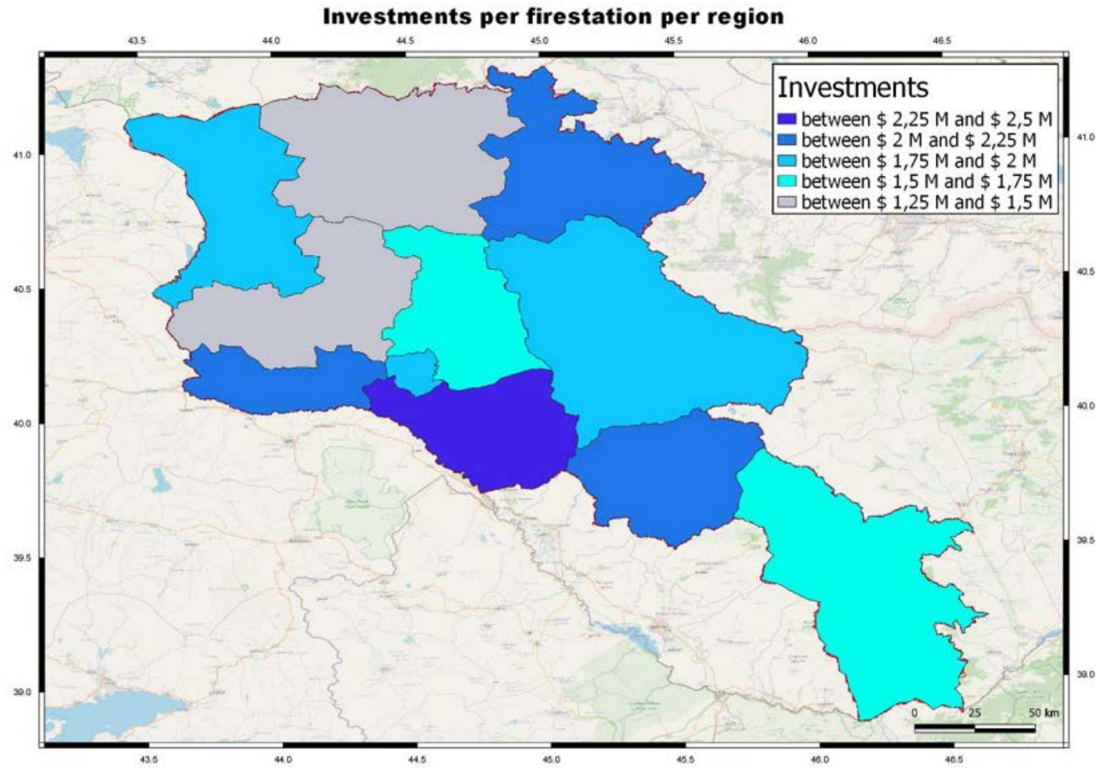


Figure C.16: Average investment per firefighters in the visited FRS in a region - Variant 1

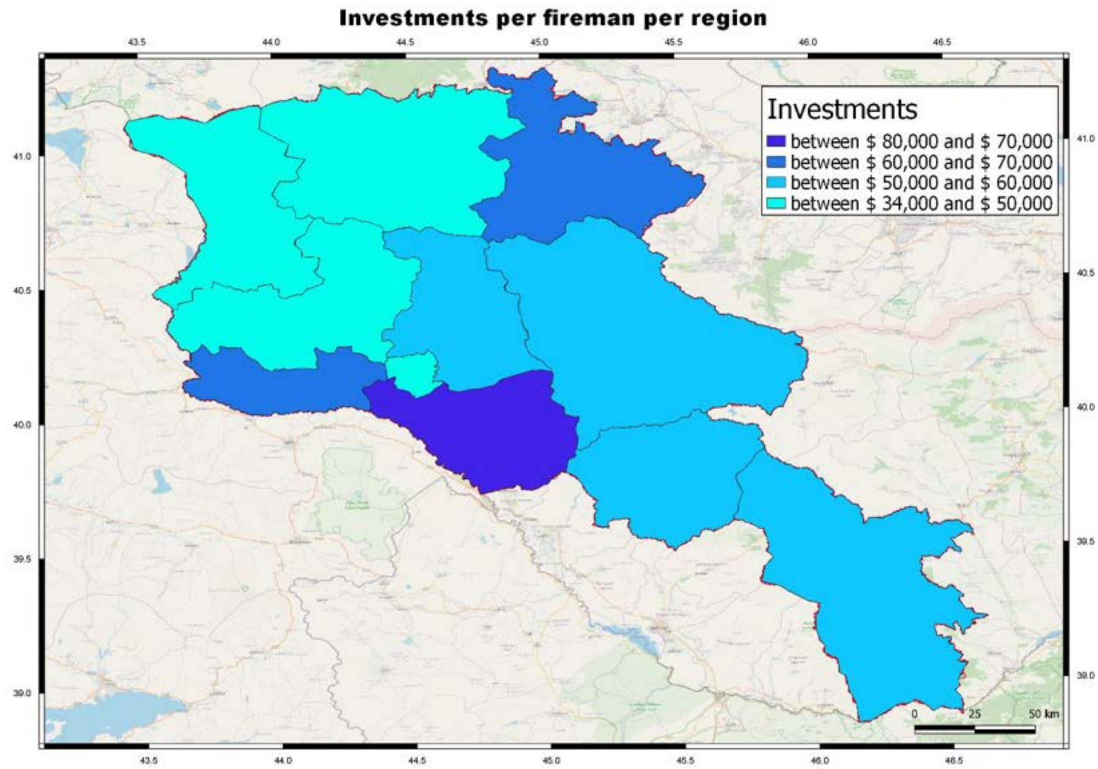


Figure C.17: Average investment per capita in all FRS in a region – Variant 1

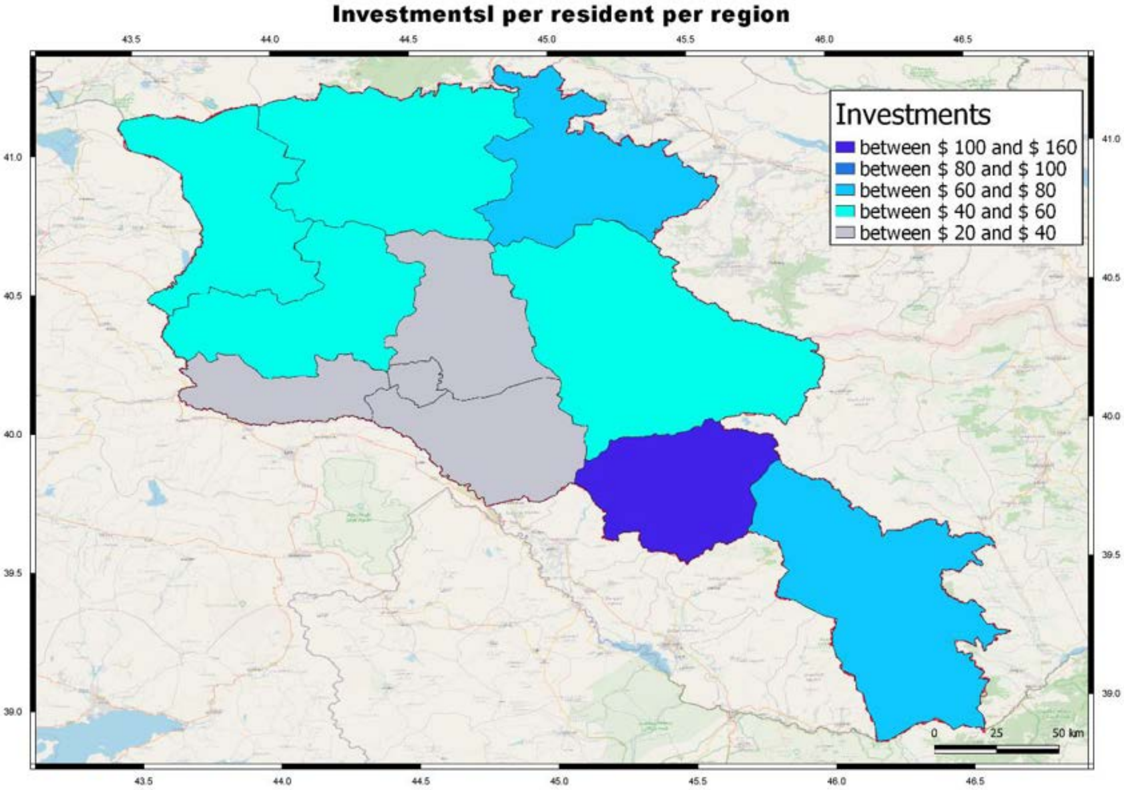


Figure C.18: Likely investment in Operational capacity in all FRS in a region – Variant 1

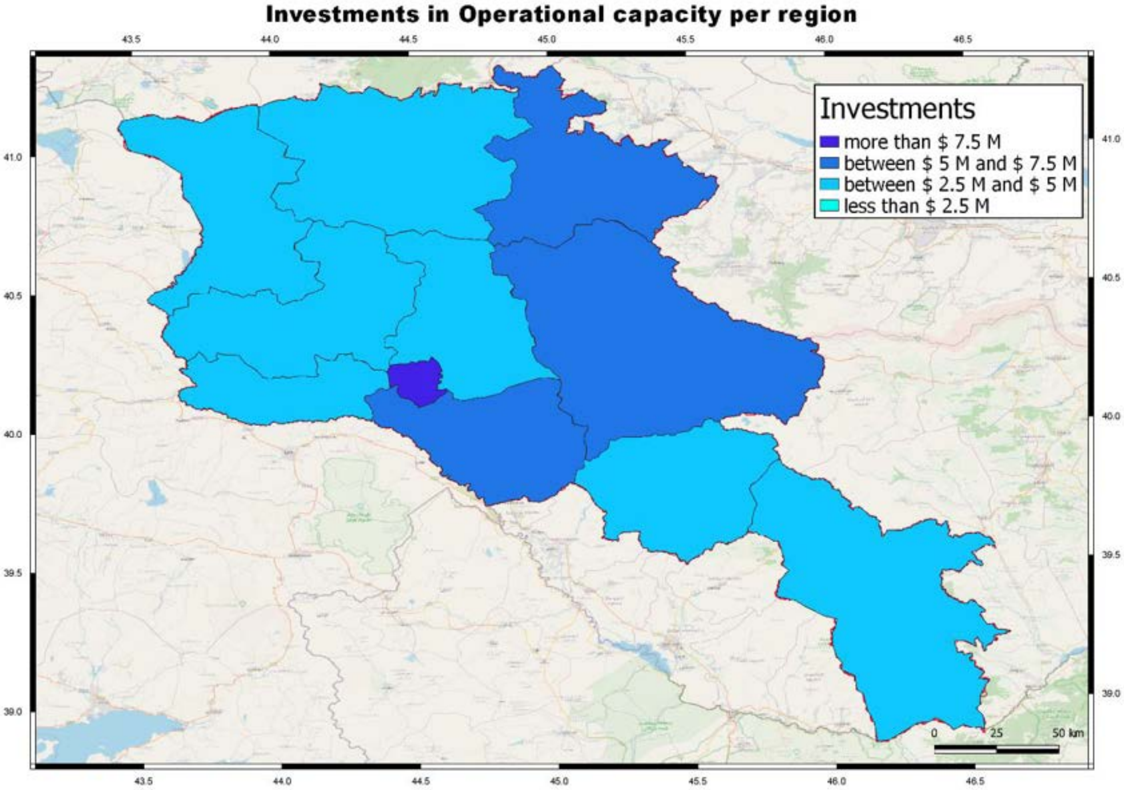


Figure C.19: Likely investment in Back-up systems in all FRS in a region – Variant 1

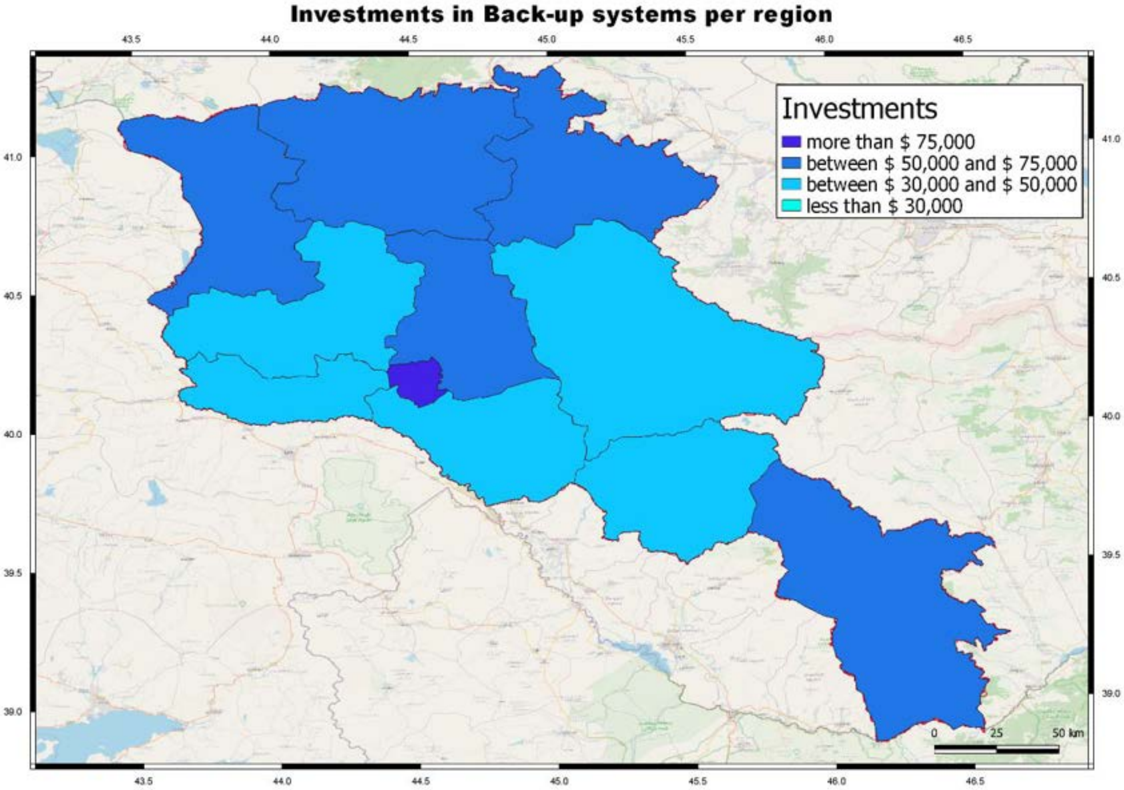


Figure C.20: Likely investment in Building infrastructure in all FRS in a region – Variant 1

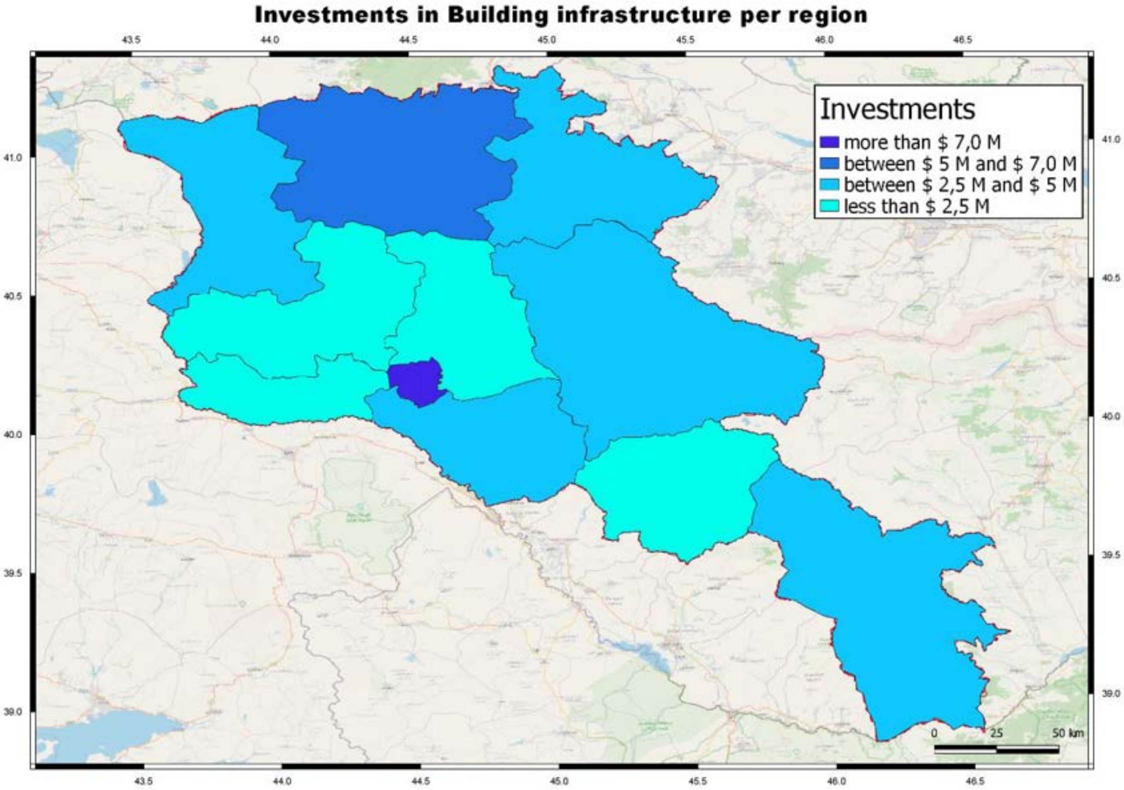
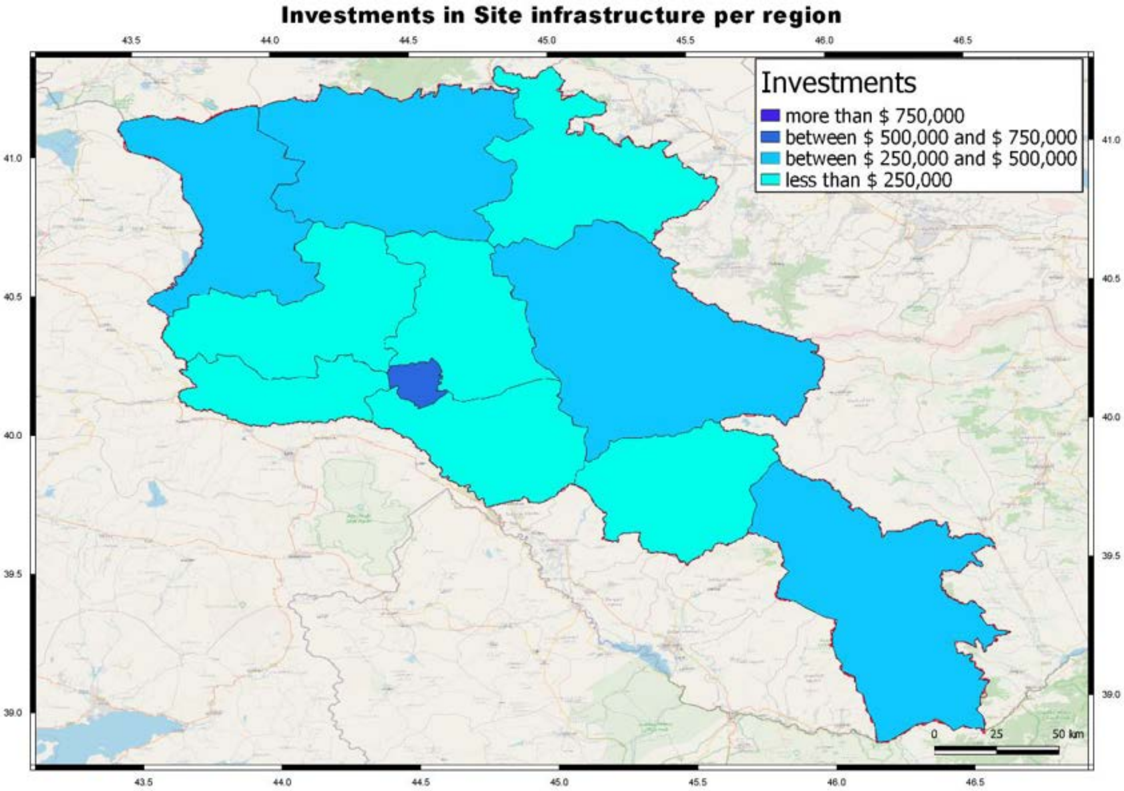


Figure C.21: Likely investment in Site infrastructure in all FRS in a region – Variant 1



D. Possible Improvement in the FRS Functionality Categories

The expected possible improvement in the scores of the functionality categories for each station estimated as described in Section 4.3 is presented on maps in Figure D.23 to Figure D.26 for all functionality categories, Figure D.28 to Figure D.31 for operational capacity, Figure D.33 to Figure D.36 for back-up systems, Figure D.38 to Figure D.41 for building infrastructure, and Figure D.43 to Figure D.46 for site and site infrastructure. The results from the baseline assessment are presented on the maps in Figure D.22, Figure D.27, Figure D.32, Figure D.37, and Figure D.42 for comparison.

Figure D.22: Baseline assessment results: All functionality categories – Normal Operation /NO/

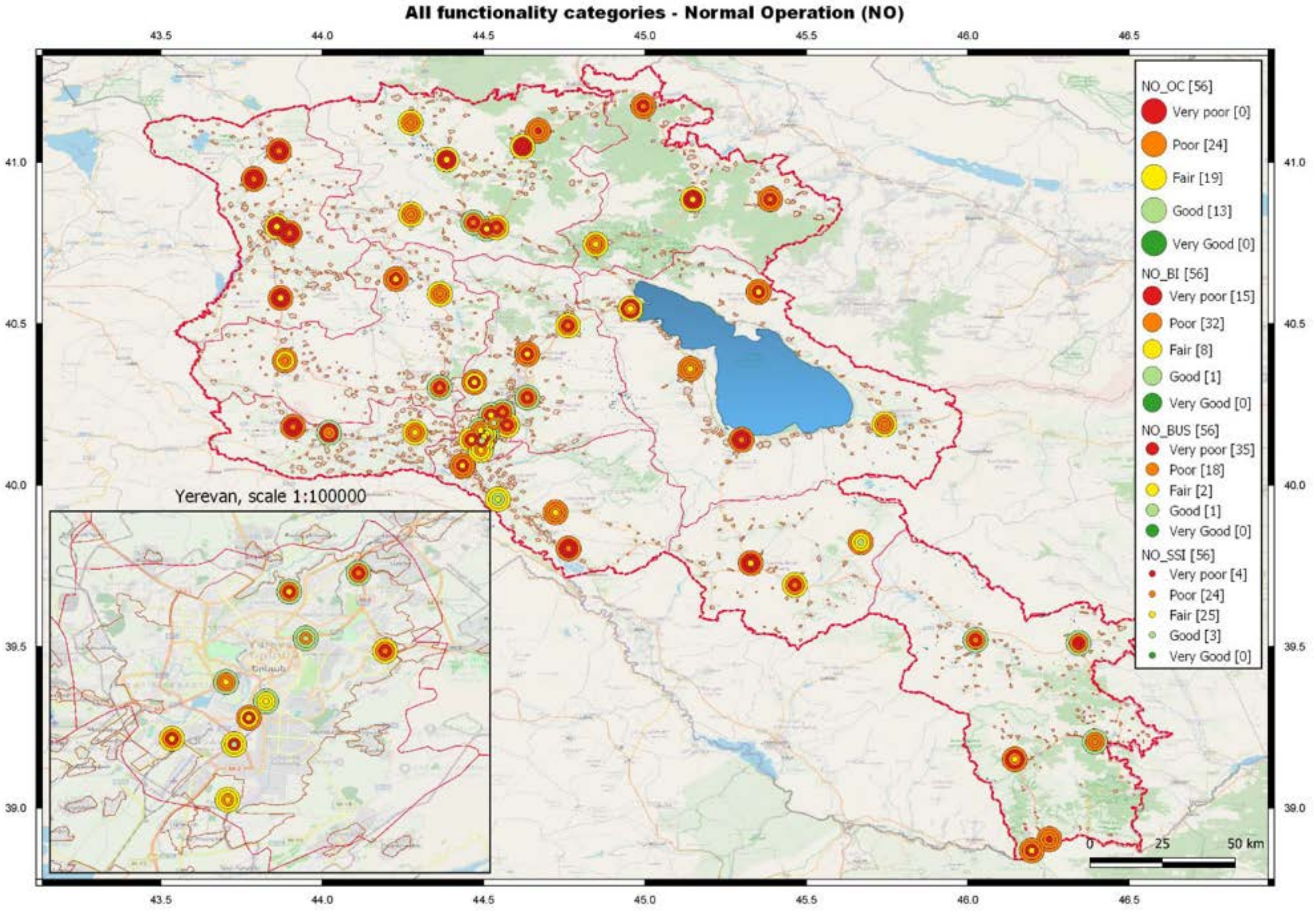


Figure D.23: Variant 1: possible improvement: All functionality categories – Normal Operation /NO/

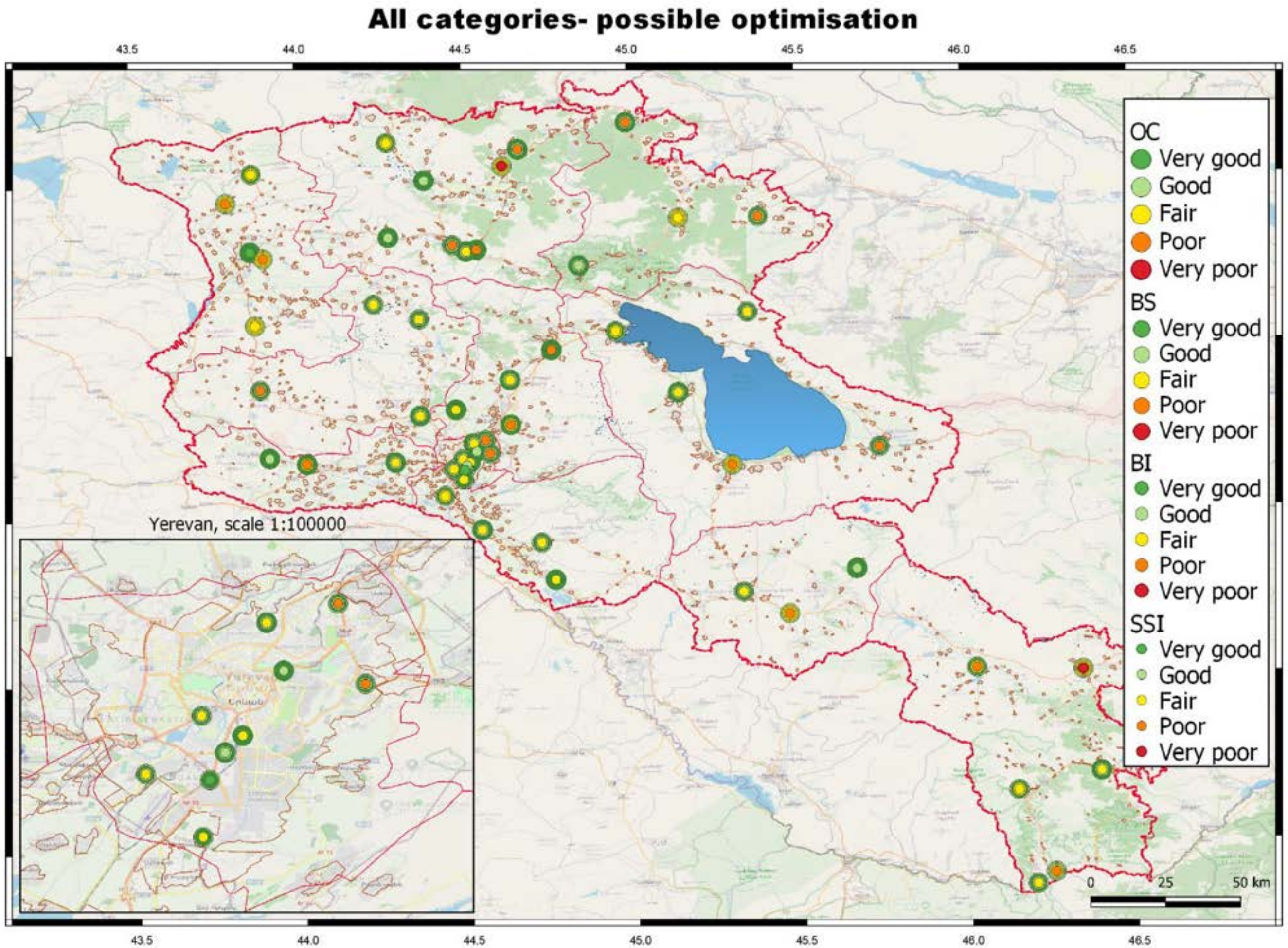


Figure D.24: Variant 2: possible improvement: All functionality categories – Normal Operation /NO/

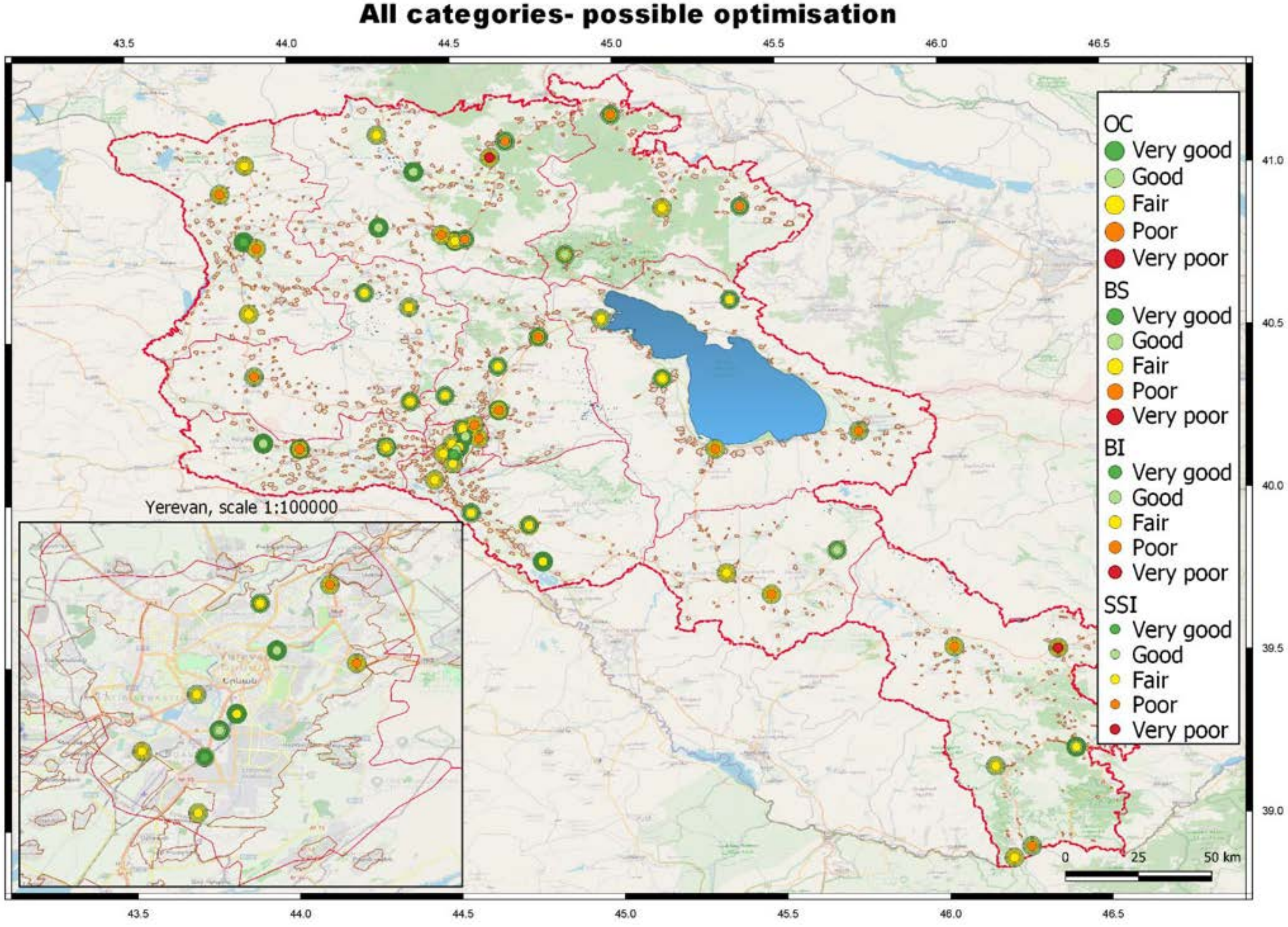


Figure D.25: Variant 3: possible improvement: All functionality categories – Normal Operation /NO/

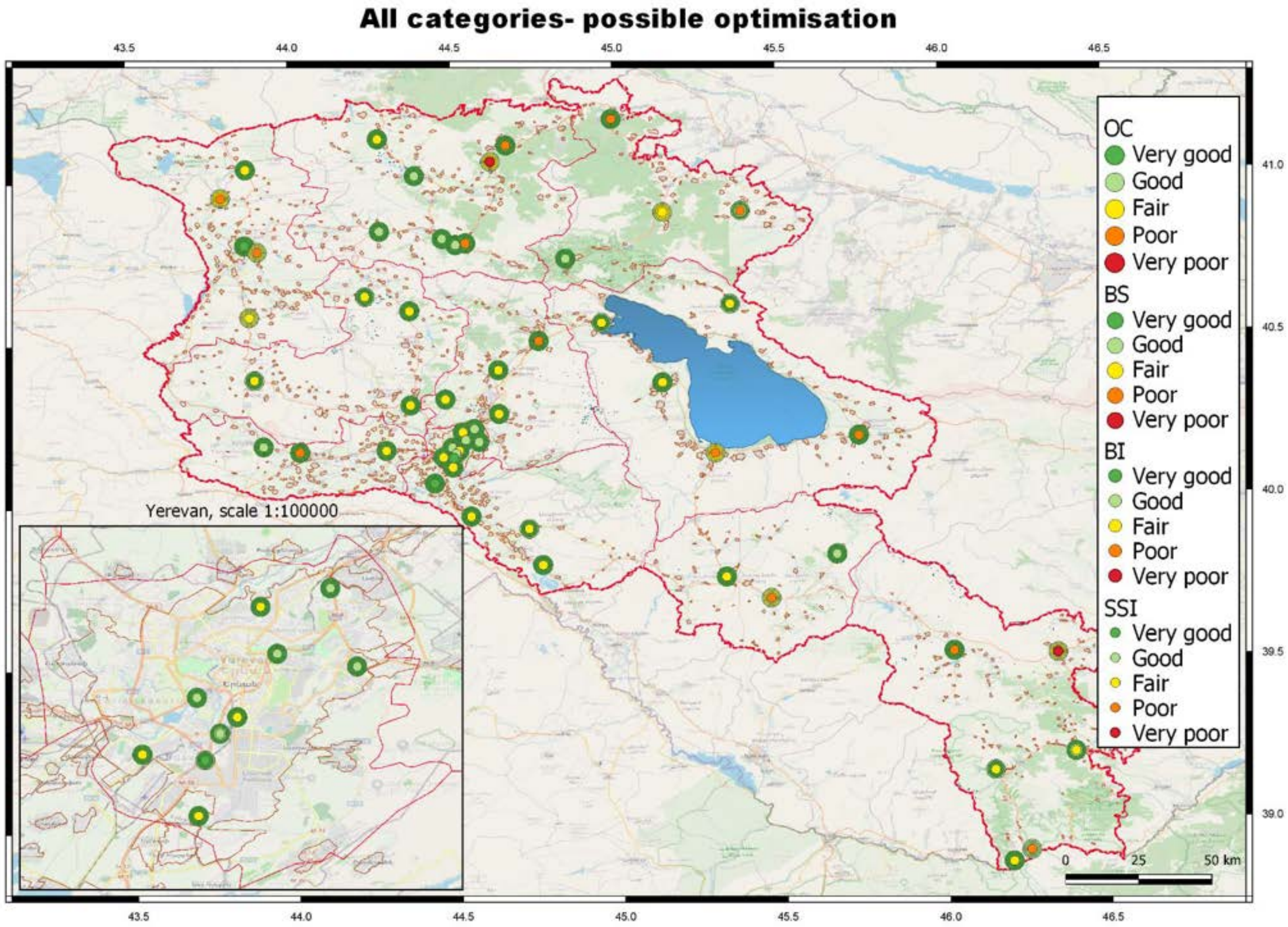


Figure D.26: Variant 4: possible improvement: All functionality categories – Normal Operation /NO/

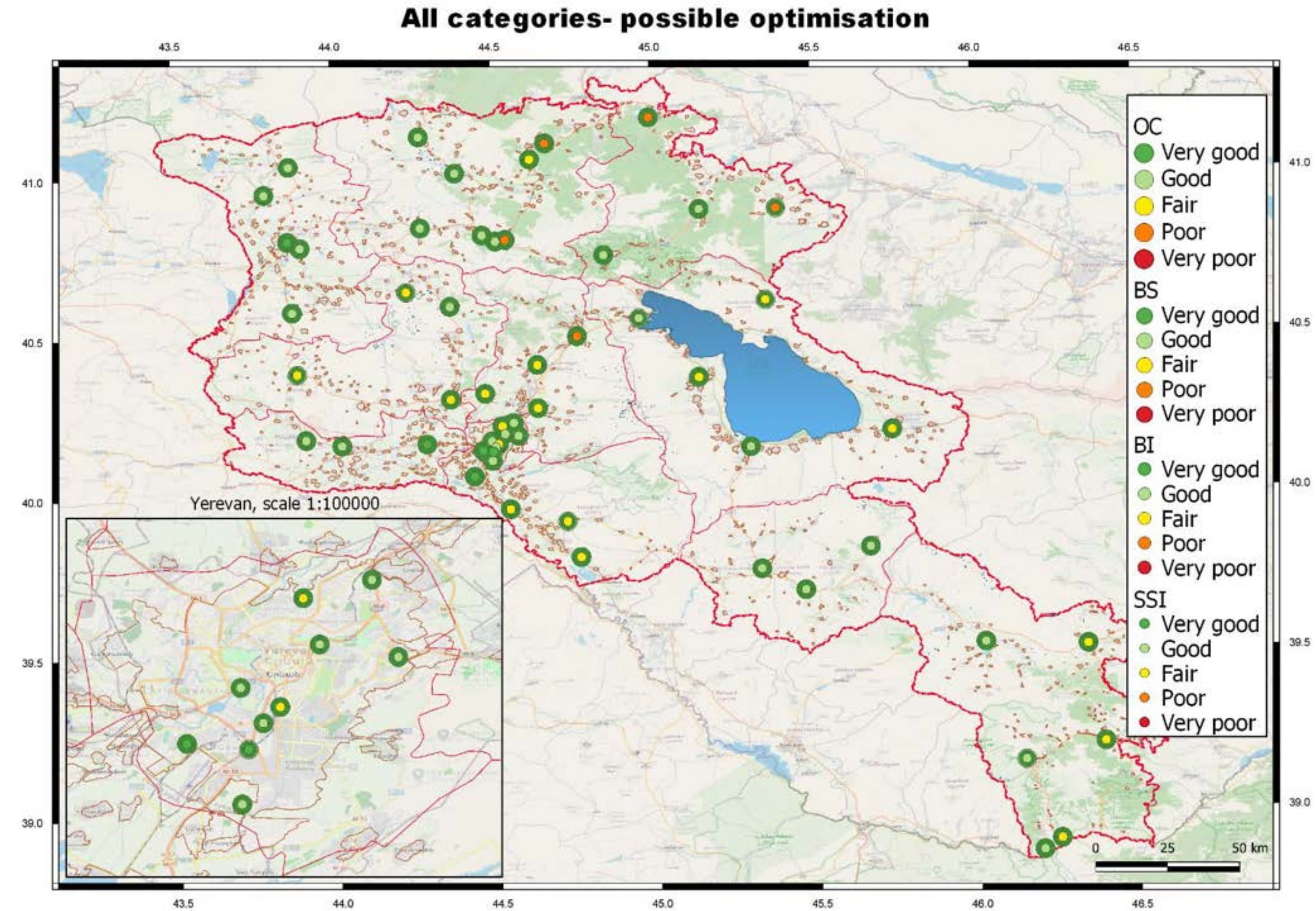


Figure D.27: Baseline assessment results: Operational Capacity – Normal Operations

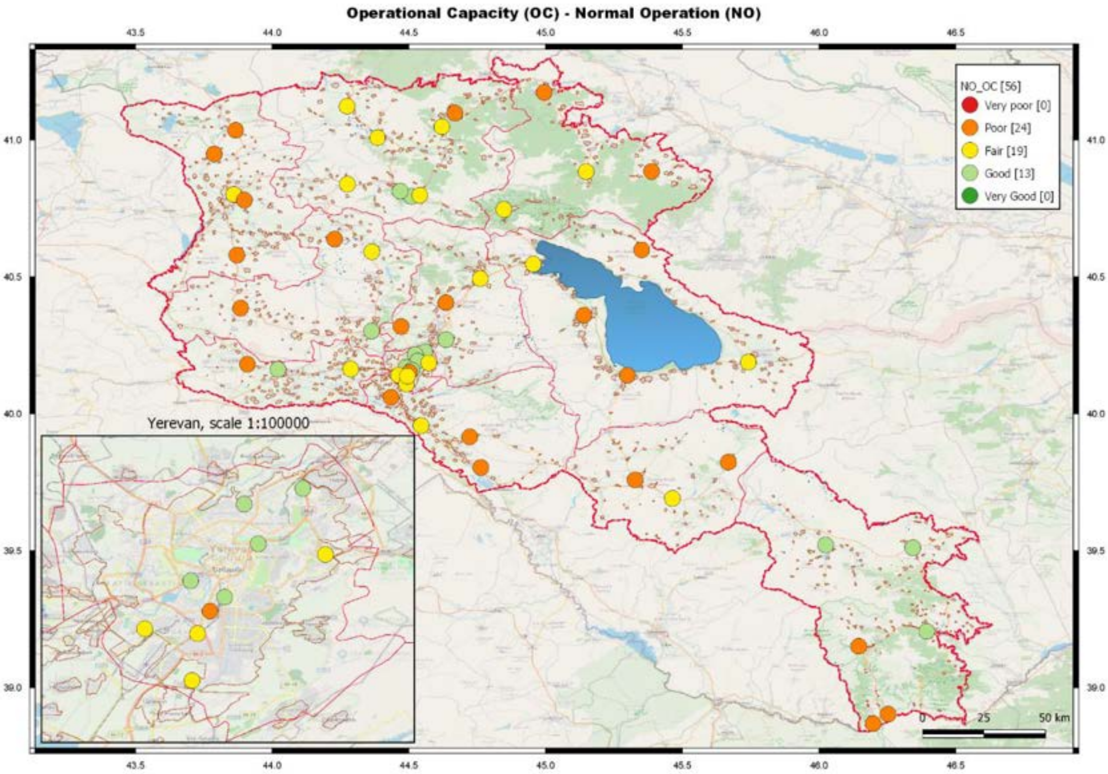


Figure D.28: Variant 1: possible improvement: Operational Capacity – Normal Operations

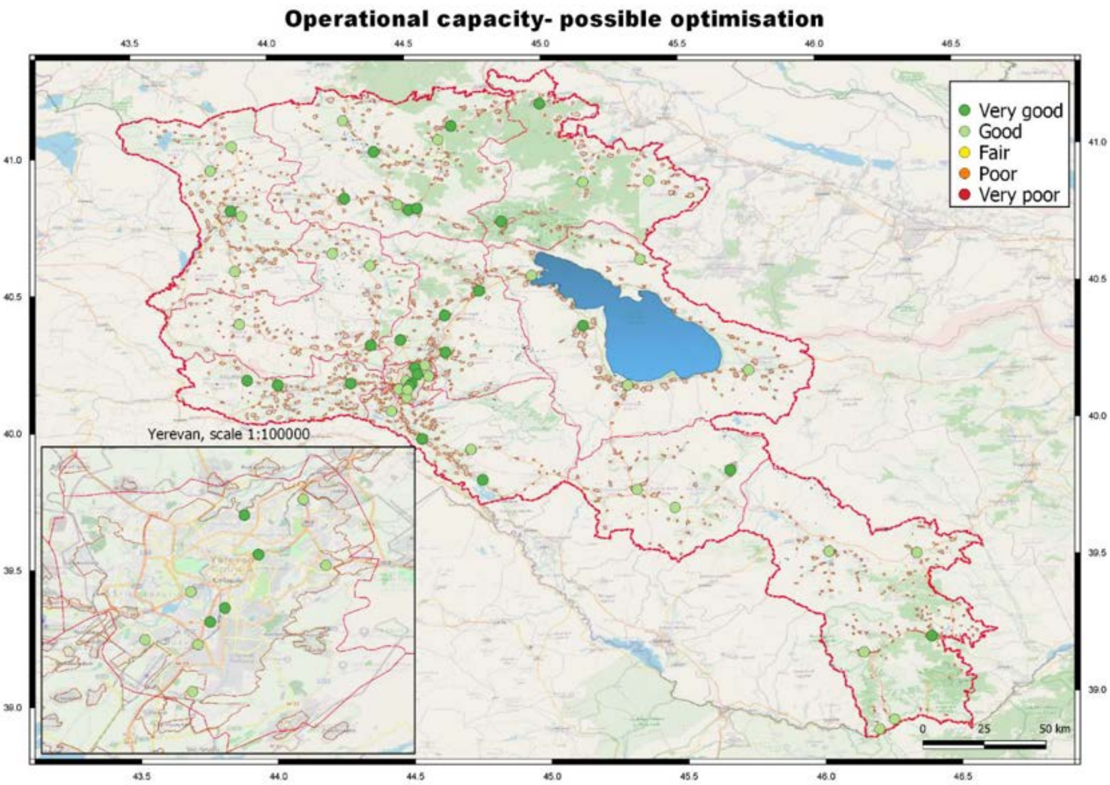


Figure D.29: Variant 2: possible improvement: Operational Capacity – Normal Operations

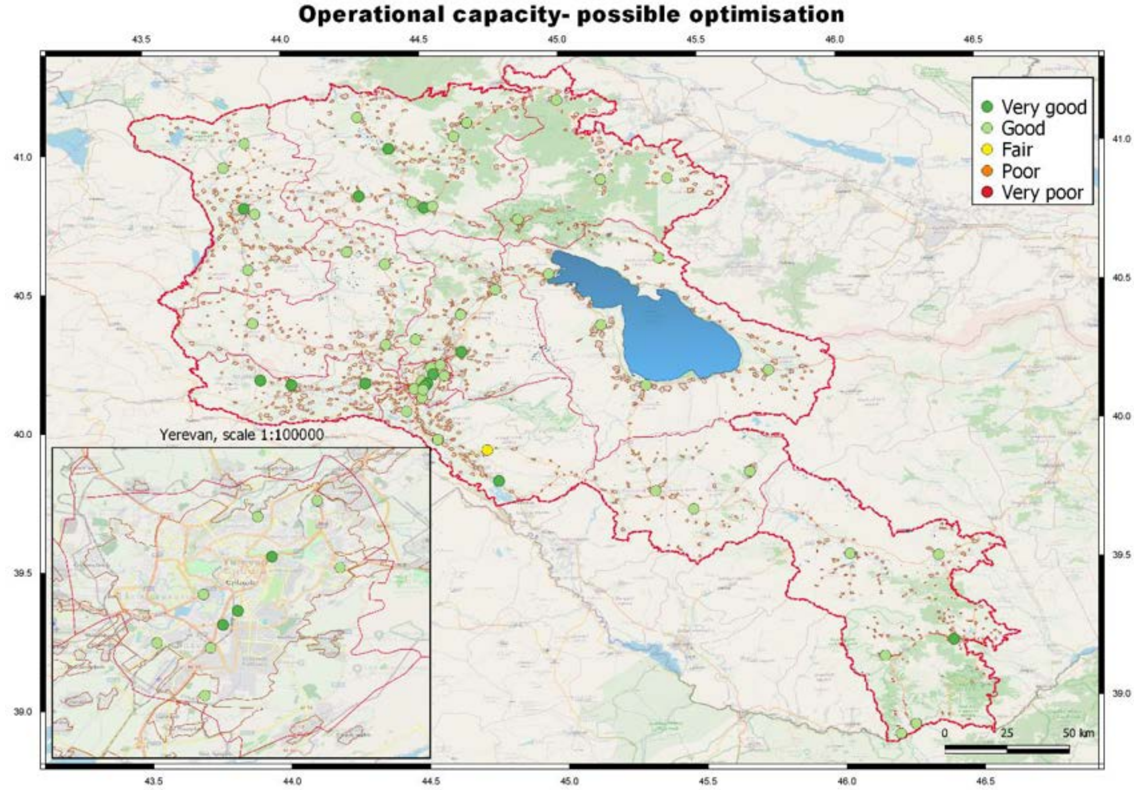


Figure D.30: Variant 3: possible improvement: Operational Capacity – Normal Operations

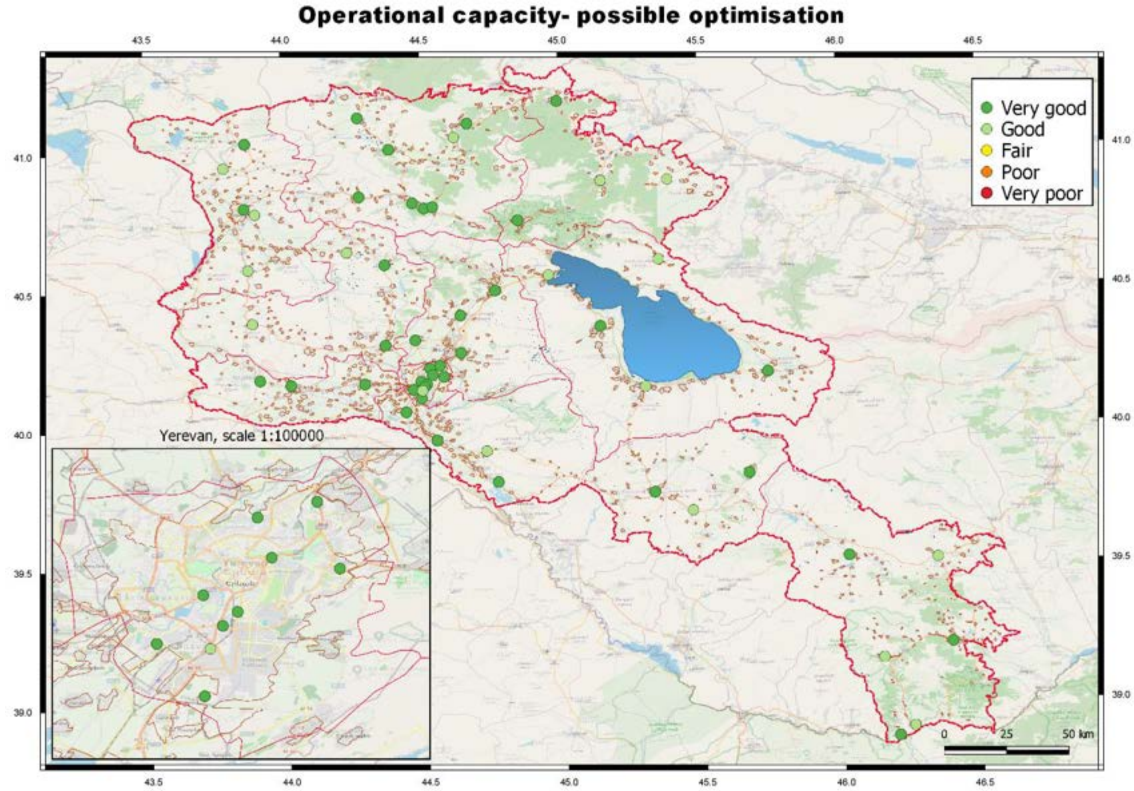


Figure D.31: Variant 4: possible improvement: Operational Capacity – Normal Operations

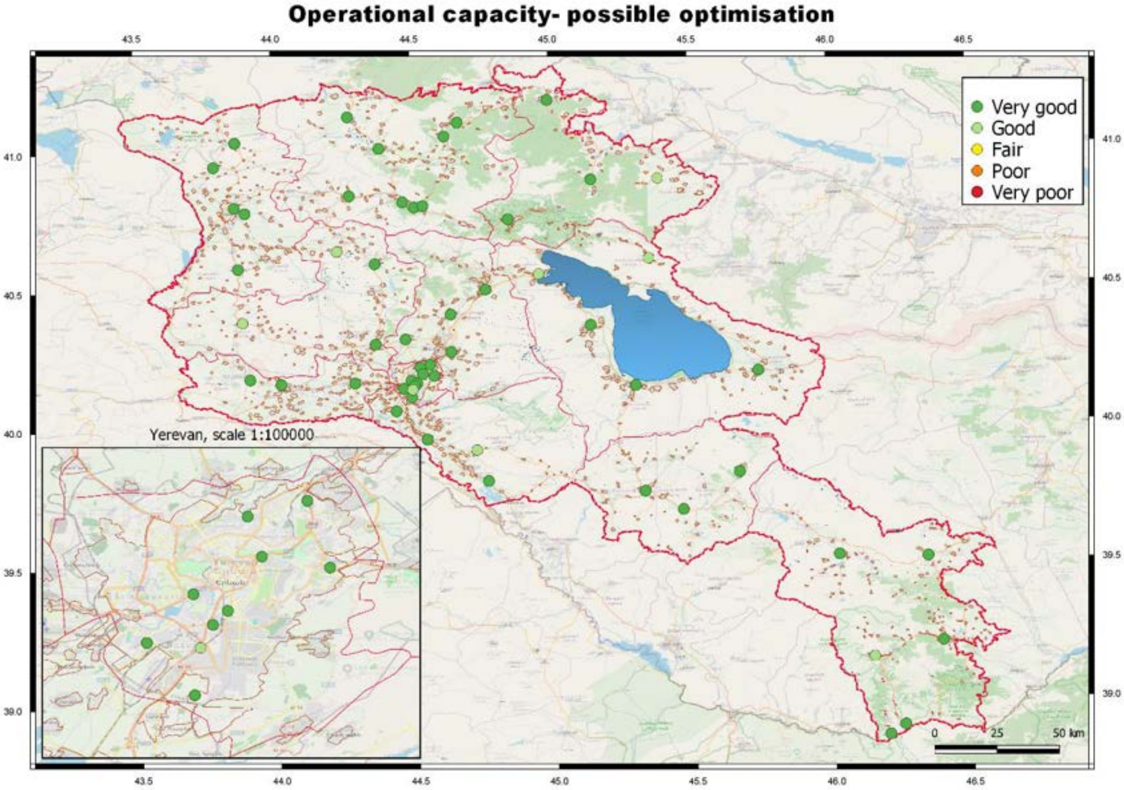


Figure D.32: Baseline assessment results: Back-up systems – Normal Operations

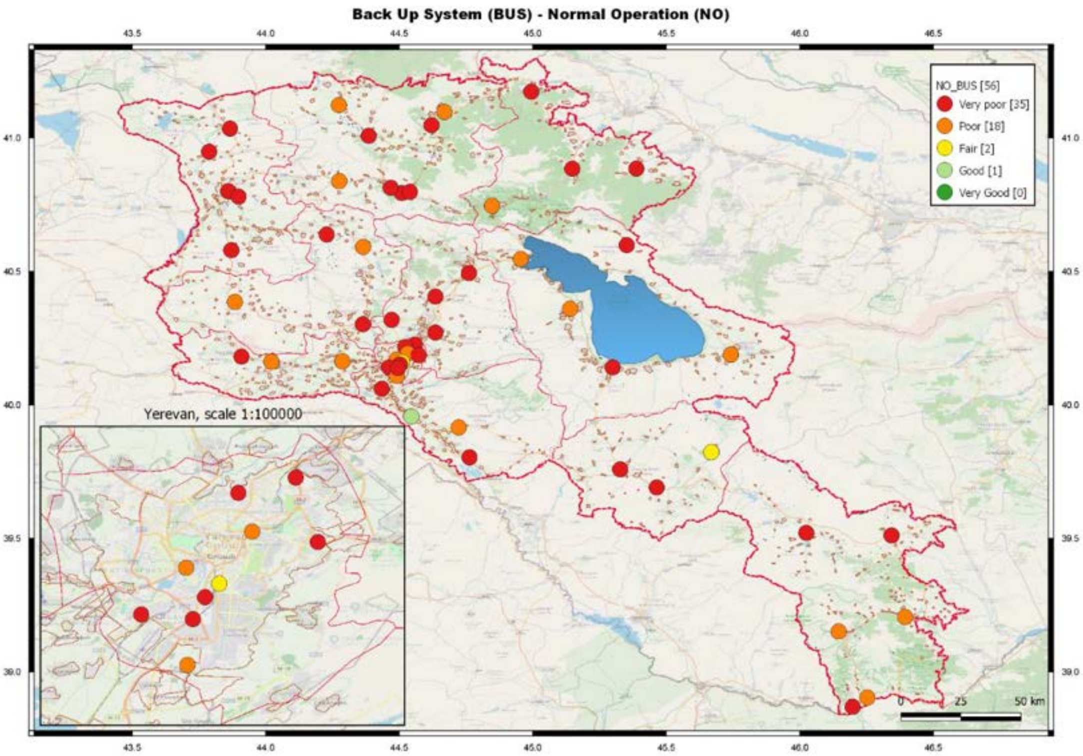


Figure D.33: Variant 1: possible improvement: Back-up systems – Normal Operations

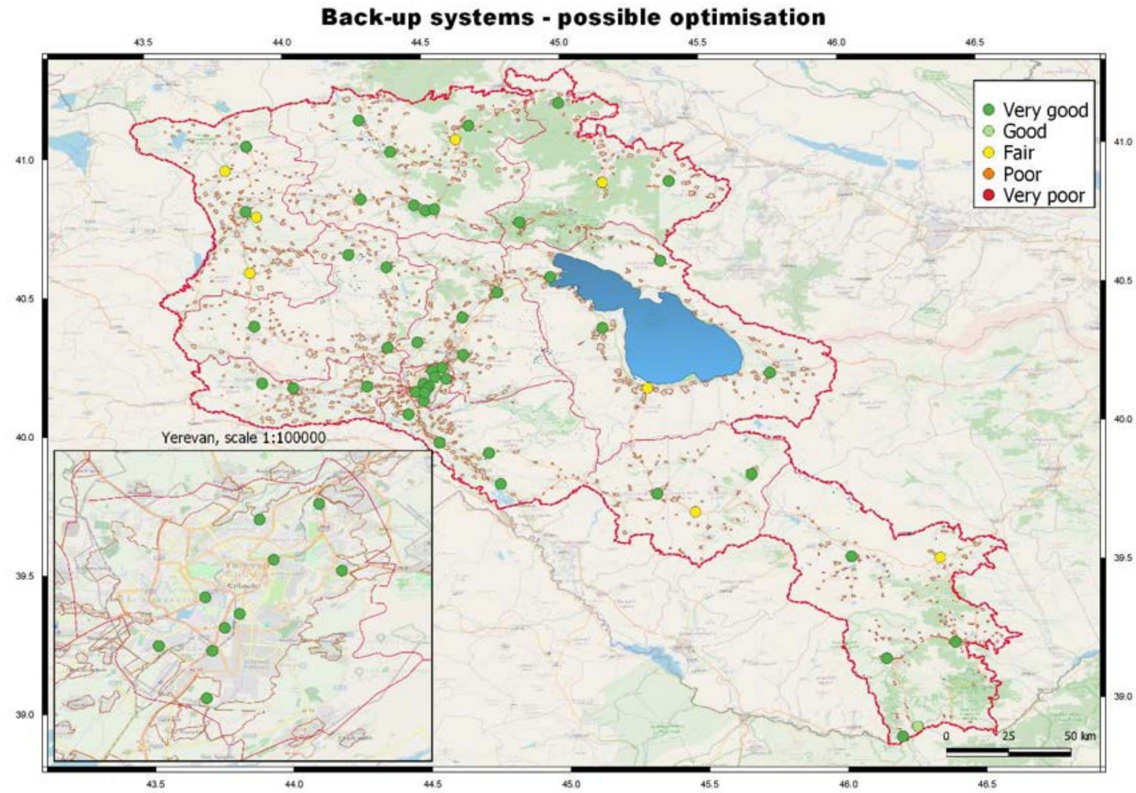


Figure D.34: Variant 2: possible improvement: Back-up systems – Normal Operations

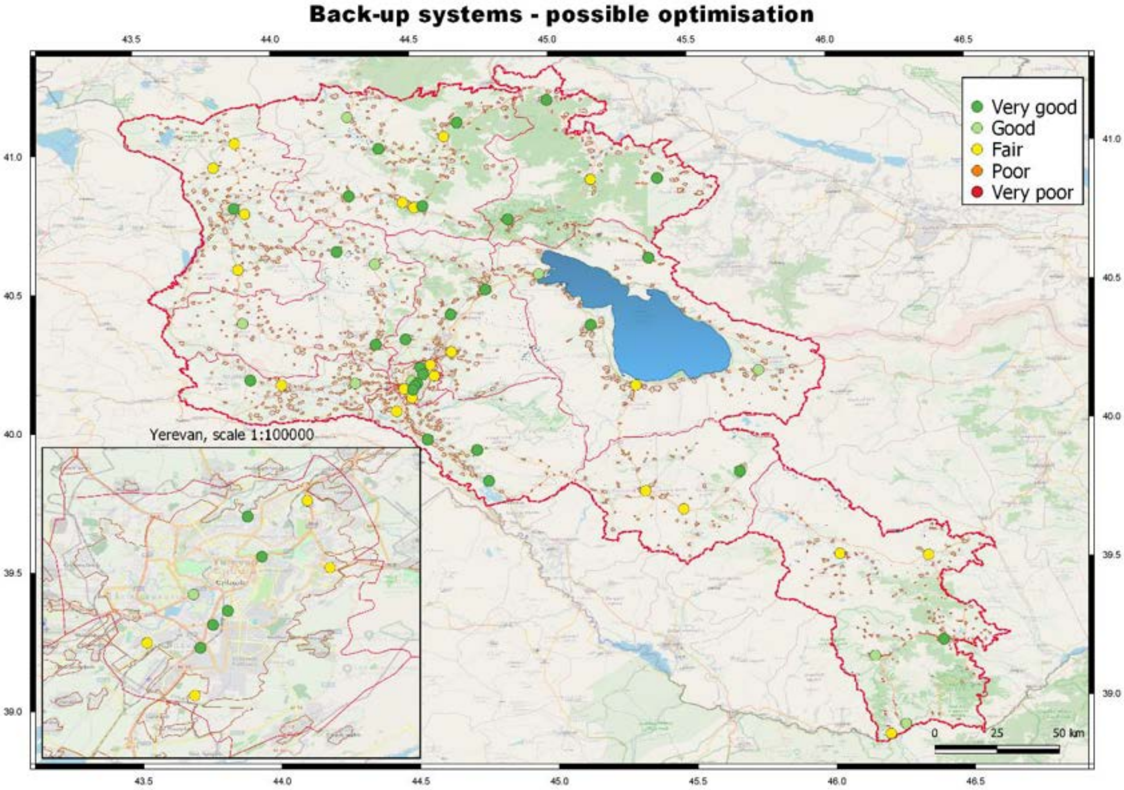


Figure D.35: Variant 3: possible improvement: Back-up systems – Normal Operations

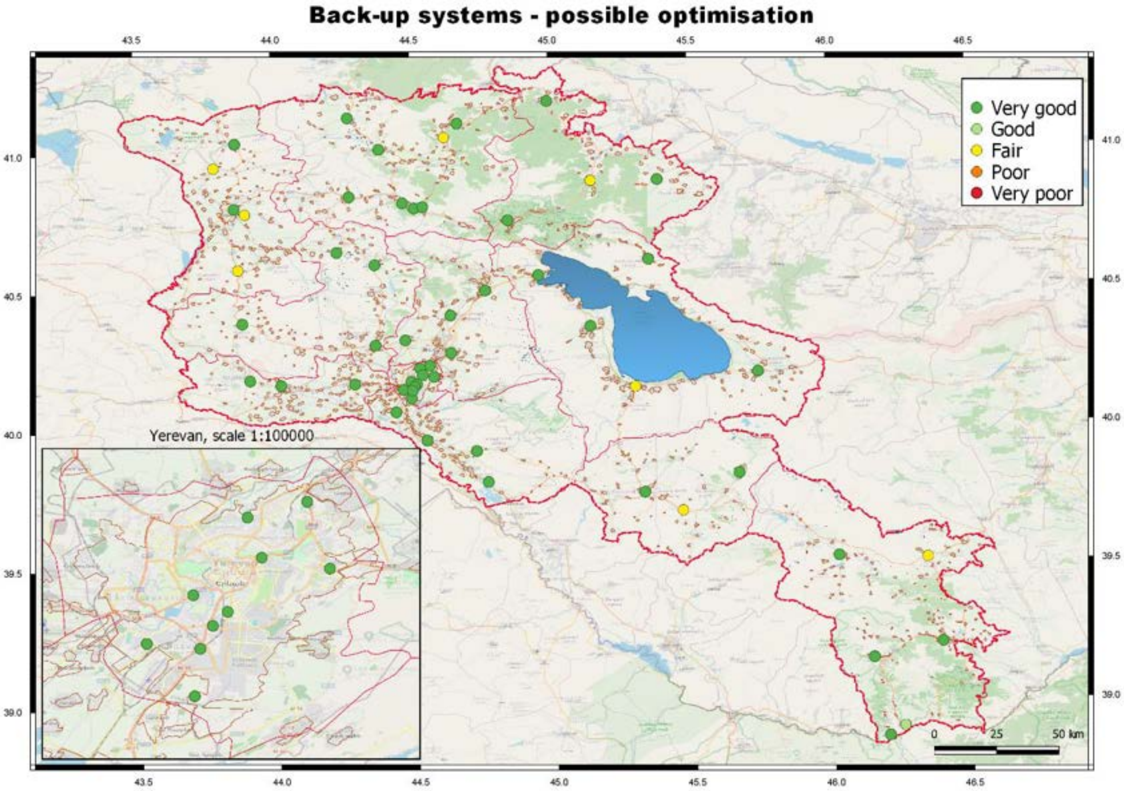


Figure D.36: Variant 4: possible improvement: Back-up systems – Normal Operations

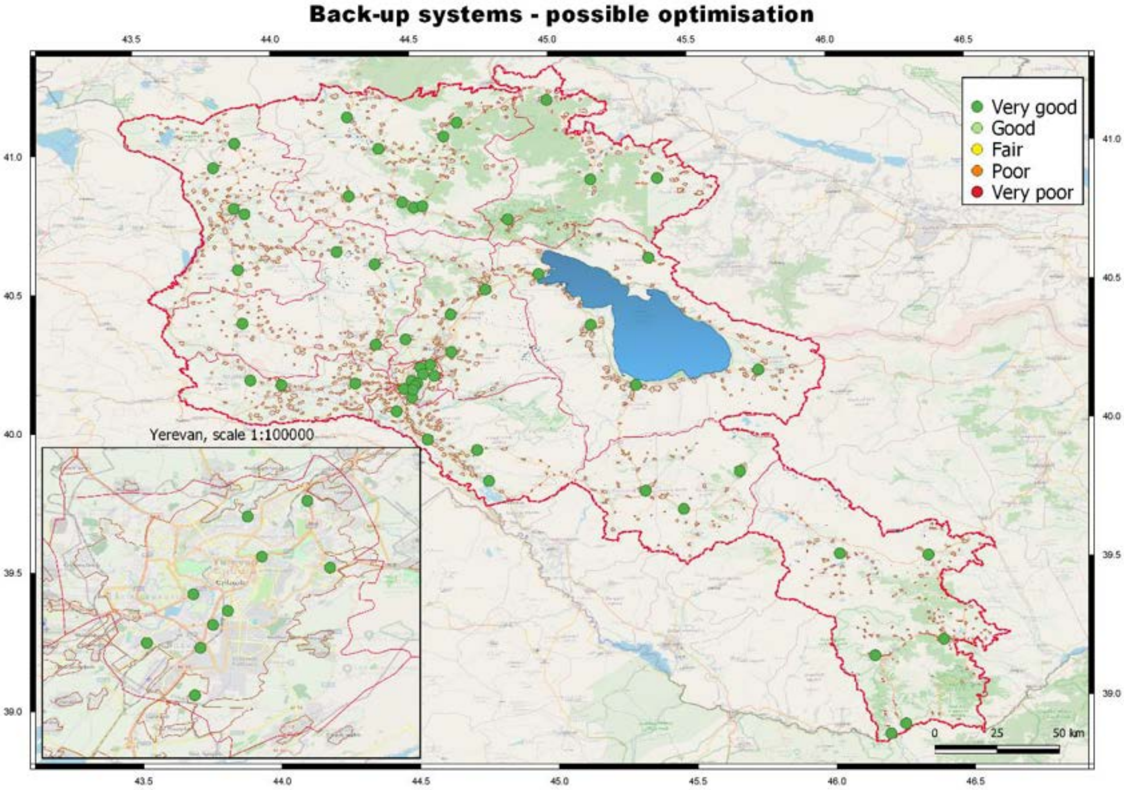


Figure D.37: Baseline assessment results: Building infrastructure – Normal Operations

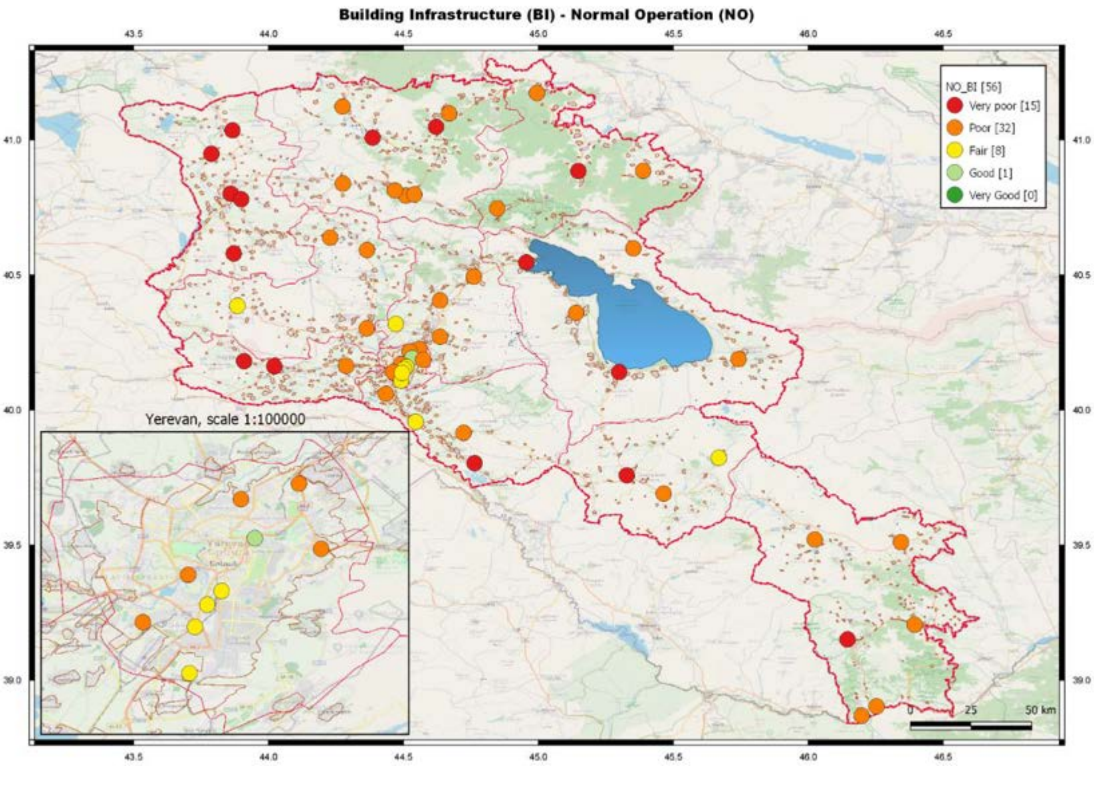


Figure D.38: Variant 1: possible improvement: Building infrastructure – Normal Operations

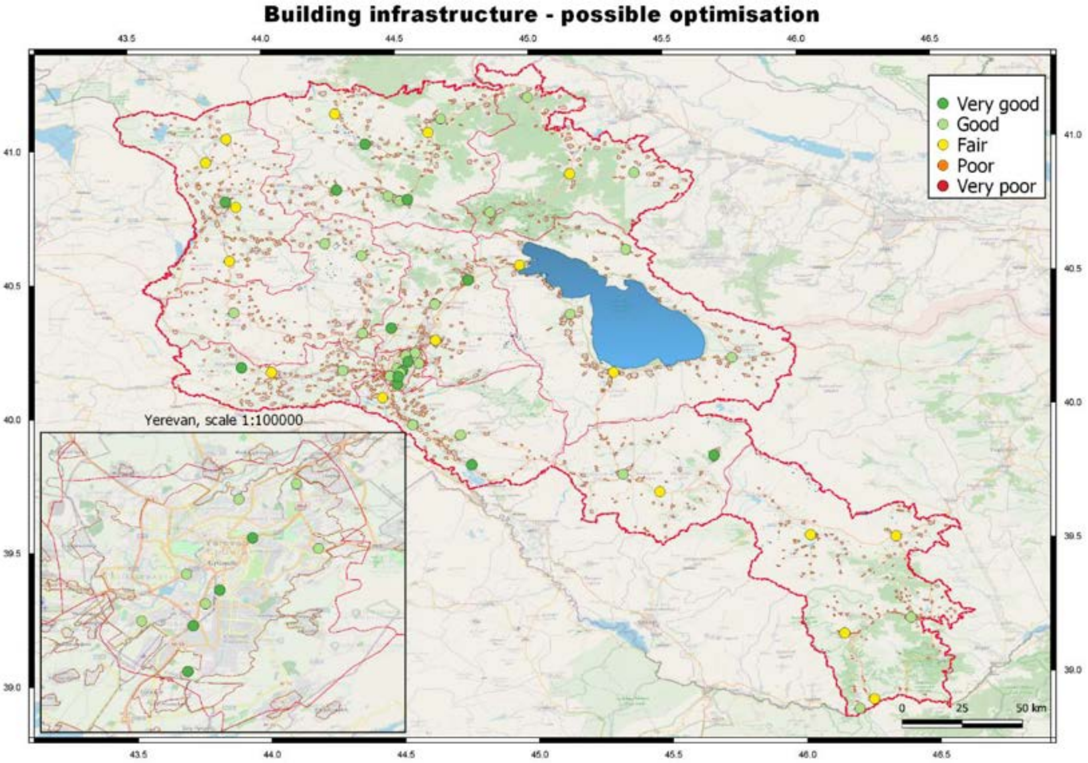


Figure D.39: Variant 2: possible improvement: Building infrastructure – Normal Operations

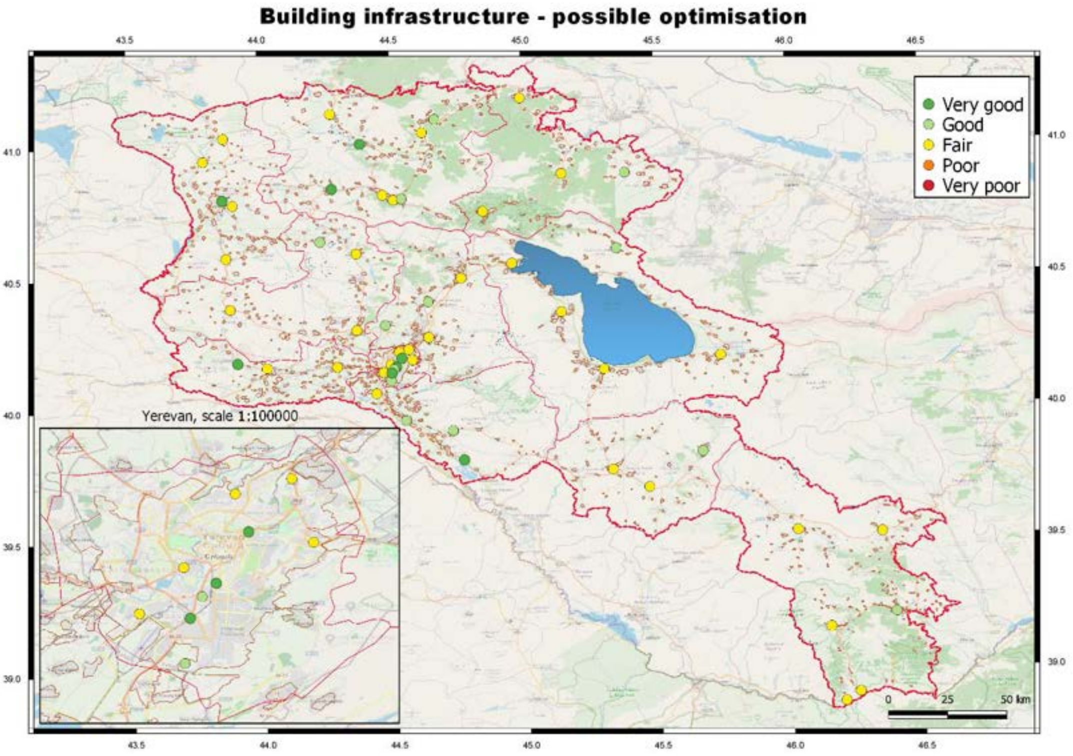


Figure D.40: Variant 3: possible improvement: Building infrastructure – Normal Operations

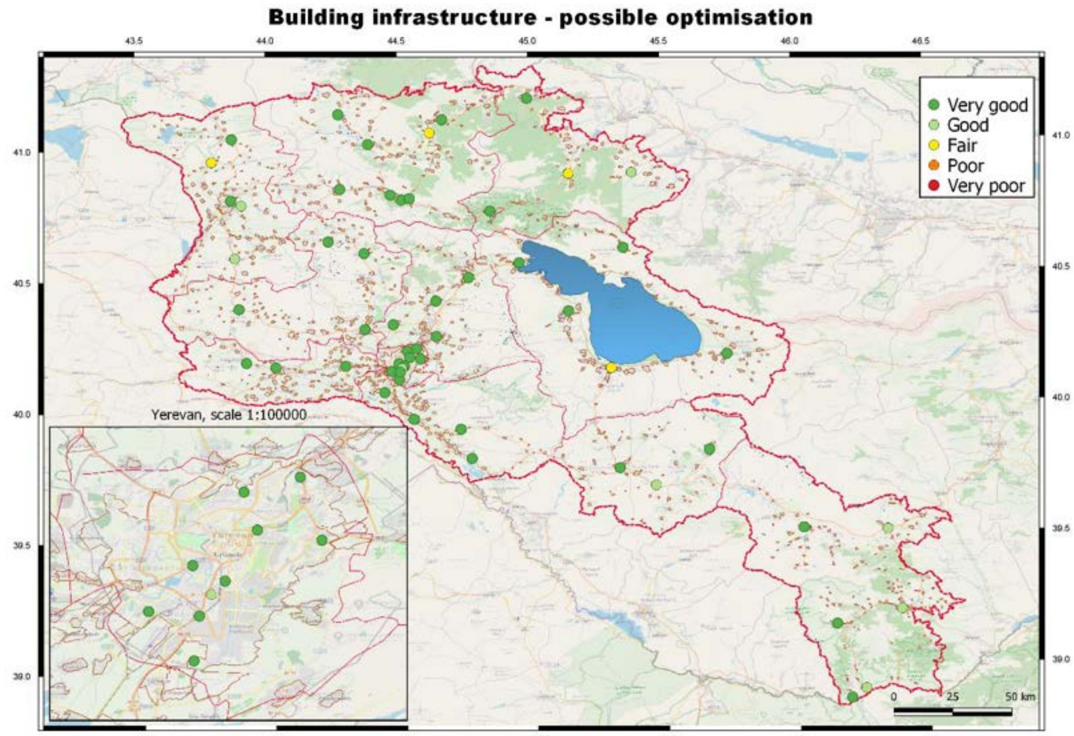


Figure D.41: Variant 4: possible improvement: Building infrastructure – Normal Operations

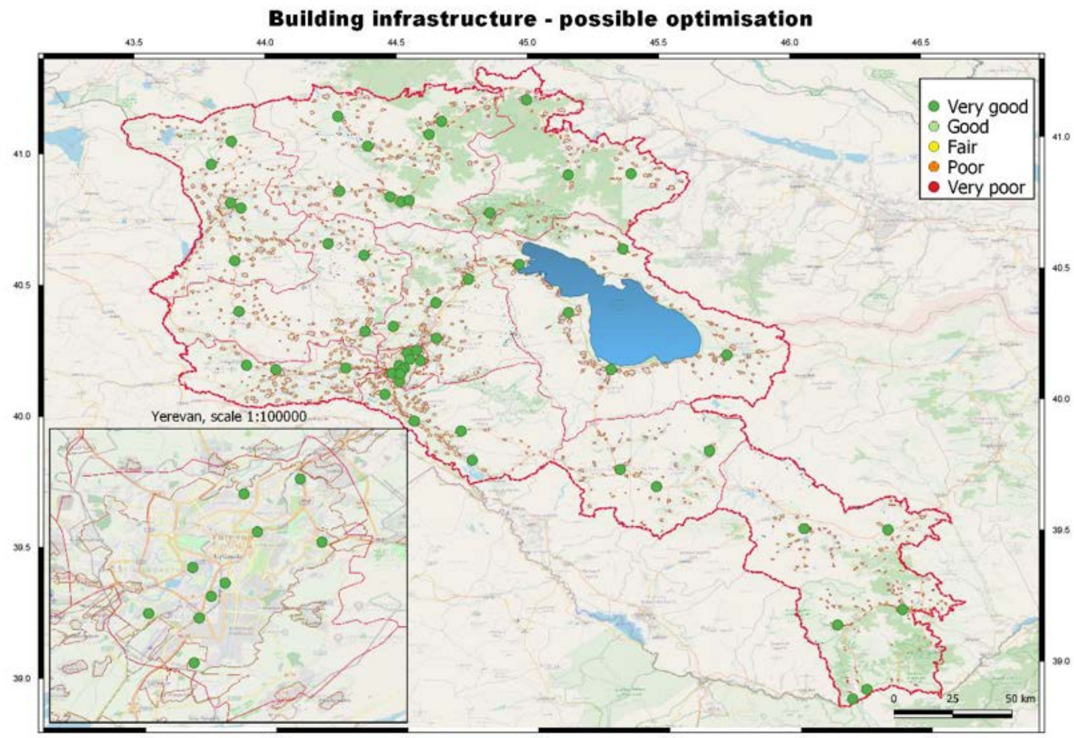


Figure D.42: Baseline assessment results: Site infrastructure – Normal Operations

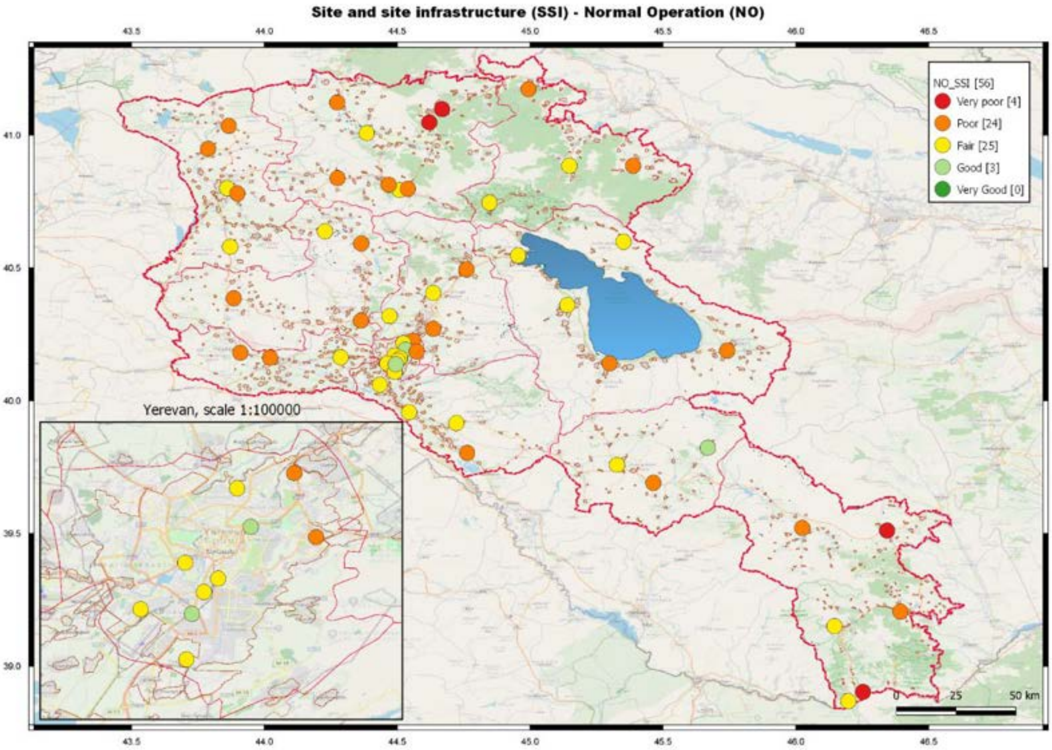


Figure D.43: Variant 1: possible improvement: Site infrastructure – Normal Operations

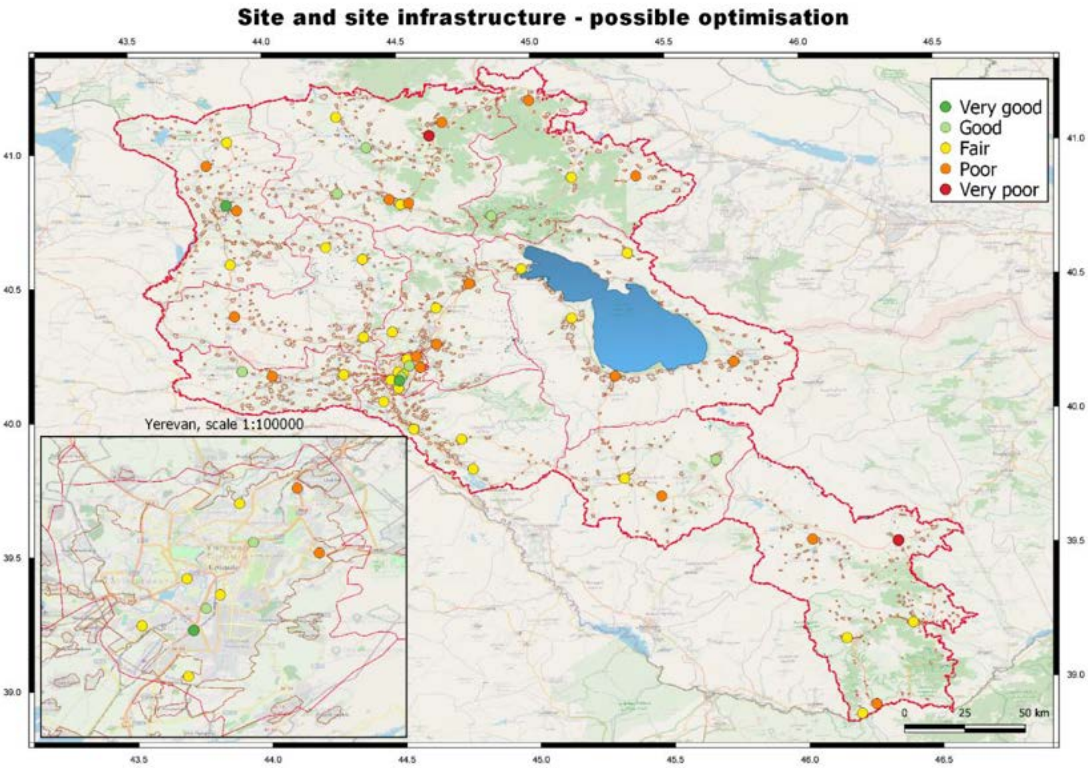


Figure D.44: Variant 2: possible improvement: Site infrastructure – Normal Operations

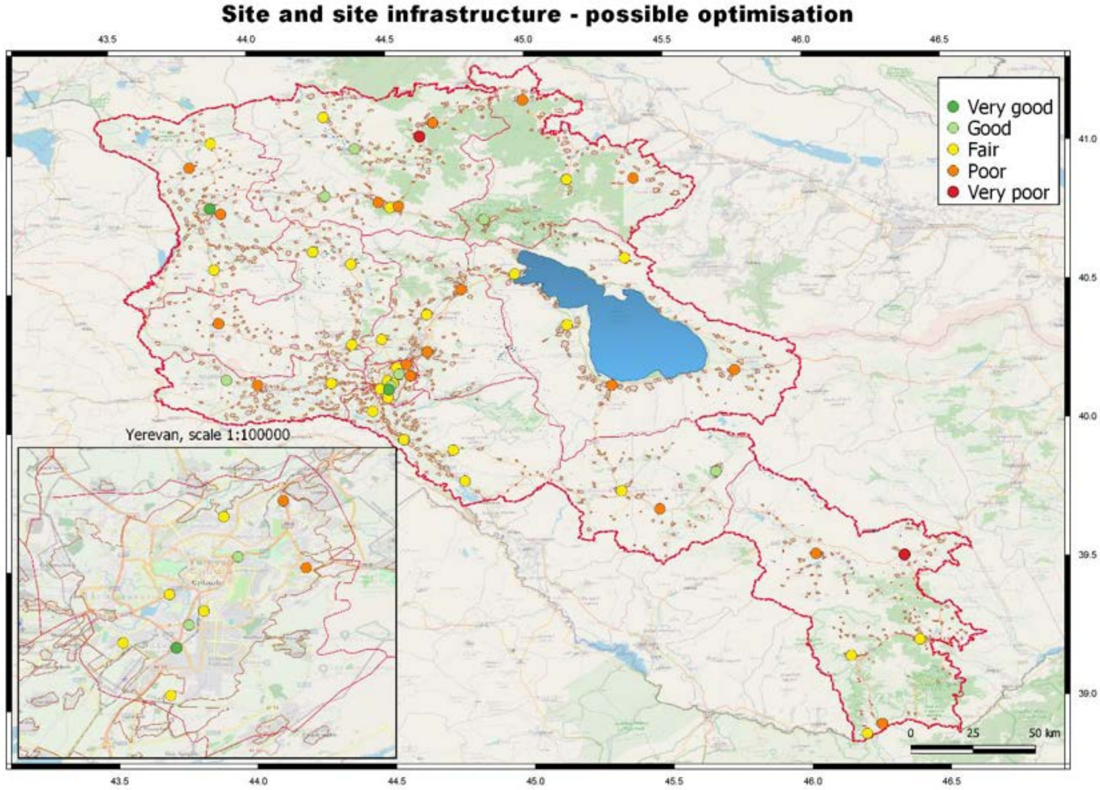


Figure D.45: Variant 3: possible improvement: Site infrastructure – Normal Operations

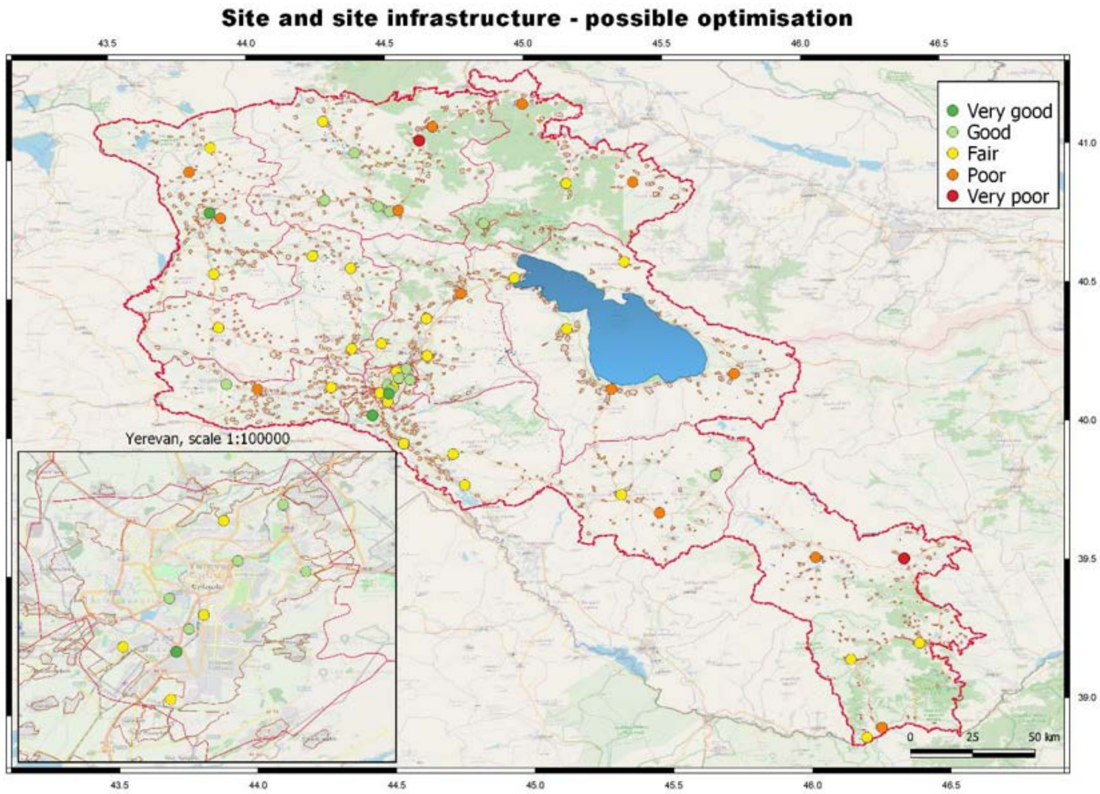
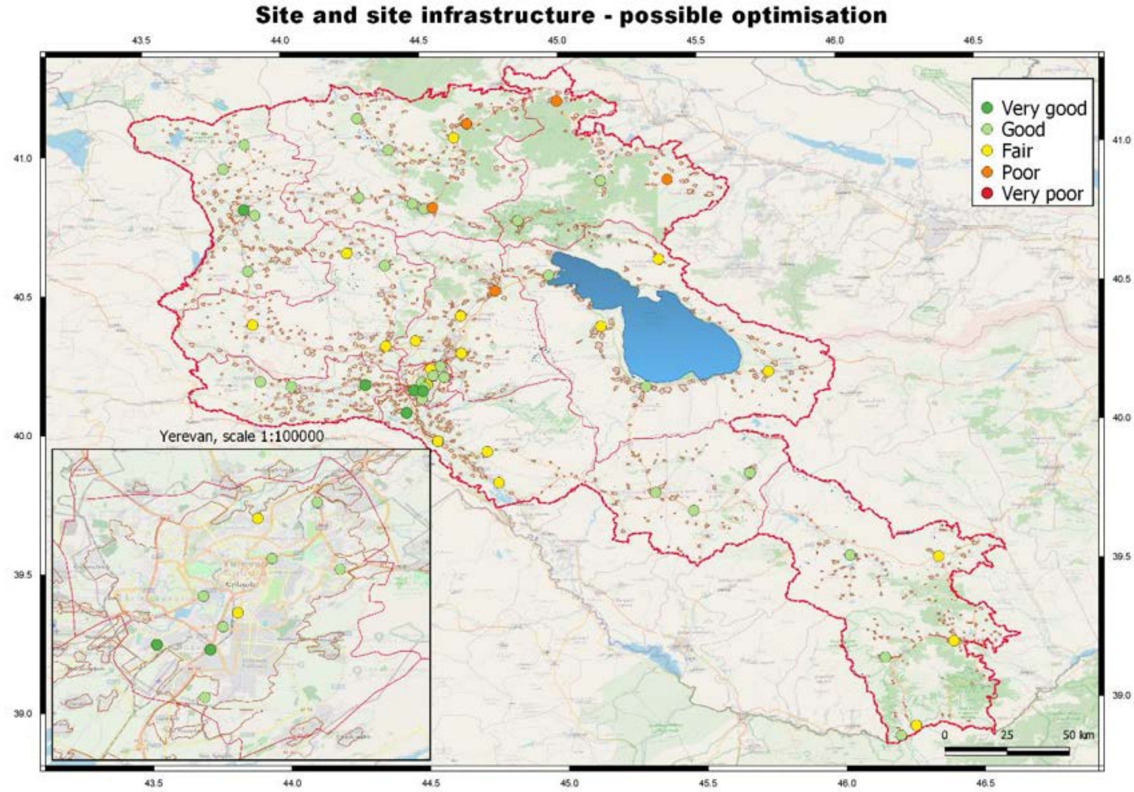


Figure D.46: Variant 4: possible improvement: Site infrastructure – Normal Operations



E. Specialised Equipment Specifications

This section presents technical specifications of some of the apparatus used for the operational capacity interventions cost estimation. The information presented was received from Mr. Acuma from Rosenbauer [P5] and was identified as non-commercially sensitive. When estimating the cost a more detailed technical and cost information was used received from Rosenbauer [P5], however, as it is commercially sensitive information any sharing is to be confirmed prior to distribution.

E.1 Brigade Response Vehicle /BRV/

Compact Line

HLF 1

Base specification:

- **Chassis:**
  - › Type: MB Sprinter 519 4x2
  - › Wheelbase 3.665
  - › Engine Output: 140 kW (190 PS) EURO 6
  - › Transmission: 6-speed manual Gearbox
  - › Power take-off: 40 kW at 2526 rpm
  - › Front passenger bench

- **Superstructure:**
  - › Original Mercedes panel van
  - › Original Mercedes rear and side doors
  - › Vertical safety sandwich partition wall between crew and equipment compartment

- **Cabin:**
  - › Crew: 1+5 (3/3)
  - › 3 x Comfort PA holder arranged in direction of travel
  - › Worktable with integrated shelving system
  - › Double hose drawers for pressure hoses
  - › Comfort holders for water-carrying fittings

- **Equipment compartment:**
  - › 1 comfort retractable wall left
  - › 1 comfort slide tray bottom right
  - › 2 tray top right for punching tools
  - › 1 comfort slide tray for portable pump

- **Roof:**
  - › Accessible roof with warning lights and anti slip material
  - › Foldable roof access ladder
  - › Powerful surround illumination

- **Loading:**
  - › Equipment according to customer request

- **Control system:**
  - › Well-arranged switch console for: flashing lights, surrounding illumination
  - › Well-arranged pump control unit RCLS in equipment compartment

- **Power supply:**
  - › 230V input sockets including charger for charging all on-board rechargable batteries (vehicle, portable fire pump)
  - › Feed socket NATO 12V

Compact Line
HLF 1

- **Extinguishing system:**
  - Extinguishing water tank 500 l incl. swash partition, tank heating 1000 W, overflow, residual discharge valve and inspection cover
  - H5 normal pressure pump: 4-level centrifugal pump, not sensitive to contamined water, driven from chassis via power take-off
  - Output: 200l at 10bar
  - Easy operation on LCS incl. power take off switch, operating hours meter, tank display, engine temperature etc.
  - Water supply via water tank or externally on B pressure input
  - Automatic level regulation for comfortable water tank filling
  - Rapid action: Rosenbauer normal pressure reel with 30m hose and RB99 branch pipe

Dimensions and weight:

L x B x H	5.980 x 2.020 x 2.800 mm
Permissible total weight	5.500 kg

Contact

Rosenbauer International AG
Paschinger Straße 90
4060 Leonding, Austria
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Fax: +43 732 6794-91

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E.2 Emergency Tender - Type 1

ET Efficient Technology
TLF 4000

Basic specifications

- Type: MAN TGM 16.290 4X4 BB
  - Engine Output: 290 hp Euro 6
  - Wheelbase: 4,250 mm
  - 2 Shackles on front and rear
  - 125 l fuel tank
- Cab:
  - MAN original double cab (1+5)
  - Rosenbauer COMFORT BA support in backrest for 4 seats
- Superstructure:
  - Rosenbauer aluminium superstructure consisting of a self-supporting, screwed sheet metal and profile construction
- Equipment compartments:
  - Deep storage compartments equipped with a hinged step with COMFORT revolving shelves for the optimum removal and safe storage of equipment.
- Pump control system:
  - LCS 2.0 compact, hard-wired
  - Pressure governor
- Extinguishing systems:
  - Type: NH35 combined normal/high pressure pump
  - Output: from 3,500 lpm at 10 bar, 400 lpm at 40 bar
  - Water tank volume: 4.000 l
- Pressure outlets:
  - Four manual normal pressure outlets in the pump compartment facing backwards
  - One manual high pressure outlet at the rear plus one for feeding the quick attack unit
- Quick attack unit:
  - Rear-mounted, high pressure hose reel (25 mm hose, 60 m)

ET Efficient Technology
TLF 3500 L

- Electrical systems:
  - Two LED beacons on the cab roof, two on the rear part of the superstructure
  - 2 LED flashing light in front grille
  - Surrounding area lighting with LED lights mounted on both sides of the roof gallery and on the rear
  - Illumination in each compartment
  - 220 V Quick start system including battery charger, air supply

Dimensions and weight

L x W x H	Max 7,810 x 2,500 x 3,460 mm
Permissible gross weight	18,000 kg

Contact

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Vers. 1.0
8804 JAlv, 04-2019

E.3 Triple Combination Pumper

AT- Advanced Technology
TLF 4000/400

Basic Specification

- Chassis
  - › Type: MAN TGM 18.340, 4x4, Euro VI
  - › Engine output: 250 kW (340 HP)
  - › Transmission: MAN ZF 12AS, Tipmatic
  - › Wheelbase: 4.500 mm
- **Cabin**
  - › Crew: 1 + 4 (2 + 0 + 3)
  - › Rosenbauer crew cab integrated into vehicle body with 2 SCBA holders Rosenbauer COMFORT in driving direction
  - › Crew cab doors glass/glass
  - › Rotating entry steps for easy access
  - › LED cabin illumination
- **Vehicle body:**
  - › Rosenbauer aluminum body made from self-supporting screwed and bonded aluminum sheets and profile construction with aluminum sandwich sheets and robust composite covers
- **Equipment compartment:**
  - › Full height lockers and COMFORT rotating compartments for optimal retrieval and secure storage of equipment.
  - › Color coding for handles and controls
  - › LED compartment lighting
- **Extinguishing system**
  - › Type: Combined normal- and high-pressure pump NH35 (FPN10-3000 and FPH 40-250 according to EN 1028 with LCS 2.0 display control
  - › Output: 3 500 l/min @ 10 bar, 400 l/min @ 40 bar
  - › Water tank 4.000 l Polyethylene
  - › Foam tank: 400 l Polyethylene
- **Pressure outlets**
  - › 2 normal pressure outlets on each vehicle side with Storz B couplings in the lower rear compartments
- **Rapid Intervention hose reel:**
  - › HP rapid intervention hose reel in compartment 7 with electric hose rewind and HP nozzle NEPIRO ERGO including a foam barrel
- **Foam Admixing System**
  - › Type: 3 stage NP FIX-MIX: 1%; 3%; 6%
- **Water-Foam monitor**
  - › Type: RM35, electrically remote controlled, on superstructure roof

AT- Advanced Technology

TLF 4000/400

Basic specification

- **Equipment**
  › Mounting for equipment according to customer specification

- **Control System**
  › Rosenbauer LCS 2.0 (Logic Control System), based on CAN-Bus technology

- **Additional Equipment**
  › 3-Point safety belts for all seats

  › Reversing camera with image representation on the front display

  › External electric and pneumatic supply

Dimensions and weight

L x W x H	7.900 x 2.550 x 3.300 mm
Permissible total weight	18.600 kg

Contact

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E.4 Aerial Truck

L64P

Turntable ladder

rosenbauer

L64 acc. to EN 14043

Technical Data

Chassis	Type	MAN TGS 33.400
	Performance	400 hp (294 kW), Euro 6
	Gearbox	manual
	Drive/wheelbase	6x4, 5.100 + 1.400 mm
	Tyres (front, rear)	385/65 R 22.5; 315/80 R 22.5
	Suspension	front: leaf, rear: leaf
Cabin	Crew/type	1+1, medium, with roof-cut
Bodywork	Type	aluminium-GRP safety bodywork with 6 locker rooms with roller shutters, colour: RAL 3000
Jacking system	Jacking width	max. 5,70 m
Main control panel	Type	main control panel „BASIC“ at the left side of the turning frame
Ladder set	Type	L64, fully automatic, 6 sections, powder-coated, colour: RAL 7016 (anthracite)
	Height	working height: 64 m, cage floor height: 61,8 m
	Control system	CAN bus
	Weighing system	3D-load measuring system by means of load measuring bolts. Permanent measurement of loads and forces which act on the ladder set
	Lifting capacity	lifting eye at the base ladder section: up to 4 t, at the ladder tip: up to 400 kg
Rescue cage	Type	capacity: 300 kg (3 persons)
	Accesses	4 accesses, thereof 3 at the front and 1 at the rear. 3 accesses are accessible in upright position (with BAs)
Lift	Type	lift for 3 persons. Access is possible in any position of the turning frame. Max. capacity: 3 persons in the lift and 1 person in the cage
Pump and Water monitor	Type	N45 water pump with up to 4.500 l/min at 10bar. Rosenbauer RM15, capacity 2000 l/min, remote-controlled from the main control panel and the cage
Stretcher support	Type	360° rotatable, capacity: 200 kg, combi-type, i.e. also suitable for basket-type stretchers
Electrics	Power	power supply 230 V / 400 V to the cage
	Generator	Portable generator Rosenbauer RS14, 14 kVA
Weight	Max. permissible	total 33 t, thereof front axle: 9 t, thereof rear axle(s): 13,0 / 13,0 t
	Actual	26,8 t (empty, when delivered)
Dimensions	L x w x h	13,200 mm x 2,550 mm x 4,000 mm

L64P

Turntable ladder

Further Equipment

- colour display in the cabin
- 2 x back-up light LED at the mirrors
- battery charger
- 2 beacons in aerodynamic shape on the cabin roof
- LED lights at the front
- reverse camera at the vehicle's rear, indication at the Metz display in the cabin
- audible warning system
- electronic warning signal with public-address function
- intercom system between main control panel and cage
- remote diagnosis system „service4fire.com"
- locker room illumination with LEDs
- area illumination lights in acc. with EN1846T2, with LEDs
- chassis lights at the rear as LED version
- 2 x adjustable LED lights at the sides of the base ladder section
- 1 x 24 V/180 W LED floodlight underneath the base ladder section
- automatic return of the ladder set to the ladder headrest
- TMS (Target-Memory-System)
- VRS (vertical-rescue-system)
- stretcher support, 360° turnable, capacity: max. 200 kg
- heavy-duty fan, including fixation for the cage
- fixation for the cage for descending device (e.g. Rollgliss)
- 2 heavy-duty LED in the cage floor, shining to the front
- 2 heavy-duty LED in the cage floor, shining downwards
- 2 x 230V/130 watt LED floodlights,each one on the left and right side of the cage
- camera at the cage front, indication at the main control panel
- anemometer at the cage

Contact

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E.5 Tanker Pumper Apparatus

TLF 18000
Customized Body System (CBS)

rosenbauer

Basis Specification

Vers. 1.0 / 09-13

Chassis

- Make: MAN TGS 33.420
- Model: 3-axle fire fighting chassis
- Engine model: 6-cylinder Diesel Engine / China 4
- Performance: 309 kW (420 HP)
- Transmission: MAN Tipmatic
- Drive: 6 x 6
- Brakes: MAN BrakeMatic
- Steering: Hydraulic power steering
- Tires: 385/65 R 22,5
- Seating: 1 + 1
- Electric system: 24 Volt
- Air Condition: AC R134A

Fire fighting system and superstructure

- Fire pump: NH35centrifugal fire pump
- Pump perf.: 3.500 l/min at 10 bar
- Water tank: 9.000 l
- Foam tank: 800 l
- Foam system: Fixmix 2.0E electronically controlled around the pump foam system
- Roof turret: Manually controlled RM24
- Bumper turret: Electronically controlled RM15
- Superstructure: Customized body system in aluminum

  Equipment and pump compartment

  Rear roof access ladder

  Aluminum roller shutters

TLF 18000
Customized Body System (CBS)

rosenbauer

Contact

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E.6 Aerial Platform

Hydraulic platforms

Powerful deployment at any height.

Because safety comes first.

rosenbauer


Aiming high.
Intuitive. Fast. Reliable.
FEUERWEHR
B 34
TF ZX15

A good reputation obliges.

A tradition of innovation and professionalism.

Rosenbauer hydraulic platforms stand for

- Safety and reliability
- Best quality
- Robustness
- Sophisticated functionality
- Innovation and cutting-edge technology
- Intuitive operation

Every rescue operation is different and requires special equipment. To develop the right equipment, you need sound technical knowledge, but also a broad understanding of its practical application. That is why we at Rosenbauer have always looked at the big picture. And it is precisely this comprehensive view that makes us what we are today: the only true system provider in the area of fire and disaster protection.

However, we do not rest on our laurels, but ask ourselves every day how we can make the existing even better and where we need to completely rethink. This is how genuine innovations that set new standards are constantly created at Rosenbauer. And throughout all of this, we never forget who our most important partners are in this constant optimization process: our customers across the globe.

Metz Technology: Implemented by Rosenbauer

Rosenbauer aerials use highly innovative Metz technology, which specializes in aerial rescue. Through its integration into the Rosenbauer Group, Metz has grown into a respected technology brand and a symbol of absolute quality in aerial rescue.


MV WERFTEN

From compact to sky-high.

Available in many varieties.

In the country, in the city or in industrial plants - the places where aerial rescue platforms are used differ greatly. The requirements are as different as the conditions. While there is often a lack of space in the city and, therefore, compact design and maneuverability are the main priorities, industrial fires usually require the greatest possible water discharge. Rosenbauer engineers, therefore, attach great importance to the flexible applications of their hydraulic platforms in their vehicles.

Rosenbauer B34: multifunctional, even in the tightest of spaces.

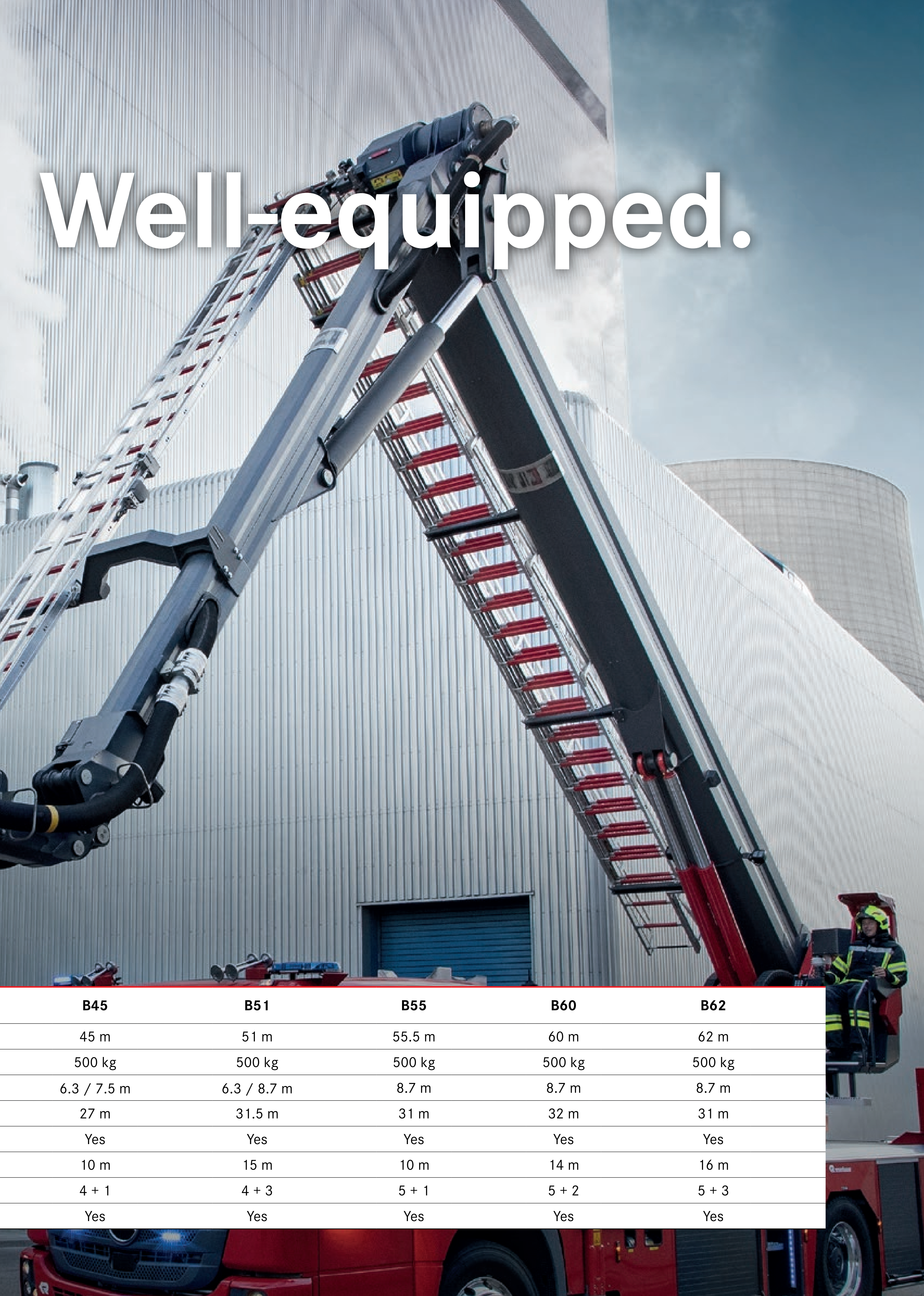
Sophisticated range of platforms

With its modular Metz Technology system, Rosenbauer offers the right product for every application and every type of fire department. The Rosenbauer platform range starts at 32 m and extends to a height of 62 m - the perfect basis for successful rescue operations of all kinds.

The Rosenbauer Hydraulic platforms

Model	B32	B34	B36	B42
Working height	32.2 m	34 m	36 m	42 m
Maximum cage load	500 kg	500 kg	630 kg	500 kg
Jacking width	5.93 m	6.3 m	5.93 m	6.3 / 7.5 m
Horizontal reach 1-man limit with cage	25.9 m	24 m	32.1 m	30.5 m
FA variety	Yes	Yes	Yes	Yes
Up and Over	7.5 m	10 m	7.5 m	10 m
Number of telescopic elements	3 + 1	3 + 1	3 + 1	4 + 1
Second telescopic boom	No	Yes	No	Yes

Well-equipped.



B45	B51	B55	B60	B62
45 m	51 m	55.5 m	60 m	62 m
500 kg	500 kg	500 kg	500 kg	500 kg
6.3 / 7.5 m	6.3 / 8.7 m	8.7 m	8.7 m	8.7 m
27 m	31.5 m	31 m	32 m	31 m
Yes	Yes	Yes	Yes	Yes
10 m	15 m	10 m	14 m	16 m
4 + 1	4 + 3	5 + 1	5 + 2	5 + 3
Yes	Yes	Yes	Yes	Yes


COFFEE

Strong in urban areas.

Aerial rescue for municipal needs.

Speed combined with flexibility

Rosenbauer hydraulic platforms offer the very highest level of safety and reliability. On the basis of many years of practical experience, innovative products were developed for municipal operations. Tailored to different rescue operations, they are suitable for operations in small cities as well as in world capitals.

The flexible municipal vehicles are equipped with state-of-the-art controls, continuous jacking width detection, a spacious cage with three entry points and barrier-free access. This means they are up to all the challenges of everyday firefighting.

Whether for fire fighting, technical assistance or rescue operations, the compact platforms have long since become an indispensable tool for municipal fire departments all over the world thanks to their fast movement times.

Rosenbauer B34 on 4x2 low floor chassis with just 3.2 m vehicle height.

Rosenbauer B42: for municipal operations, where the 30-metre class is just not enough.

Rosenbauer B42 hydraulic platform with N80 built-in pump, Hydromatic foam proportioning, 4,000 l foam tank and second turret on the podium.

Outstanding extinguishing performance.

Aerial rescue for industrial use.

Extinguishing power combined with state-of-the-art platforms

Rosenbauer hydraulic platforms for industry are in operation around the globe. The hydraulic platforms were specially developed for factory fire departments and for fighting large fires, they enable rapid assistance in any dangerous situation. Thanks to large development know-how that goes into every individual vehicle, Rosenbauer guarantees a perfect combination of firefighting equipment and platform technology.

With pump volumes of up to 15,000 l/min combined with an output of up to 6,000 l/min in the rescue cage, these internationally deployable aerial rescue devices can handle any challenge.

Rosenbauer N80 with Hydromatic foam proportioning in mid-ship installation.

Rosenbauer B51 with N55 pump and Hydromatic foam proportioning.

The Water Tower.

Boom for great heights.

Extinguishing capacity and range

Water Towers are used wherever maximum extinguishing performance is required. Thanks to Rosenbauer's intelligent modular system, the telescopic booms of the hydraulic platforms are also used in the Water Tower series. There they ensure maximum extinguishing heights between 30 and 60 m.

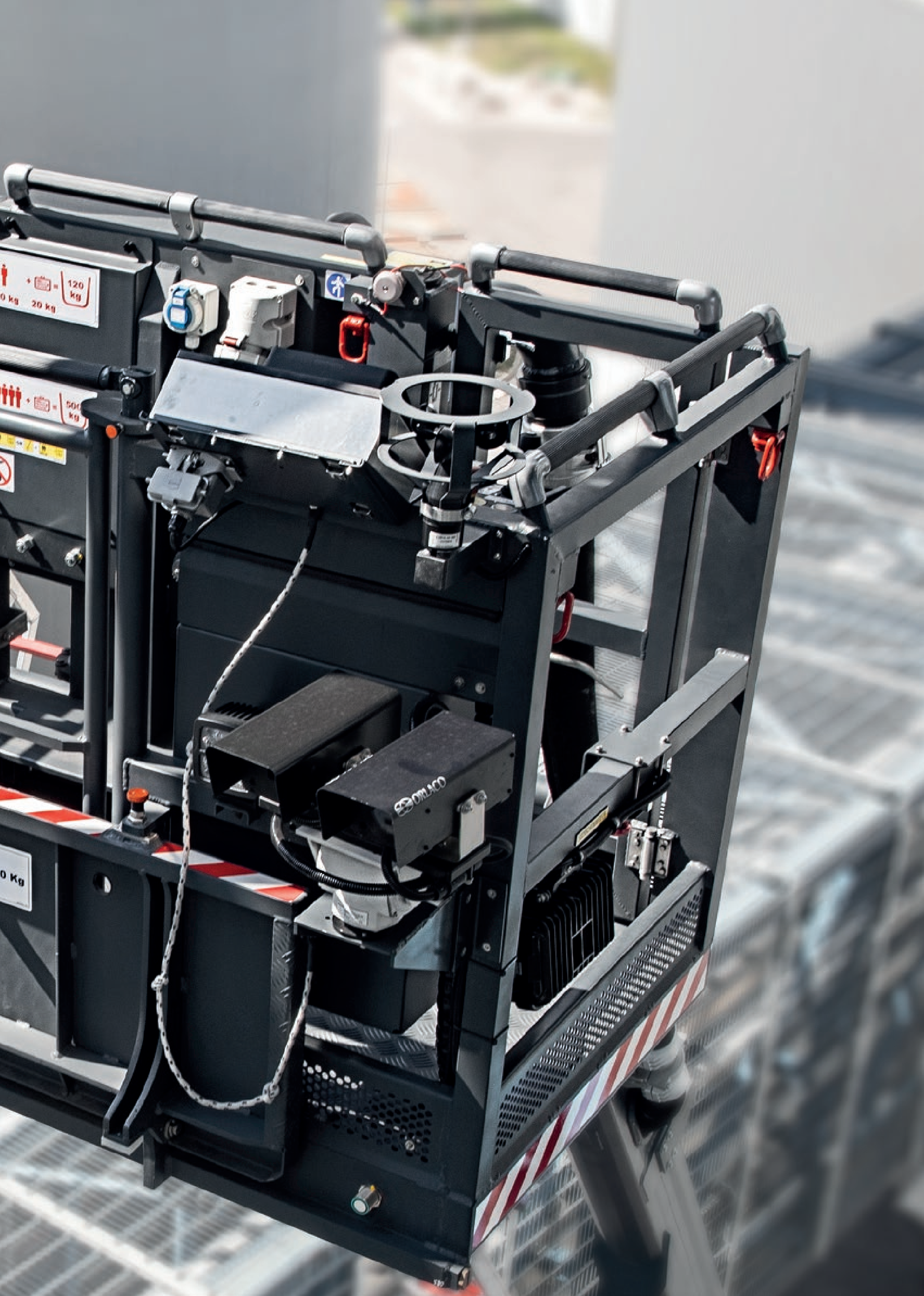
With up to 8,000 l/min monitor output, they are the optimum emergency vehicles for large industrial fires. Equipped with the largest Rosenbauer built-in pumps (up to 15,000 l/min flow rate) and large foam tanks, they support the emergency services in the fight against fire.

Rosenbauer N110 built-in pump with Hydromatic.

Rosenbauer W42: customer-specific solution for maximum equipment compartment volumes.

Rosenbauer W60 with 7,500 l/min output at 60 m height.

Quality in detail.


120 kg
20 kg
ORLACO

The highly developed rescue cage.

Sophisticated down to the smallest detail.

Thought out in all directions

The cage of a Rosenbauer hydraulic platform is well suited to the needs of all imaginable rescue operations. Functionality and efficiency are our top priorities. The many helpful functions that make Rosenbauer rescue cages so unique are harmoniously combined and enable exceptionally ergonomic work, as well as intuitive operation. This consistently practice-oriented concept has proven itself worldwide.

Another advantage is the light, more comfortable design of the cage. The versatile platform accessories are equally impressive across a wide variety of tasks for the modern fire department.

In the middle of it all.

The rescue cage is regarded as the central workplace of a firefighter. Rosenbauer has succeeded in implementing a completely new functional concept for the rescue cage through consistent further development.

With folding platform, as well as entry options at the front, rear and side.

Stretcher storage on the floor for the safe transport of injured persons.

Folding platform

The platform, which bears a live load of 200 kg, can be folded down. This greatly increases the usable area in the cage, which makes it easier to enter buildings, accommodate wheelchairs, and even easier to load heavy duty carriers.

Robust design

The highly developed rescue cage consists of a durable, robust aluminum construction and is manufactured to be the optimal size and weight. Depending on the version, there is space for up to six people.

Solid stretcher support

Three different bearings with up to 300 kg load ensure flexible mounting options. From the simple folding stretcher to the heavy-duty stretcher, a wide range of different versions of the Rosenbauer rescue cage can be accommodated.

Three entry points

There are three upright entry points for safely and comfortably climbing aboard. Thanks to the unique front entry point, a wheelchair user can be accommodated in the cage without any hindrance.

Flexible equipment options

Numerous additional equipment options make the Rosenbauer rescue cage truly multi-talented. The cage can be equipped with rescue winches, diving ladders, fresh air risers, cooling fan storage, rescue hoses, camera systems, fall protection systems and much more.

Rotating cage

The cage swivels 45° to the left and right, regardless of with or without rescue ladders. Thus precise and individual positioning in relation to the object is achieved.

The high-strength telescopic boom.

Highest stability for maximum safety.

Stable and durable

The telescopic boom plays a critical role in rescue operations. Thanks to modern construction methods, Rosenbauer hydraulic platforms are equipped with extremely stable and durable telescopic boom sets.

Intelligent, since they are modular

The intelligent Rosenbauer modular system consists of a 3, 4 or 5-part main boom paired with a 1, 2 or 3-part cage boom.

More practical, since more flexible

The second cage boom offers even greater flexibility, as it can be swivelled by 180°. This means that even objects that are difficult to access can be reached.

Safer than required

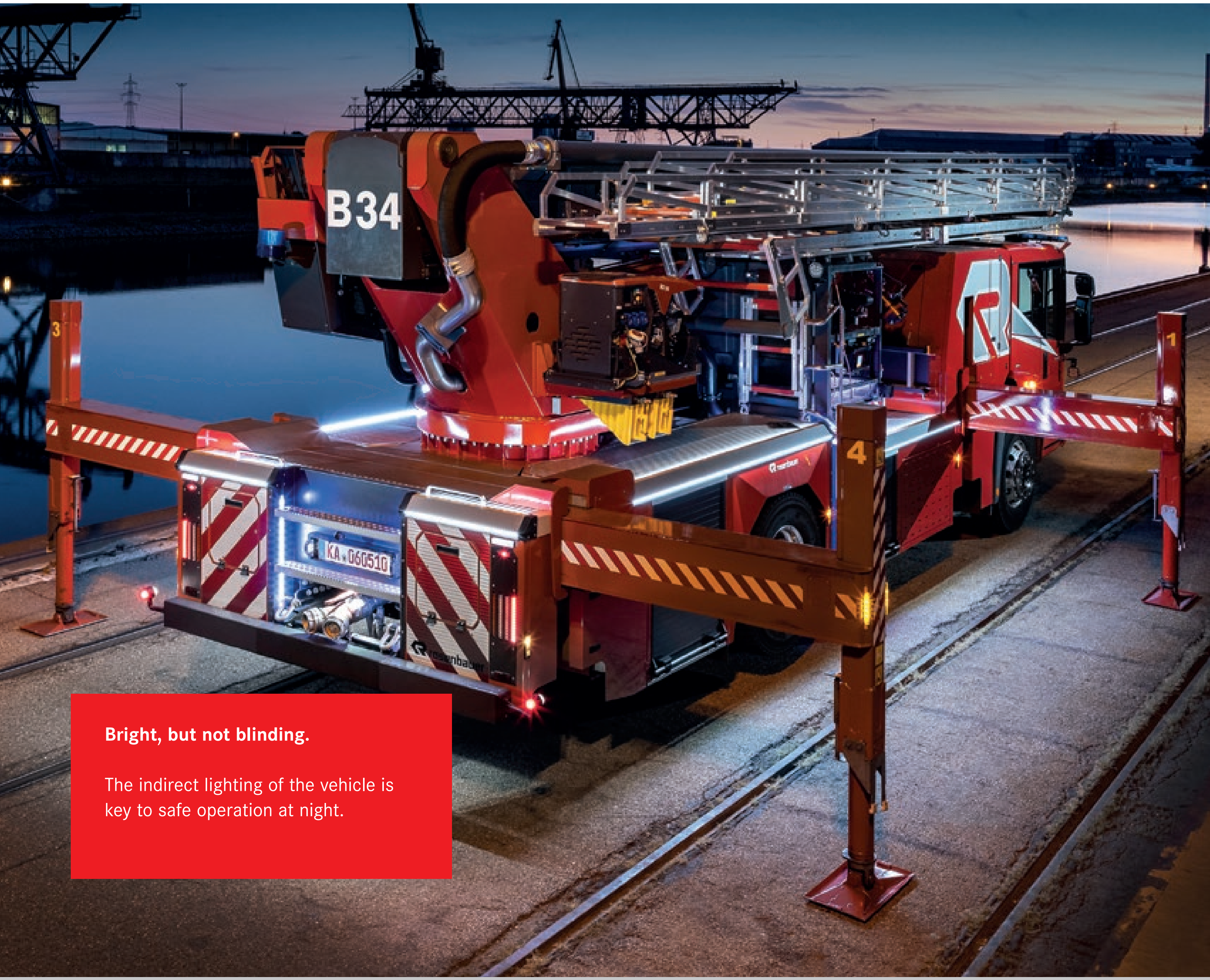
For increased safety, Rosenbauer uses two righting cylinders as standard, even if this is not required by the specifications of the European standard EN1777.

The telescopic boom carries people, equipment and also large quantities of extinguishing technology.

The sophisticated podium.

Best view through modern illumination.

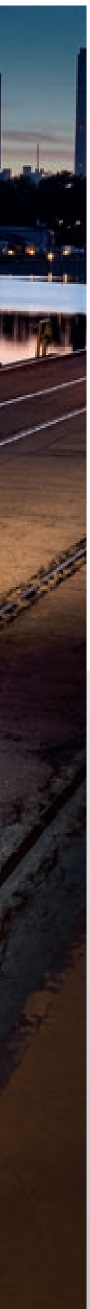
Because many operations occur at night or in poor visibility, lighting solutions are especially important to the emergency crews. Accordingly, the Rosenbauer hydraulic platforms are fitted with a modern LED lighting concept as standard. An additional side detail: the podium is delivered as standard in an extremely well-equipped high-end version.



Bright, but not blinding.

The indirect lighting of the vehicle is key to safe operation at night.

Modular aluminum platform.



Smart surrounding field illumination

An LED strip runs around the complete length of the podium and ensures optimum visibility, even in bad lighting conditions.
The LED lighting is securely integrated and completely and evenly illuminates the immediate vicinity of the vehicle without glare.

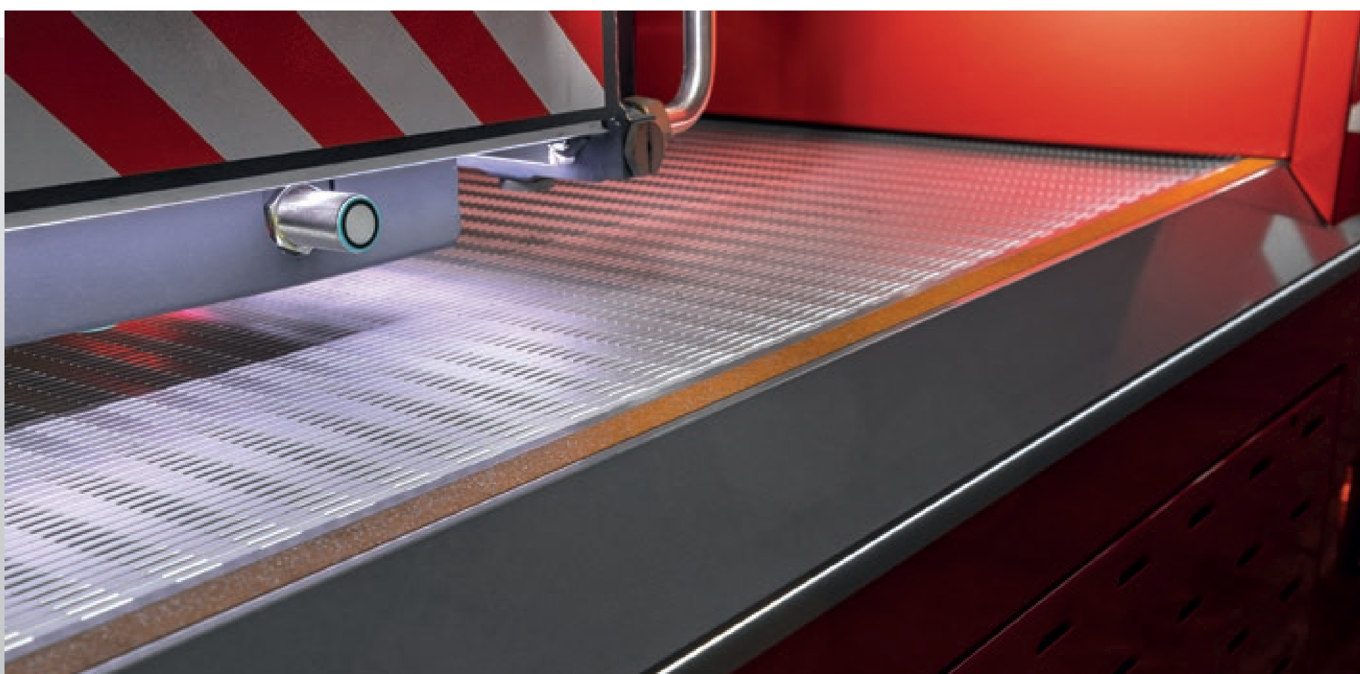
Bright cover area

Another securely integrated LED strip around the cover area of the podium ensures complete and even illumination. Therefore, the entire cover area remains fully illuminated at night, during poor weather conditions, and other times of limited visibility.

Safety-optimized entry points

Additional LED strips illuminate the rear entry and exit points, including steps and handles. This guarantees absolute sure-footedness. The handle situation itself could be ergonomically optimized and, therefore, further improved.

LED surface illumination.



LED lighting for safe working at night as standard.

The variable jacking system.

Unwavering stability creates safety.

Stabilizing vertical/horizontal jacking system

Every Rosenbauer hydraulic platform is equipped with a hydraulic vertical/horizontal jacking system. All jacking movements in the horizontal and vertical direction are continuously controllable within the maximum jacking width.

Nothing to worry about.

Safe footing is required for a wide horizontal reach. Rosenbauer's variable jacking system is space-saving, adaptive and secure.

For maximum horizontal reach: the jacking width is continuously adjustable.

High variability.

For tight spaces

Thanks to the unique, continuously adjustable horizontal/vertical jacking system, Rosenbauer hydraulic platforms are easily positioned even in tight spaces and extend with cage load by the full extension length of the telescopic boom. Rotating by 360° is also possible with minimal jacking.

Adaptation to the terrain

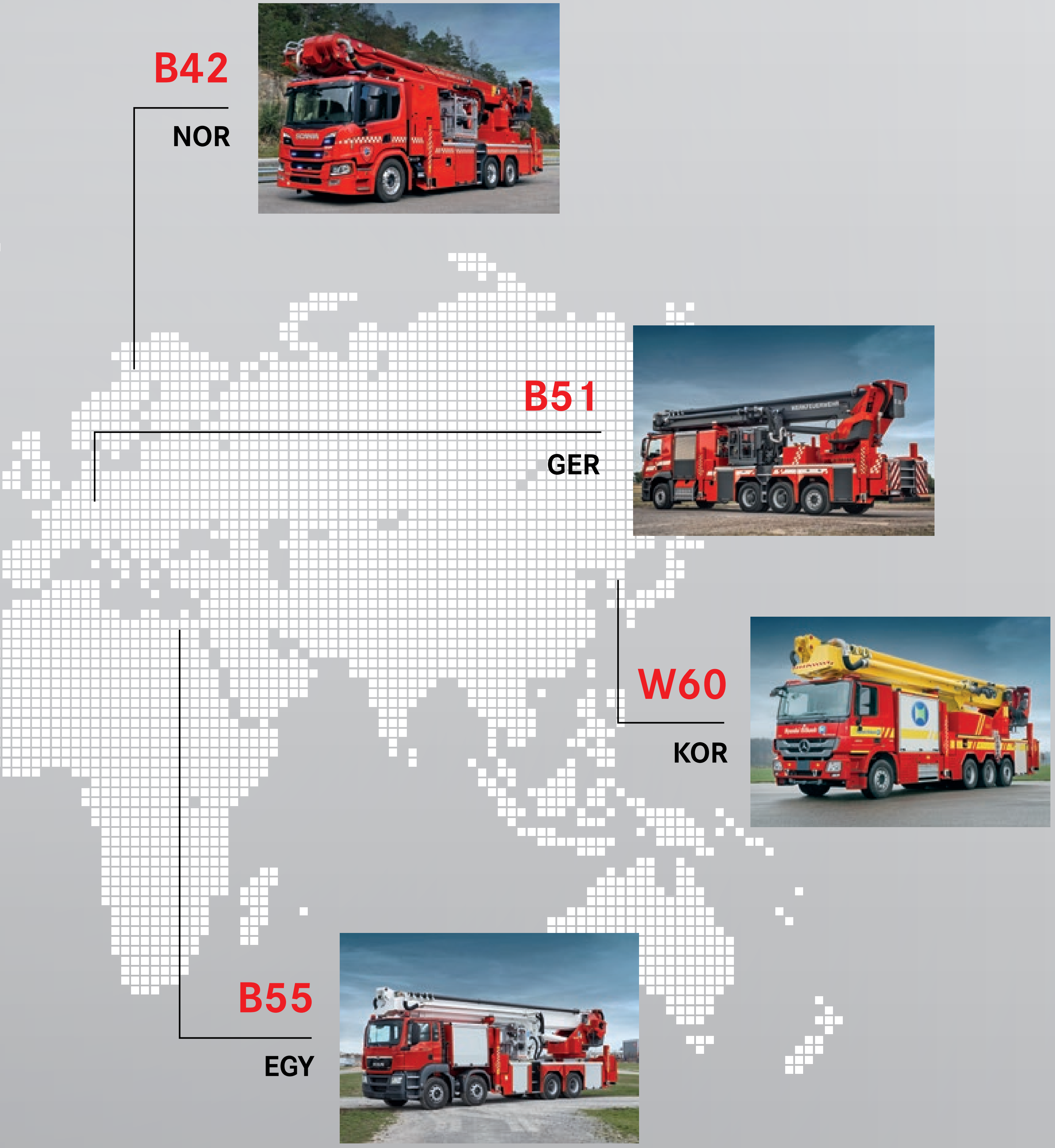
Rosenbauer hydraulic platforms achieve optimal stability even on uneven surfaces, because each jack adapts individually to the qualities of the terrain or street through the automatic levelling. The jacking system can also easily drive over obstacles.

Trademark Internationality.

In operation around the globe.

Cross your own boundaries.

Whether freezing cold or sweltering heat, -40°C or +50°C, a Canadian winter or an Egyptian summer: Rosenbauer hydraulic platforms are built for every possible extreme situation. Fire departments protect and rescue goods and human lives with Rosenbauer aerial ladders on every continent of the world.


B42
NOR
B51
GER
W60
KOR
B55
EGY

Quality that protects lives.

Rosenbauer hydraulic platforms are high-tech products of the very highest quality.

Production in the best hands.

Experience. Know-how. Reliability.

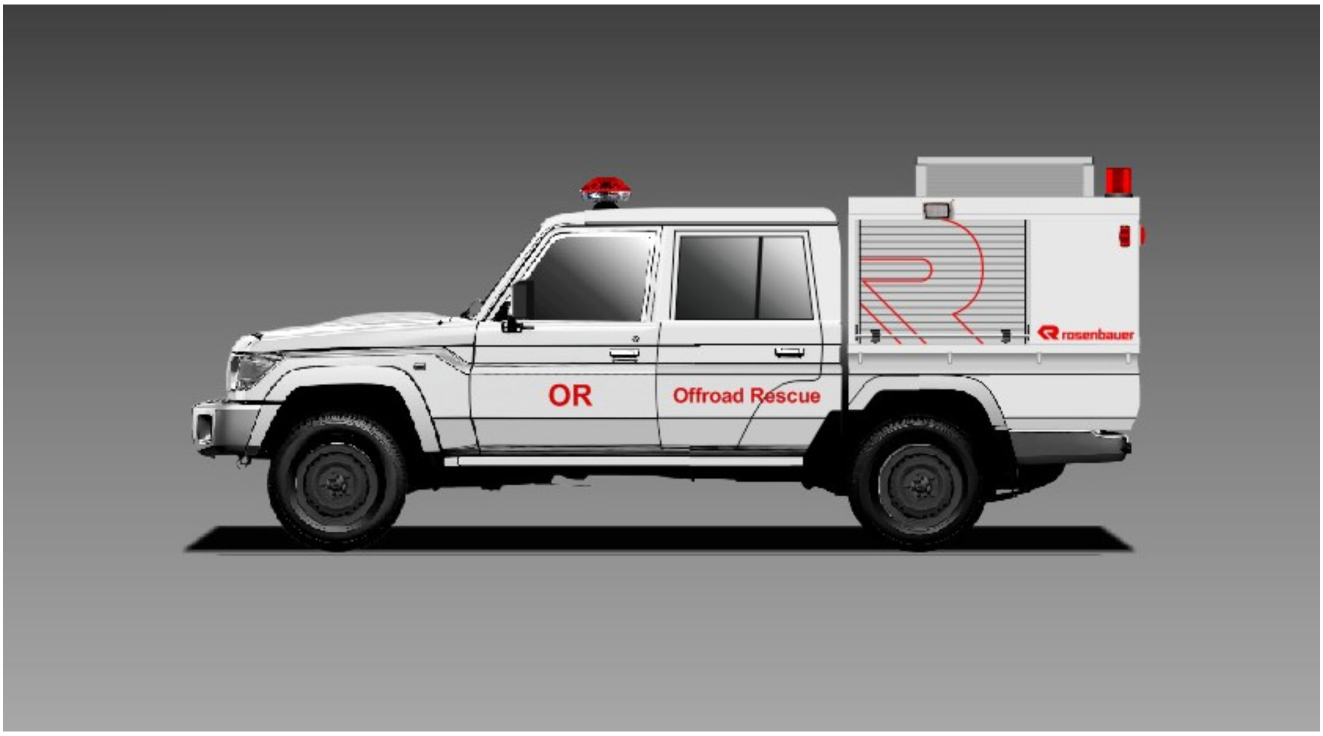
A standard you can count on

Production at Rosenbauer takes place in synchronized flow assembly and is just as convincing in terms of quality as the end product. Only professionals trained by Rosenbauer are involved in the workplace. Each component undergoes comprehensive quality control through automated testing and integrated quality checks. And what applies to individual parts also applies to the complete vehicle.

All components are manufactured in the Rosenbauer production network.

E.7 Small Rescue Vehicle

OFFROAD RESCUE
TOYOTA



Base specification

- **Chassis**
  - Type: TOYOTA Landcruiser 4x4
  - Engine output: 167 kW / 228 hp
  - Transmission: manual
  - Wheelbase: 3,180 mm
- **Cabin**
  - Type: Original Toyota Double Cabin
  - Crew: 1+4
- **Vehicle body**
  - Rosenbauer aluminum body system: **bonded & bolted** laser cut aluminum sheets combined with **aluminum extrusion profiles** as well as light weight aluminum **honeycomb** core sheets
- **Electric Equipment**
  - Light mast: FIRECO full LED 6x43W, height approx. 4,300 mm above ground
  - Winch: WARN 3,6t. electric
- **Rescue Equipment**
  - LUKAS E-Draulic Spreader and Cutter
  - LUKAS Rescue Ram
  - VETTER Lifting bag set
  - SCBA sets
  - Rescue tools
  - Portable LED lighting system

OFFROAD RESCUE
TOYOTA

Dimensions and weight

L x W x H	5,550 x 1,700 x 2,220 mm
Permissible total weight	3,500 kg

approx.

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