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IBI

RUBBLE TO MOUNTAINS

Guidelines for Managing Asbestos at the Bakalian Disposal Site

UN-Habitat Mandate

UN-Habitat, the United Nations Human Settlements Programme, is mandated by the United Nations General Assembly to promote socially and environmentally sustainable towns and cities, and adequate housing for all, and is the lead agency within the United Nations system for coordinating activities in the field of human settlements. It is mandated through the Habitat Agenda to take the lead in disaster mitigation and post-crisis rehabilitation capabilities in human settlements.

UN-Habitat's global responsibilities in emergency, humanitarian and post-crisis response are to support national and decentralized governments as well as civil society in strengthening their capacity for managing human-made and natural disasters affecting human settlements. Experience has shown that the potential for development gain is high in the immediate aftermath of a crisis, and this is a key principle underlying UN-Habitat's efforts to deploy at the earliest opportunity following a disaster. UN-Habitat's added value is that it is the United Nations agency specialized in working in cities and human settlements.

Since 2006, the agency has been present in Lebanon, first involved in recovery and reconstruction efforts in South Lebanon, Beirut, and Northern Lebanon (particularly in the Nahr el Bared Camp crisis response in 2007), and in efforts to improve the living conditions in the 43 Palestinian out-of-camp concentrations. Since 2013, UN-Habitat has been involved in responding to the Syrian refugee crisis, and since 4 August 2020 to the Beirut blast. UN-Habitat, as part of the United Nations in Lebanon, is also part of the concerted effort to support the country navigate the ongoing protracted socio-economic crisis. This is being done through directed and tangible support at the local authority and community level, while maintaining efforts towards establishing principles of good urbanization at the national level, as a key enabler of sustainable development.

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Rubble to Mountains Initiative

To address and prevent some of the foreseeable environmental hazards that would be caused by disposing of rubble left by the Beirut Port explosions into landfills, UN-Habitat in coordination with several partners established the Rubble to Mountains initiative. Through its three-pronged approach, the initiative aims to transform rubble and glass into a biodegradable, sand-like material that will be used to fill holes left by mining in Lebanon's mountains, build furniture for Beirut's public spaces and establish a permanent site for processing waste left by construction and demolition.

Disclaimer

Credits and Acknowledgments

UN-Habitat Lebanon gratefully acknowledges the support of UNICEF for the development of this report and the Rubble to Mountains initiative. The generous cooperation, advice and information provided by the Municipality of Beirut and the Governor of Beirut are recognized. The report owes its achievement to the Rubble to Mountains initiative partners namely the American University of Beirut's Neighborhood Initiative (AUBNI), Development Inc., and the Lebanon Reforestation Initiative (LRI). Other United Nations agencies and national authorities kindly gave their advice and time to the process of reviewing the report. In particular, we would like to acknowledge the contributions of:

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Foreword

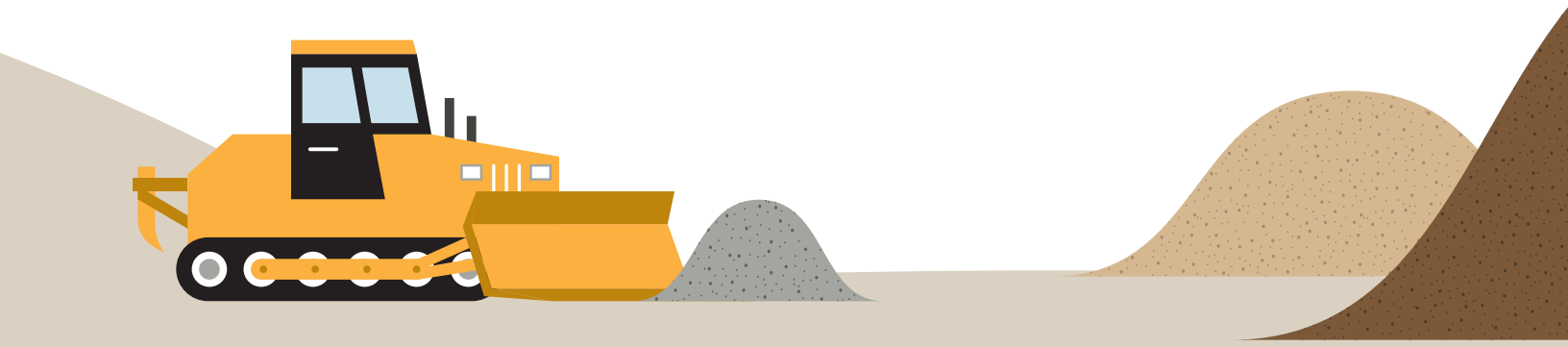
This document is intended primarily for regulators of contaminated sites, auditors, and industry consultants. Parts of this document may also be useful to local governments (e.g., environmental health officers), site workers, developers, owners, and members of local communities as well as the general public.

This document has been prepared by IBI Group, under the direction of UN Habitat, Arcenciel, and the Rubble to Mountain initiative, to guide the investigation, remediation, and management of potential asbestos-contaminated debris stockpiled from the recent Port of Beirut explosion at the Bakalian Disposal Site. These guidelines are based on Canadian and international best practices and tailored to Lebanon conditions. These guidelines are based on Canadian, United Kingdom, and international best practices and tailored to Lebanon conditions.

Asbestos contamination is a major issue in the Middle East and North Africa (MENA) as a result of extensive past (and current) use.

These guidelines discuss the nature and toxicity of asbestos, its occurrence in the MENA region, investigation procedures and criteria appropriate for different environmental scenarios, and acceptable management strategies tailored specifically for the site.

For matters related to occupational health, advice should be sought from local physicians and governmental health and safety authorities.



Background

Asbestos is a naturally occurring mineral fibre. Due to its unique properties, it was used in a variety of different building materials in the 1970s and can be found in some products still being manufactured. It is estimated that manufacturers once used asbestos in more than 3,000 different commercial applications.

Asbestos differs from most other contaminants. In particular, its toxicology is such that it primarily affects humans rather than harming environment. Inhaling asbestos fibres can produce a range of lung-associated diseases, including cancers, even after a low level of exposure.

In a building context, asbestos-containing material (ACM) is generally grouped and reported as either friable or non-friable. **Friable ACM** is a material that, when dry, can be crumbled, pulverized, or reduced to powder by basic hand pressure. These materials are high-risk contaminants, as they will more readily produce asbestos fibres if disturbed or removed. Examples of friable materials include sprayed or trowelled materials, such as acoustical ceiling spray, boiler insulation, and paper pipe insulation. **Non-friable** means the asbestos is more tightly bound in the matrix of the material. These materials are less likely to generate asbestos fibres if they are in good condition and are not subjected to sanding, grinding, cutting, or abrading. Examples of non-friable materials include vinyl floor tiles, cement pipes, and pipe gaskets.

There is a lack of published data on the extent of asbestos in the MENA region and, more specifically, within Lebanon. However, the fact that not one country in the region has ratified International Labour Organization (ILO) convention 162, which stipulates that health and safety measures must be in place to safeguard people working with asbestos, is cause for concern.

Previous studies have produced evidence of asbestos at the Bakalian disposal site. These include an earlier environmental investigation and other investigations conducted in the country for a commercial client that has assets throughout the region, including Lebanon.

The horrific explosion at the Port of Beirut that occurred on August 4, 2020 caused city-wide devastation and generated large volumes of debris made up of broken glass, rubble, and other waste streams. A USAID-led project in December 2020 found that this stockpiled debris is contaminated with ACM.

The following sections provide a narrative to assist with identifying asbestos and managing this hazard during the process of sorting clean rubble and glass from contaminated waste. This process aims to:

- Properly manage all streams at the site;
- Ensure hazards are properly (and temporarily) contained on site until end disposal at the receiving location (quarry); and
- Ensure that proper environmental and health safeguards are implemented according to acceptable norms and standards.

Contamination Threshold

In keeping with Canadian occupational health and safety legislation and regulations (O.Reg. 278/05 in Ontario and Chapter S-2.1, r.13 in Quebec), as well as UK Health and Safety Executive (HSE), a risk-based and, where necessary, conservative approach will need to be employed to deal with the uncertainties associated with protecting workers and the public from contamination at the site.

These guidelines have been prepared in conjunction with the review of the following Lebanese legislations for hazardous waste:

- Law 444/2002 Protection of the environment.
- Decree 5606/2019 Determination of the Fundamentals of Hazardous waste management.
- Decision of the Minister of Environment No. 998/1 dated 24/12/2019 Determination of the procedures and fundamentals for implementing the first chapter (Generator and his obligations) of Section Two of the Decree Determination of the Fundamentals of Hazardous Wastes Management (No. 5606 dated 11/9/2019).
- Decision of the Minister of Environment No. 999/1 dated 24/12/2019 Determination of the procedures and fundamentals for implementing the second chapter (Carrier and his obligations) of Section Two of the decree Determination of the Fundamentals of Hazardous Wastes Management (No. 5606 dated 11/9/2019).
- Decision of the Minister of Environment No. 59/1 dated 21/1/2020 Determination of the procedures and fundamentals for implementing the first chapter (Hazardous wastes storage facilities) of Section Three of the decree Determination of the Fundamentals of Hazardous Wastes Management (No. 5606 dated 11/9/2019).
- Decision of the Minister of Environment No.71/1 dated 19/5/1997.
- Law 387/1994 ratification of Basel Convention.
- Decision of the Minister of Environment No. 42/1 dated 26/3/1996 banning the import of asbestos/CROCIDOLITE type.
- Decision of the Minister of Environment No. 174/1 dated 2/11/1998 Banning the import of certain types of asbestos.
- Law No. 64 of 1988 on the protection of the environment against pollution from hazardous waste disposal and substances.

When national standards are non-existing or are incomplete, the most stringent of international standards have been applied. For these guidelines, a threshold of 0.1% asbestos by dry weight will serve as the main investigation criterion to classify a waste stockpile as being asbestos-contaminated.

For ambient outdoor air quality, as per Occupational Safety and Health Administration (OSHA) standards, a permissible exposure limit (PEL) of 0.1 fibre per cubic centimeter of air as an 8-hour, time-weighted average (TWA) will be used to signify asbestos contamination.

In addition, the stockpiles will be tested for lead leachability in accordance with Ontario Regulation 558 (Schedule 4) and with Toxicity Characteristic Leaching Procedure (TCLP) Test Method 1311 (found in EPA publication SW-846: **Test Methods for Evaluating Solid Waste – Physical/Chemical Methods**). Schedule 4 limits the concentration of lead in the leachate to no more than 5 mg/L; materials that exceed that limit are considered hazardous waste.

Lastly, the wastewater collected and filtered following showering (within the decontamination facility) and ground-washing activities will be analyzed for asbestos fibres in compliance with NEN-ISO 14966 using the scanning electron microscopy (SEM) analysis method.

Figure 1. Location of Stockpiles at the Site

Bakalian Disposal Site

The Bakalian waste storage site is in northeastern Beirut. It is located in the Karantina district (Medawar 1343) and faces a landmark century-old flour mill, the Bakalian Four Mills. The site falls under the jurisdiction of two entities, the Governor of Beirut and the Port of Beirut.

Approximately 100,000 tonnes of mixed rubble and 15,000 tonnes of glass are currently stored at the site. There are 4 distinctive stockpiles, as shown in the following figure. For the purposes of these guidelines, these stockpiles will be referred to as the **Glass, Rubble, Mixed 1, and Mixed 2 stockpiles**. The difference between Mixed 1 and Mixed 2 stockpiles is that Mixed 1 was collected from surrounding areas impacted by the Port of Beirut explosion whereas Mixed 2 was debris collected exclusively from a plot of private land intended to be an Audi car dealership.

GLASS

RUBBLE STOCKPILE

MIXED 1 STOCKPILE

MIXED 2 STOCKPILE

(**Note:** *The stockpiles depicted in Figure 1 are for illustrative purposes only; they are not presented to scale, nor do they show the exact locations of the stockpiles.*)

During the early stages of planning the site's layout, a hangar was added to house the crushing operations under negative air pressure. However, as crushing operations are conducted outdoors, enclosing the process in a hangar is not required; moreover, a series of mitigation measures will be introduced to address any dispersion of fibres during crushing operations. More on the types of mitigation measures in following sections of this guideline.

The site layout must always consider health and safety. Therefore, it is critical that the designated areas described in Figure 2 be maintained in their current locations to prevent cross-contamination. The stockpiles and crushing operations must be isolated from other areas at the site and tracking potentially asbestos-contaminated dust into other areas (more on the types of mitigation measures in following sections of this guideline. An area leading to the work area, free of potential contamination, will need to be designated as the "clean zone" for decontamination procedures. The southwest corner, around the offices and parking area, will need to be designated the clean zone; all other areas of the site are described in this document as the "dirty zone."

All materials currently entering the site for disposal are to be treated as asbestos-contaminated due to the unknown composition of the materials (as no previous hazardous material investigation was conducted).

Figure 2. Site Layout

UNHCR = Office of the United Nations High Commissioner for Refugees.

Bakalian Disposal Site (Continued)

The following are other key elements of the site layout:

1. **Controlled exit point.** The north exit point is to be used by heavy vehicles entering the dirty zone to drop off materials, supplies, equipment, and so forth. All other vehicles (e.g., cars and dump trucks) must exit from the same entry point (dump trucks will have a dedicated lane). Dump trucks are permitted to enter the site but only to dump material mechanically—exiting a vehicle to manually dispose of materials is not permitted.
2. **Movement restricted to a paved pathway**. Those entering the site to dispose of approved materials at the defined disposal drop-off area must not deviate from this pathway and must continue to the washdown area prior to leaving the site. This pathway must remain clean and clear of debris.
3. **Mandatory decontamination facility**. Everyone arriving at the site to work must enter through a decontamination facility. (More information on this facility can be found in subsequent sections of this document.) This will be the only access point for entering and leaving the main work area of the site. (This instruction applies to all consultants and United Nations [UN] and local government officials coming to the site to review operations.)

During site preparation works, the manipulation of construction and demolition streams on site will be minimal. Any manipulations of stockpiles will be accompanied with mitigation measures, such as wetting down, decontamination, and respiratory protection just to name a few. In addition, the glass stockpile will be relocated to a designated location during the weekend while the site is not receiving the daily disposal loads.

Insurance on the equipment used on site, its operators, and associated site hazards will be the responsibility of the awarded bidder who will carry out crushing operations. Insurance of site personnel involved with sorting activities will be administered by the Association of Volunteers in International Service (AVSI) Foundation. Insurance for site personnel carrying out other tasks on site along with those who have overall responsibility for the site will be insured by Development Inc. SAL.

A drawing to scale of the site layout can be found in Appendix A.

Health and Safety Measures at Site

Three types of groups are expected to access the site:

- UN-contracted workers, affiliated partners, and government and international authority officials;
- Contractors and consultants; and
- Individuals employed in the waste management industry.

All of these individuals must take proper precautions to protect themselves. They will also play an important role in eliminating potential exposure or cross-contamination of the hazards present at the site.

Two levels of training will be provided on site:

1. Asbestos awareness intended to provide the worker with the information they need to understand the hazards associated with asbestos, and instruction on how to safeguard themselves and surroundings.
2. Respirator use and maintenance of equipment. Associated with this training, a respirator fit test will be conducted and administered by IBI Group.

In addition, daily toolbox sessions will be conducted with all site personnel to serve as a reminder of the precautionary measures that must be followed on site and to ensure that that site personnel are using the correct respiratory and personal protective equipments.

Those involved in on-site crushing operations or consultancy oversight within the dirty zone must conform with the following requirements regarding the use of respiratory and other personal protective equipment:

- Workers near crushing operations must wear a full-face respirator equipped with P100 filters to capture airborne particles (0.3 microns and greater).
- Workers involved in sorting activities (or those operating heavy machinery) must, at a minimum, wear a half-face respirator equipped with P100 filters to capture particles that are 0.3 microns or greater in size.
- All site personnel wearing a respirator must be fit-tested and trained on the use and maintenance of their respirator by a qualified person.
- All personnel must wear the following:
  - » Disposable coveralls (Category 3, Type 5/6) made of a microporous material that provides a barrier against harmful particles and chemicals. The coveralls should be equipped with a hood and elastic bands around the wrists and ankles (ISO 13982).
  - » Gloves are to comply with the European Standard for Protective Gloves, EN 388.
  - » Laceless safety footwear to protect against burns, cuts, punctures, and impact (e.g., steel toe–capped wellington or rigger boots).
  - » Safety hat, vest, and glasses.

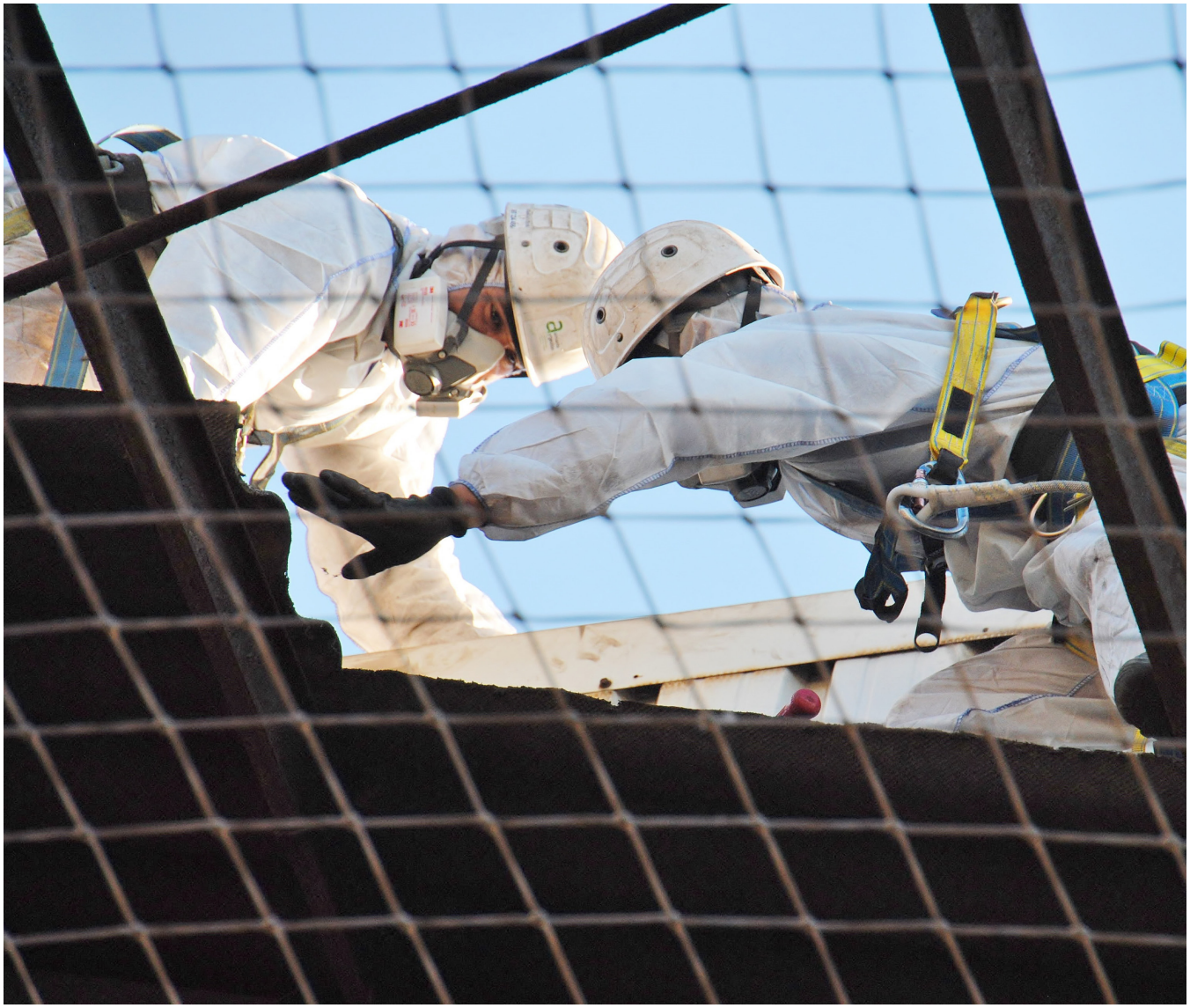
Those who enter the site but remain in the clean zone must wear the following:

- A new N95 respirator (replaced after 8 hours, if applicable).
- Laceless safety footwear to protect against burns, cuts, punctures, and impact (e.g., steel toe–capped wellington or rigger boots).
- Safety hat, vest, and glasses.

Those who drive into the site to dispose of waste must take the following precautions. Specifically, they must:

- Wear a new N95 respirator (replaced after 8 hours, if applicable) or two separate three-layer surgical masks. Following frequent visits to the site to review the current site operations, it was noted that those who drive into the site to dispose of waste are typically equipped with three-layer surgical masks.
- Remain in their vehicle, keep the windows closed, and not deviate from the pathway at any time while on site.

Figure 3. Two Respirators (Full Face and Half-Mask) and a Common N95 Mask



Additional Site Precaution Measures

Daily Disposal Activities

Gatehouse site personnel must screen the type of vehicles approaching the site and must only allow trucks equipped with a tipping mechanism. In addition, those who drive into the site to dispose of waste must take the following precautions. Specifically, they must:

- Wear two separate three layers surgical masks;
- Remain in their vehicle, keep the windows closed, and not deviate from the pathway at any time while on site; and
- Allow the labourer provided to them on the ground (who will be wearing proper respiratory and personal protective equipment) to release the truck's gate for disposal.

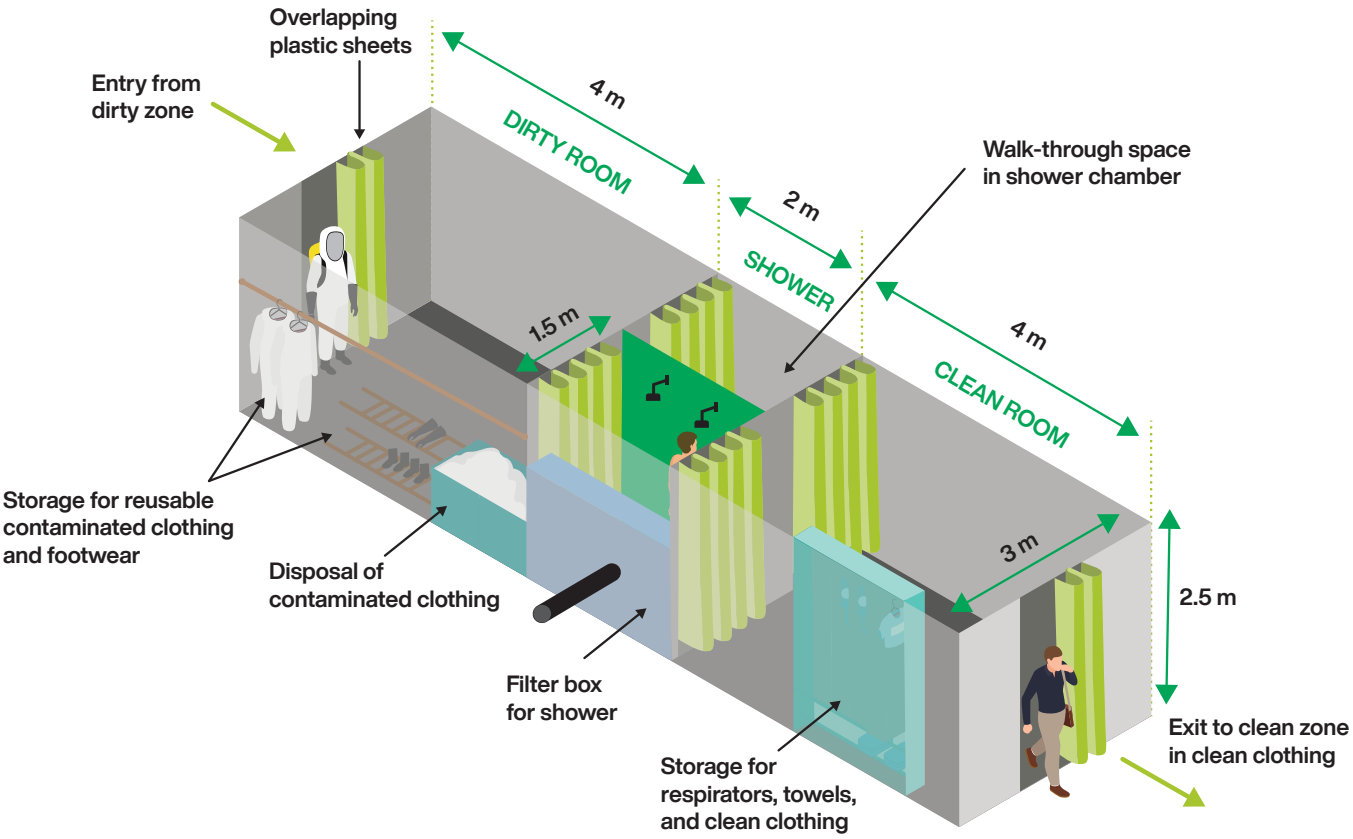
Upon completion and just prior to exiting the site the driver must stop to allow the proper washing down of their vehicle's tires on the paved road. A wheel-cleaning procedure will be used to mitigate the amount of dust and debris that could potentially be deposited on neighbouring roadways by vehicles exiting the site.

An area near the port of entry/exit has been designated for this operation prior to vehicles leaving site. A power washer, equipped with 100 PSI capability, will be used to wash off any dust/debris from the vehicle's wheels and sheeting, with wastewater being collected and filtered through a paved road drainage system consisting of concave channels leading to the point of filtration.

For transfer of materials and goods from the clean to the dirty zone, the process will involve on ground machinery stationed in the dirty zone that will be responsible for transferring debris between zones (at the border). Drop-offs from external trucks are not permitted to enter the dirty zone.

For the long-term use of the Bakalian site as a construction and demolition management site for Beirut, the feasibility of having an on-site weigh-scale system is being investigated.

Figure 4. Possible Layout for Decontamination Facility



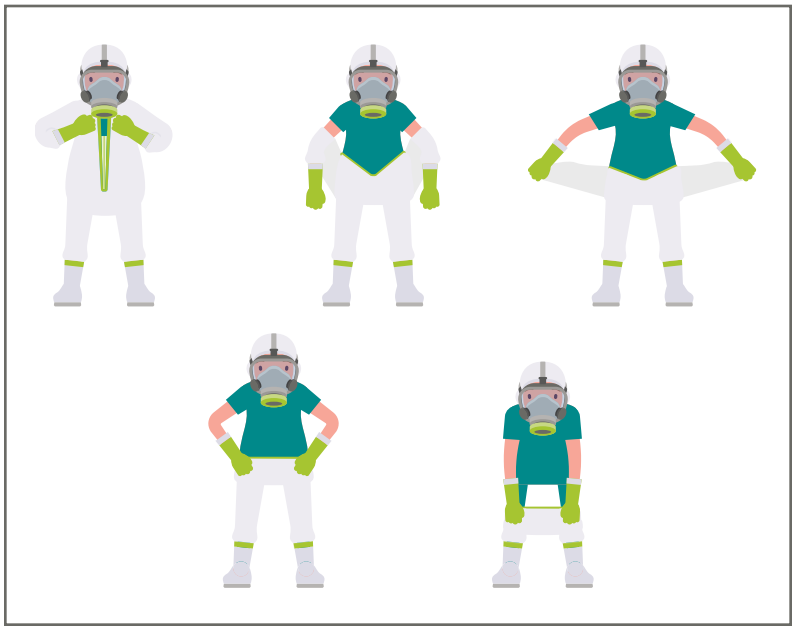


Figure 5. Steps to Remove Contaminated Coverall

Ideally, in front of a mirror, tilt head back to reach zipper, unzip completely without touching any skin, and start removing coverall from top to bottom. After freeing shoulders, remove the outer gloves while pulling the arms out of the sleeves. With inner gloves roll the coverall, from the waist down and from the inside of the coverall, down to the top of the boots. Use one boot to pull off coverall from other boot and vice versa, the step away from the coverall and dispose of it in the appropriate container.

Additional Site Precaution Measures (Continued)

Decontamination Facility

As stated, all site personnel, contractors, and consultants entering the dirty zone must pass through a decontamination facility comprising at least three interconnected chambers: a clean room, a shower room, and an equipment room.

The facility will be approximately 3 m wide by 10 m long. The doorways between the rooms of the decontamination unit must be fitted with curtains of 6 mil polyethylene sheeting (or other suitable material of the same thickness) on each side that close behind workers as they pass through a doorway. This is to minimize the spread of fibres between areas. The sheeting must be mounted on study frames and may be frosted, opaque, or coloured to provide worker privacy.

A portable cabin (porta-cabin) could serve as a decontamination facility but would have to be retrofitted to allow for two separate points of access (from the clean and dirty areas), and the interior of the cabin would need to be designed with appropriate framing and 6 mil sheeting.

Figure 4 illustrates a possible interior layout for the decontamination facility.

Before leaving the dirty zone and, just prior to entering the decontamination unit, all personnel will be required to remove gross contamination and debris from their protective clothing and feet. The worker must soak their coveralls, gloves, boots, and the surface of their respirator with amended water[1] using a manually pressurized sprayer. In addition, the filters fixed to the respirator must be cleaned using a HEPA-filtered vacuum. Care must be taken when cleaning around the respirator to avoid damaging the filter.

Following this, the worker then proceeds to the first chamber and removes all clothing and equipment, except for their respirator. All tools and extra work clothing, such as a shirt or boots that are now considered contaminated, must remain in the first chamber and must be stored separately for each worker. All disposable protective clothing must be placed in an appropriately marked container for disposal with other contaminated waste materials at the site (refer to Figure 5 for proper steps to take off contaminated coveralls). As the worker enters the next chamber and, while still wearing a respirator, they must pass through the shower and thoroughly wet their body, including their face and hair. The wastewater from showering activities will be collected and filtered through a water filtration system to capture any potential asbestos fibres. The filtered water will be reused on site for dust suppression purposes.

The worker then proceeds to the next chamber and removes their respirator to clean the inner components with an alcohol-based wipe. They then seal the filters with duct tape. Next, they dry themselves and put on clean coveralls (or street clothes) and shoes before they exit the decontamination unit.

Dust Suppression

The on-site crushers should be equipped with internal wetting nozzles to minimize the generation of dust during the process of crushing. In addition to this, water-hose operators must be present to combat and suppress any dust generated in and around the crushing operation.

[1] Water to which a surfactant has been added to decrease the surface tension.

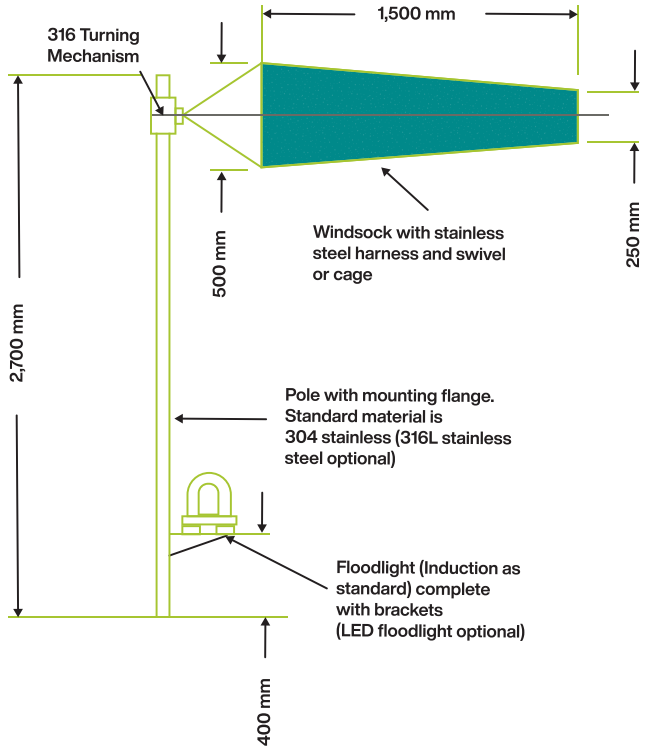
Additional Site Precaution Measures (Continued)

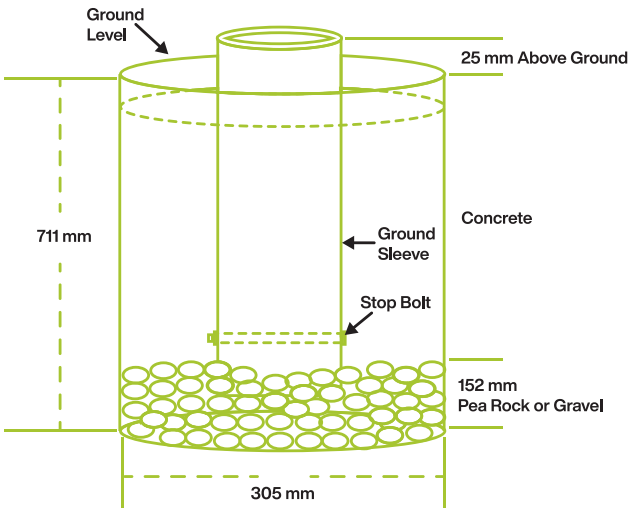
In the event the crushing machine is not equipped with internal wetting nozzles, a mist cannon must be fixed in place, pointed in the direction of the crusher, and kept operating at all times during crushing.

Additional active mitigation measures will also be implemented to control dust at the site:

- The access pathway will be paved (or have a hard-packed surface).
- The speed limit for on-site traffic will be a maximum of 15 km/hr.
- The height of the material released from the excavator bucket into screens, the crusher, or other areas will be set to the absolute minimum level.
- Work may be suspended if a high level of dust is generated that cannot be controlled due to high winds (i.e., winds exceeding 48.3 km/hr). A windsock will be installed at the site to provide basic guidance on wind direction and speed (refer to Figure 6 for windsock and pole specifications).
- Information collected from the windsock will provide guidance on the placement and orientation of the mobile dust screen. The material of the dust screen should be a nylon fabric that uses warp knitting technology. The mesh type can be either square or oblong and should be sized to 0.8 mm x 0.8 mm to contain general dust particles.
- Before departing the site, vehicles will be decontaminated at the designated washdown area near the entry/exit point.

Figure 6. Windsock and Pole Specifications





Additional Site Precaution Measures (Continued)

Figure 7. Vajraa Mist Cannon Dust Suppression System

Other Health and Safety Measures at the Site

Due to the presence of asbestos and the nature of the operations that will be taking place, on-site signage must warn all personnel about the hazards in the work area. An adequate number of signs in both English and Arabic will be posted in strategic locations. Furthermore, although the site will not be active 24 hours a day, after-hours security will be required to ensure that stockpiles are not manipulated, temporarily stored asbestos-containing waste is not disturbed, and on-site assets are not vandalized. In addition to the aforementioned measures, a well-lit site is critical for managing the site during non-working hours.

Classic heat stress is also a hazard that needs to be addressed on site. Canopy structures will be introduced to provide shade to workers around crushing operations and well managed work breaks will be needed to ensure workers are well hydrated.

For the comfort of workers, portable sanitation unit(s) will be made available on site.

Figure 8. Examples of signs in the work area

Instructions for the Temporary Storage of Asbestos Waste

This section details the approved methods for managing the risks associated with the temporary storage of asbestos waste prior to disposal at an approved location. The asbestos waste stored on site must remain in sealed containers. The structure in which the asbestos waste will be stored must have enough space to hold the amount of asbestos waste extracted from the stockpiles and allow for safe entry.

For proper management, it is suggested that the storage facility be approximately 560 m^2 in area. The physical structure must be secure from all sides and safeguarded from unauthorized access. This large area is suggested to allow for comfort during entry, as the asbestos waste must be carefully transferred and stacked for space optimization. In addition, there is a possibility that the facility will be receiving other ACM waste from external locations (e.g. Mar Mekhayel next to Electricite Du Liban, Mar Mekhayel Train Station, Mar Mekhayel Fuel Station, Karm el Zeiton Achrafieh, just to name a few); thus, the facility must be designed with future planning in mind. It is worth noting that the extra space will allow for good housekeeping, which is an important element in the overall management of the facility.

Figure 9. Double-Lined Asbestos Bags (Approx. Dimensions: 90 x 90 x 110 cm)

The floor of the structure should be made of a hard surface, such as asphalt or concrete, and the facility must be completely enclosed with a single gateway to serve as an entry/exit point. The internal height of the structure should be a minimum of 3 m to allow for the stacking of asbestos waste and clearance during lifting operations. The facility's interior must be well lit to ensure the asbestos waste is not impacted during transport. Materials that are cost-effective and available in the country are to be considered for wall and roofing systems. Additional communication posters for this facility must be installed to safeguard the hazards within this facility.

Non-friable or friable asbestos waste extracted during screening and segregation activities or transferred to the site from an external location must be liberally wetted, handled with care, sealed, and secured in an asbestos "big bag" (Figure 9) made of two layers of heavy 6 mil polyethylene sheeting. Prior to placing the bag within the temporary waste storage area, the bag must be wetted down thoroughly for a second time, and its surface wiped.

When using a loader (or similar equipment) to transfer the hazard from the point of identification to the temporary waste storage area, special care must be taken during loading and unloading activities to avoid puncturing, ripping, or compromising the integrity of the bag, which could potentially disturb or disperse asbestos fibres.

Understanding Site Operations

As asbestos has been confirmed to be present on site, it is critical to understand the complete process from the time debris is removed from the stockpile to the time it is crushed into fine rubble or glass for reuse. To fully understand this process, we must first review the heavy machinery on the ground. This will enable the project team to better understand the mechanics behind each step of the process so that the overall program can be supplemented with appropriate health and safety measures.

In preparing this guidance document, the team from IBI Group reviewed the specifications of the equipment that will be used for the crushing and screening of the rubble and glass to gain a better understanding of how these units operate and how mitigation measures can be introduced to deal with potential risks.

Rubble-Crushing Operations

Figure 10 depicts how the rubble will be handled and crushed.

The first step of the crushing operation is to transfer a predetermined amount of stockpile material onto a screener for mechanical segregation. During transfer activities, water-hose operators will be spraying water while they follow the excavator's bucket. The excavator operator will make sure to manipulate the stockpile in a way that does not generate added dust as materials are transferred (e.g. by minimizing the height of the bucket during movement and dropping operations).

Once the stockpile material is transferred to the top level of the inclined screen, while conintously bweing wetted, the screen then performs its duty and separates materials by size: fine (less than 80mm in size), medium (80-130mm in size) and bulky (greater than 130mm in size). The fine material sieves through the different levels of the screen and moves toward the bottom, where it is transferred over to the sorted/crushed rubble stockpile for sampling. The medium and bulky materials are visually investigated for further segregation into concrete, presumed ACM, and "other" (e.g., plastics, metals, glass, general waste). Following this task, the bulky concrete is then transferred to the crushing machine and the product is transferred over to the sorted/crushed rubble stockpile for another round of sampling for asbestos content.

Materials presumed to contain asbestos must undergo the disposal preparation procedures detailed in the previous section before being transferred to the temporary storage area. Other materials (e.g., plastics, metals, glass, general waste) will be transferred to an a wading pool filled with amended water for decontamination and secondary segregation in the clean zone. Sought-after material (e.g., material that can be resold) is then removed and placed aside for off-site transfer. All remaining material is then scheduled for transport to a landfill. After all materials are removed, the wastewater in the wading pool will be pumped into a tank and run through a filtration unit that removes fibres and debris.

The wastewater filtration system should be supplied with a two-stage filtration system. The first stage filter is to remove particles 25 µm and larger. The second stage filter removes particles 5 µm and larger. Following each day of use the filters should be inspected for replacement. If filters are to be replaced, they are considered asbestos-contaminated, and so the task must be carried out utilizing proper respiratory and personal protective equipments.

In addition, the filters must be disposed of as ACM waste.

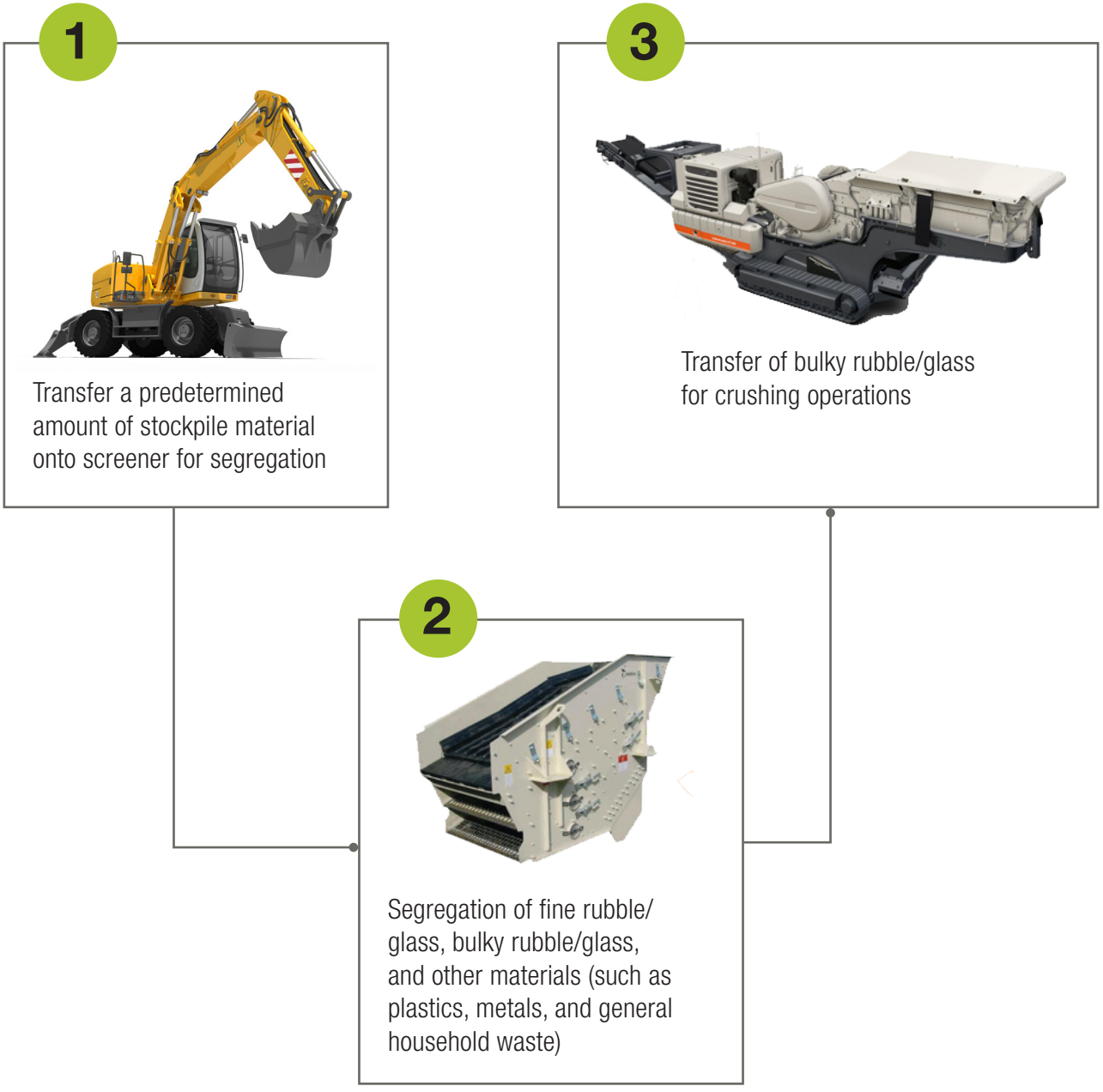
MANUAL SEGREGATION

As previously explained, other materials will be submerged in a wading pool filled with amended water for decontamination. At minimum, the wading pool should be 4 m long, 2 m wide, and 1 m deep, and should be placed on a flat surface that is stable enough

to withstand the weight and pressure of the water. The water in the wading pool will be amended with a ratio of 8 parts water to 1 part liquid detergent (water amendments reduce the surface tension of the water droplets and improve the water's effectiveness by increasing its affinity for adhesion to asbestos fibres).

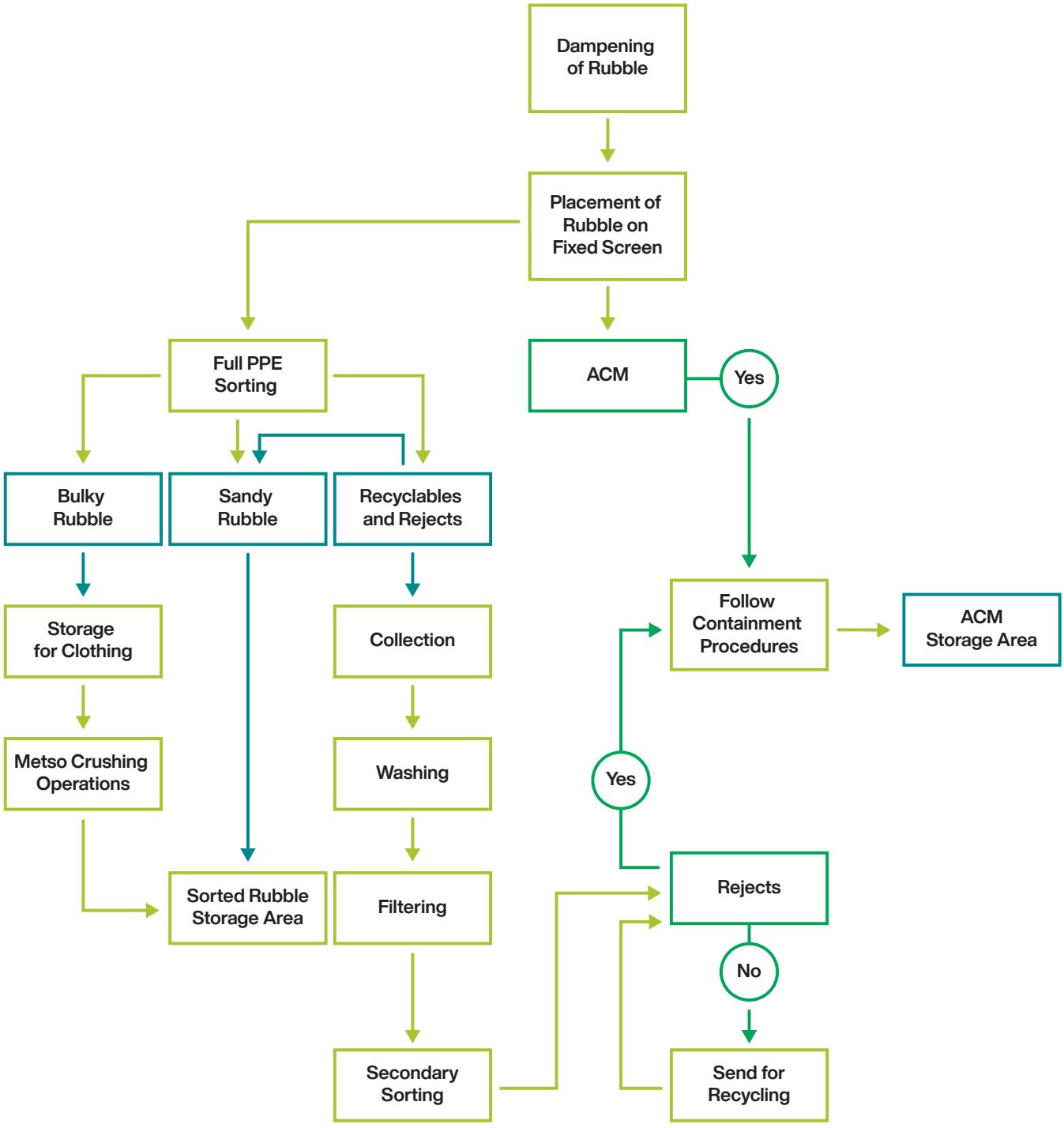
After decontamination and the removal of sought-after materials, the remaining materials are to be placed in a closed wheeled waste bin and transferred to the clean zone. Prior to entering the clean zone, the wheeled bin is to be washed. In the clean zone and beneath the shade provided from a canopy structure, secondary segregation will take place where rejected glass and plastics will be collected for further development.

Figure 10. Rubble-Crushing Process



Below is the process flow for the rubble-crushing operations.

Figure 11. Bakalian Sorting and Crushing Operations



ACM = asbestos-containing material
PPE = personal protective equipment.

Understanding Site Operations (Continued)

Glass-Crushing Operations

Figure 12. Glass-Crushing Process

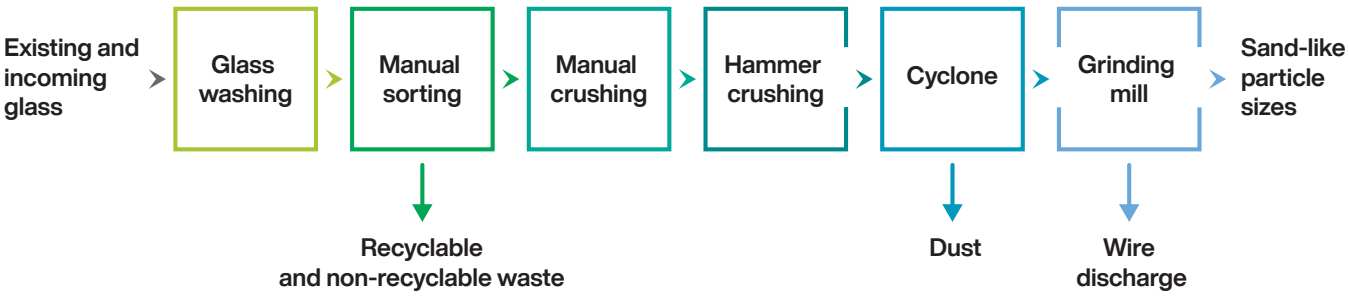


Figure 12 depicts how the glass will be handled and crushed.

The first step of the crushing operation is to transfer a predetermined amount of stockpile material to be submerged in amended water. During transfer activities, water-hose operators will be spraying water while they follow the excavator's bucket. The excavator operator will make sure to manipulate the stockpile in a way that does not generate added dust as materials are transferred. Once the water is turbid in appearance, the water vessel will be flushed out and filtered through a filtration unit that removes fibres and debris.

The washed stockpile material is then transferred to a sorting conveyor where manual sorting of presumed ACM and "other" (e.g., plastics, metals, glass, general waste) is carried out. The size of the glass that enters the glass crusher line must be less than 200 mm, anything beyond this size must go through manual crushing using hand tools. Following this task, the sorted glass is then transferred to the crushing line and then travels upward through a cyclone to be milled to sand-like particle sizes.

During the cyclone stage, there is a dust deposit that occurs within the cyclone and is collected using bags; this dust deposit will be sampled for asbestos content.

Materials presumed to contain asbestos must undergo the disposal preparation procedures detailed in the previous section before being transferred to the temporary storage area. Other materials (e.g., plastics, metals, glass, general waste) will be transferred to a water-filled wading pool for decontamination and secondary segregation. Sought-after material (e.g., material that can be resold) is then removed and placed aside for off-site transfer. All remaining general household waste material is then scheduled for transport to a landfill. After all materials are removed, the wastewater in the wading pool will be pumped into a tank and run through a filtration unit that removes fibres and debris.

Sampling Program

A standardized approach that draws from US **Environmental Protection Agency** (EPA) procedures for dealing with debris created from natural disasters will be employed to understand the characterization of the site debris during the sampling task. Based on the volumes present on site, it is expected that a total of 28 debris/dust samples will be collected and analyzed for asbestos content using polarized light microscopy and, if required, transmission electron microscopy according to US EPA test method 600/R 93/116 with gravimetric reduction and ASTM D5755 (Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading), respectively. Prior to laboratory analysis, each sample will undergo milling to achieve homogenization.

The suggested number of samples is aligned with industry best practices based on consultations with Ontario Ministry of Environment officials as well as laboratories, and is in line with EPA procedures. The approach in understanding the number of samples required from the communicated volume of the stockpile mimics the standards prescribed in Ontario Regulation 153/04 on the completion of a record of site condition (e.g., for reused soil that will serve as fill) and the standard on how **TCLP procedures** are performed.

The regulation states that if the stockpile volume is greater than 5,000 m^3, then the minimum number of samples that must be collected and analyzed is as follows:

$N = 32 + (V - 5{,}000) \div 300$

N – minimum number of samples

V – stockpile volume in m^3

Incorporating the correct volume of the stockpile into the formula produces, at a minimum, a total of 61 samples. For TCLP procedures for construction and demolition waste streams, 40% of the N value is commonly taken to capture a representative number of samples. In this case, approximately 24 samples, at a minimum, will be required to capture a representative number of samples to analyze.

The following table shows the number of samples required for each type of fine material for this small-scale trial.

Table 1. Sample of Different Types of Materials

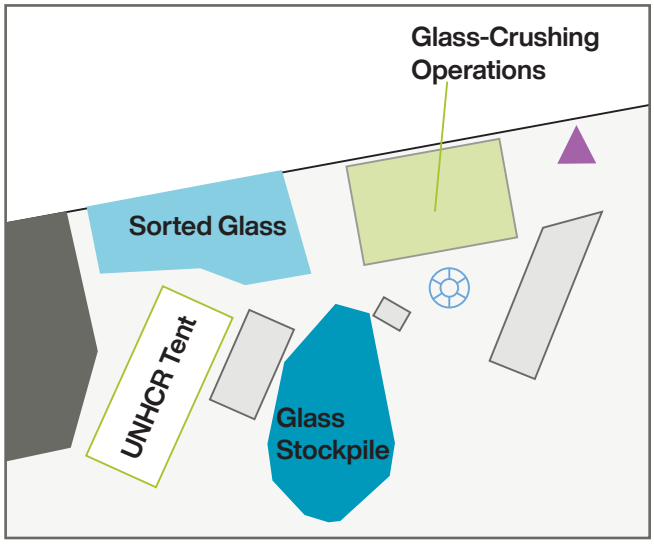
STOCKPILE	FINE MATERIAL CAPTURE LOCATION OR TIMING	NUMBER OF SAMPLE(S)
Glass Stockpile	Baseline sample from stockpile	1
	From bottom of screen	2
	Following crushing operations	2
Rubble Stockpile	Baseline sample from stockpile	1
	From bottom of screen	3
	Following crushing operations	3
Mixed 1 Stockpile	Baseline sample from stockpile	1
	From bottom of screen	5
	Following crushing operations	5
Mixed 2 Stockpile	Baseline sample from stockpile	1
	From bottom of screen	2
	Following crushing operations	2

Sampling Program (Continued)

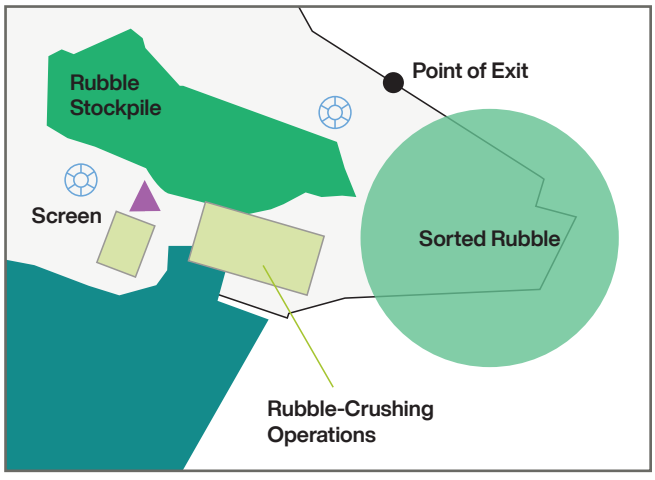
To support eliminating the hangar on site (for the purpose of housing crushing operations under negative air pressure), outdoor air sampling will be conducted to test for the concentration of airborne asbestos in and around strategic site locations.

Figure 13. Three Locations of Importance for the Air Quality Investigation

GLASS-CRUSHING OPERATIONS

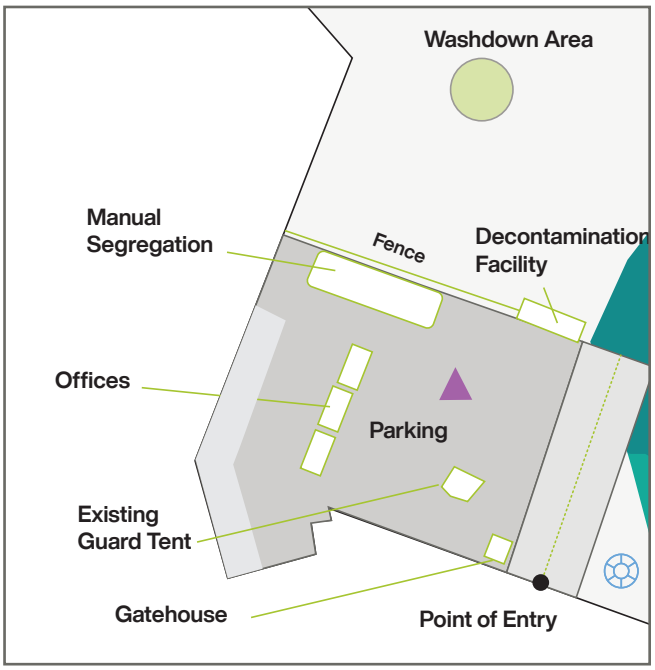


RUBBLE-CRUSHING OPERATIONS



For this site, three locations have been identified as areas of importance for the air quality investigation: glass-crushing operations, rubble-crushing operations, and clean zone (the proposed air sample locations are highlighted with purple triangle symbols in the figure below).

CLEAN ZONE

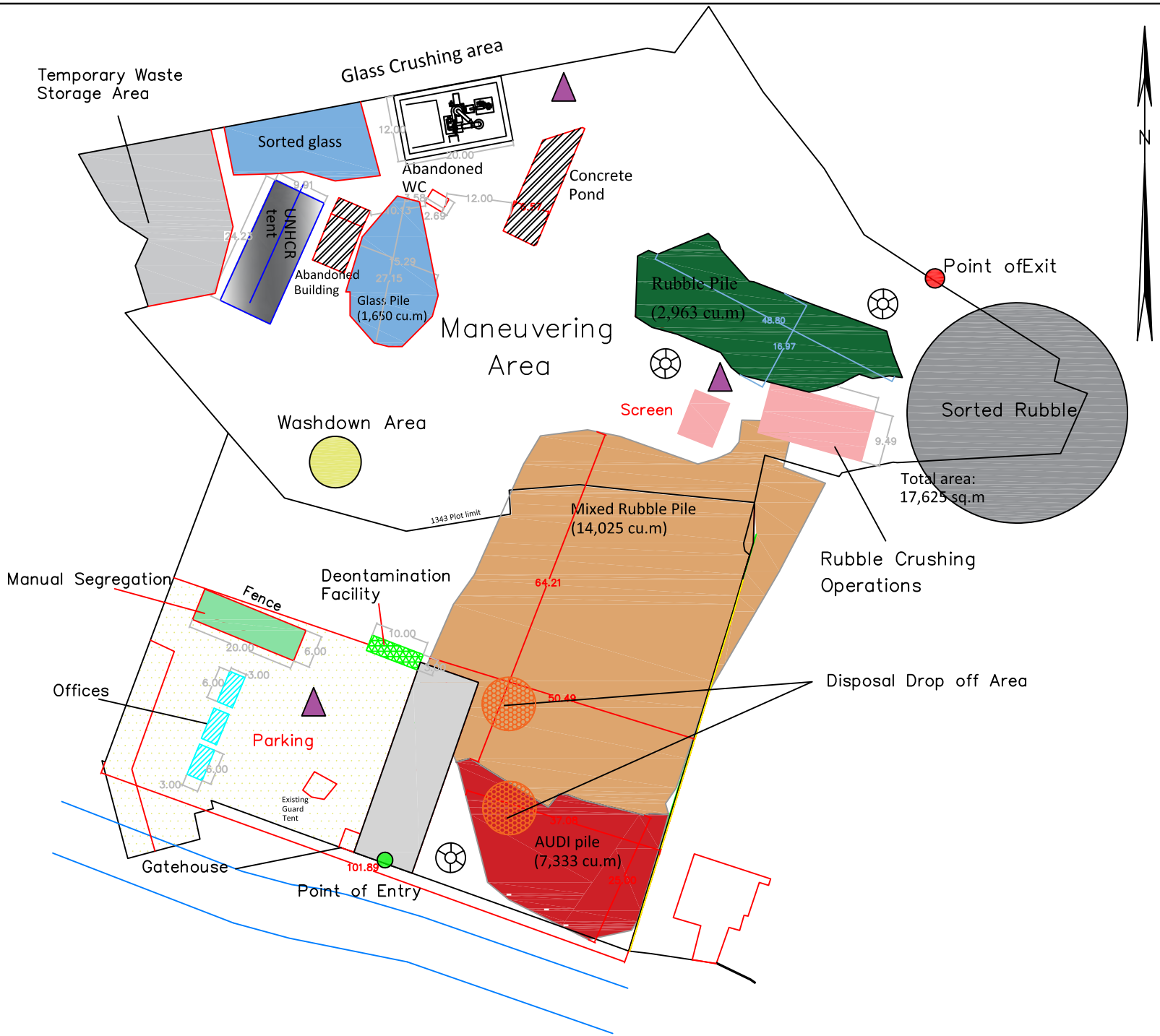


A pre-calibrated pump will be used to draw in a steady amount of air through a filter that collects airborne fibres. The pump will be calibrated to 3 L/min and will run for the majority of the day (8 hours) to capture approximately 1,400 litres of air for analysis.

The sample will be sent to an accredited laboratory and analyzed using transmission electron microscopy.

If the quality of the air at the site does not meet the minimum level set, then site operations will cease and will be revised with the goal of improving air quality conditions for the protection of site personnel and the surrounding community.

Appendix A: Site Layout to Scale



BAQALIAN SITE SURVEY
1343 MODAWAR, BEIRUT

1 | Setting Out layout

LEGEND

- Air Sampling points
- Point of Entry
- Point of Exit
- Plastic Water Tank
- Washdown Area
- Parcel Borders
- Disposal Drop off Area
- Existing Structure
- Portacabine
- Deontamination Facility
- Manual Segregation
- Fence

STATUS: TENDER

UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME

UN HABITAT FOR A BETTER URBAN FUTURE

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LOCATION: Baqalian–Karantina	BUILDING	
TITLE/ITEMS	SCALE: 1/1000	DATE: 08.2021
DRAWING NO:	FORMAT: A4	SHEET:

UN HABITAT
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RUBBLE TO MOUNTAINS

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