

# **BAKU METRO EXPANSION PROJECT**

## **GREEN LINE**

### **Contaminated Land Assessment and Management Plan (CLAMP)**

Prepared for Baku Metropolitan Closed JSC

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Prepared for:

The Baku Metropolitan Closed Joint-Stock Company

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## List of Acronyms

|                  |                                                           |
|------------------|-----------------------------------------------------------|
| AIIB             | Asian Infrastructure Investment Bank                      |
| AZS              | Azerbaijan State Standards                                |
| BM               | Baku Metro / Baku Metropolitan Closed Joint-Stock Company |
| BMEP             | Baku Metro Expansion Project                              |
| BTEX             | Benzene, Toluene, Ethylbenzene and Xylenes                |
| CLAMP            | Contaminated Land Assessment and Management Plan          |
| EHS              | Environment, Health and Safety                            |
| EIA              | Environmental Impact Assessment                           |
| EPA              | United States Environmental Protection Agency             |
| ESIA             | Environmental and Social Impact Assessment                |
| ESMP             | Environmental and Social Management Plan                  |
| GIIP             | Good International Industry Practice                      |
| GM               | Grievance Mechanism                                       |
| GOST             | State Standards / Former Soviet and CIS Standards         |
| H&S              | Health and Safety                                         |
| H <sub>2</sub> S | Hydrogen Sulfide                                          |
| HSE              | Health, Safety and Environment                            |
| IFC              | International Finance Corporation                         |
| JSC              | Joint-Stock Company                                       |
| LEL              | Lower Explosive Limit                                     |
| LLC              | Limited Liability Company                                 |
| LNAPL            | Light Non-Aqueous Phase Liquid                            |
| MAC              | Maximum Allowable Concentration                           |
| MENR             | Ministry of Ecology and Natural Resources                 |
| NATM             | New Austrian Tunnelling Method                            |
| OHS              | Occupational Health and Safety                            |
| OHSP             | Occupational Health and Safety Plan                       |
| PAH(s)           | Polycyclic Aromatic Hydrocarbon(s)                        |
| PCB(s)           | Polychlorinated Biphenyl(s)                               |
| PCE              | Tetrachloroethylene                                       |
| PID              | Photoionization Detector                                  |

|         |                                               |
|---------|-----------------------------------------------|
| PIU     | Project Implementation Unit                   |
| PPE     | Personal Protective Equipment                 |
| QA/QC   | Quality Assurance / Quality Control           |
| RBC     | Risk-Based Concentration                      |
| RPE     | Respiratory Protective Equipment              |
| RSL     | Regional Screening Level                      |
| SDMP    | Spoil Disposal Management Plan                |
| SEP     | Stakeholder Engagement Plan                   |
| SPS     | Safeguard Policy Statement                    |
| SR      | Safeguard Requirements                        |
| SVOC(s) | Semi-Volatile Organic Compound(s)             |
| TBM     | Tunnel Boring Machine                         |
| TCE     | Trichloroethylene                             |
| TCL     | Target Compound List                          |
| TCLP    | Toxicity Characteristic Leaching Procedure    |
| TLV     | Threshold Limit Value                         |
| TOC     | Total Organic Carbon                          |
| TPH     | Total Petroleum Hydrocarbons                  |
| US EPA  | United States Environmental Protection Agency |
| VOC(s)  | Volatile Organic Compound(s)                  |
| VISL    | Vapor Intrusion Screening Level               |
| WAC     | Waste Acceptance Criteria                     |
| WHO     | World Health Organization                     |
| WMC     | Waste Management Center                       |

# 1. Introduction

## 1.1 Project Description

The Government of the Republic of Azerbaijan, through Baku Metropolitan Closed Joint-Stock Company (“Baku Metro” or “BM”), is implementing Phase II of the Baku Metro Expansion Project (“BMEP”), which includes the extension of the Green Line within the urban area of Baku. The Green Line Extension is expected to be financed by the Asian Infrastructure Investment Bank (AIIB) and is being developed in accordance with applicable national legislation, the AIIB Environmental and Social Framework (ESF) 2024 and relevant international good practice.

The Green Line Extension comprises approximately 7.4 km of fully underground alignment and four new underground stations (Y-14, Y-15, Y-16 and Y-17), extending from Khatai to Hazi Aslanov. The alignment is intended to improve east–west connectivity across densely populated residential districts, enhance network resilience, and improve overall operational efficiency. Stations Y-15 and Y-17 include civil structures that were partially constructed during earlier project phases, which will be integrated, upgraded, and completed under the Project.

This Contaminated Land Assessment and Management Plan (CLAMP) for the Green Line forms part of the Project’s Environmental and Social Management Plan (ESMP) and applies to all permanent and temporary works associated with the Green Line Extension. The Plan covers pre-construction and construction phases, including tunnels, stations, shafts, construction compounds, ancillary facilities, access areas, and the upgrading of pre-existing structures. Project Location is shown in Figure 1.



Figure 1: Green Line Extension

## 1.2 Purpose of This Contaminated Land Assessment Management Plan

Central Baku—particularly Sabayil, Yasamal, Narimanov, Khatai, and the coastal industrial belt—has a long, documented history of oil extraction, refining, heavy machinery manufacturing, and intensive Soviet-era industrial use. As detailed in ESIA Chapter 12 (Geology, Soils, and Groundwater), historical ground leaks and unmitigated industrial discharges have left a legacy of localized contamination, with subsurface matrices containing elevated fractions of Total Petroleum Hydrocarbons (TPH), Polycyclic

Aromatic Hydrocarbons (PAHs), heavy metals, and hyper-saline chemical residues within the shallow urban strata.

While the broader Green Line alignment does not predominantly pass through continuous corridors classified as high-risk for regional soil contamination, specific segments present confirmed risk interfaces that cannot be ignored. Most notably, the easternmost segments approaching and bounding Most notably, the segments crossing the historically industrial "Black City" area — in particular those approaching and bounding Stations Y-15 and Y-16 — intersect directly with legacy industrial brownfields, where the baseline site investigation confirmed free-phase petroleum product (LNAPL), elevated petroleum hydrocarbons and geogenic arsenic in soil and groundwater. According to the baseline scoping in ESIA Chapter 20, individual project residual footprints confirm that subsurface work fronts have a high probability of intersecting localized, unmapped pockets of active soil and groundwater contamination. Therefore, a comprehensive, risk-based contaminated land assessment and management protocol is mandatory to ensure these subsurface variables are controlled.

The functional scope of this CLAMP encompasses all pre-construction and active construction phases, explicitly mapping out primary underground excavation methodologies where contaminated soil or groundwater ingress may occur such as

TBM operation, NATM operation and open-cut station excavations, and any other excavations required during construction phase.

The objective is to prevent release of contaminants to environment, avoid human exposure to contaminants (both workers and community) and avoid fire and explosion risks during construction.

During the construction phase, the Contractor shall develop and implement a detailed, site-specific Construction CLAMP consistent with this overarching CLAMP, as construction methods are finalised and vehicle movement requirements are confirmed.

## 2. NATIONAL LEGISLATION AND LENDER'S REQUIREMENTS

### 2.1 Overview

This chapter summarises the applicable national legislative requirements, the Lender's policy requirements, and relevant international good practice that have informed the structure, scope, and implementation approach of this Plan. Further details on the legal and institutional framework for the Project are provided in Chapter 4 (Legal and Institutional Framework) of the ESIA.

### 2.2 National Legislation

The following Azerbaijani laws and regulations are relevant to geological and hydrogeological aspects of the Project:

- Water Code of the Republic of Azerbaijan (1997, as amended) – Establishes the legal basis for the use, protection, and management of surface and groundwater resources, including prevention of pollution, monitoring, and licensing of abstraction and discharge activities.
- Law on Subsoil (1998, as amended) – Regulates exploration, use, and protection of subsoil resources, including geological investigations, tunnelling works, and groundwater management. This law defines obligations for minimizing adverse geological impacts during construction.
- Law on Environmental Protection (1999, as amended) – Provides overarching environmental protection principles, pollution prevention duties, and restoration requirements for land and water resources. It also underpins the Environmental Impact Assessment (EIA/ESIA) system.
- Law on Water Supply and Wastewater (1999) – Defines responsibilities for water supply and wastewater collection systems, establishes discharge and treatment standards, and requires protection of aquifers used for drinking water.
- Law on Sanitary-Epidemiological Safety (1992, as amended) – Governs protection of public health from environmental pollution, including regulation of sanitary protection zones for water intakes and quality standards for potable water.

These laws are administered primarily by the Ministry of Ecology and Natural Resources (MENR), the Ministry of Health, and local executive authorities responsible for urban development and construction permits.

#### Other Relevant National Standards and Policies

- State Standards (GOST / AZS) — Set maximum allowable concentrations (MACs) for pollutants in soil and groundwater.
- State Programme on the Use of Subsoil and Groundwater Resources (Government Decree No. 291/2010) — Outlines state priorities for sustainable groundwater extraction, pollution prevention, and geological hazard management.
- National Water Strategy (2020) — Promotes efficient water resource use, integration of water and land protection policies, and enhanced monitoring systems.

## 2.3 Lender's Requirements

The Project and this CLAMP are governed by the international environmental and social safeguard mandates of the Asian Infrastructure Investment Bank (AIIB) Environmental and Social Framework (ESF, 2024), comprising the Environmental and Social Policy (ESP) and its associated Environmental and Social Standards (ESS).

AIIB ESS1 (Assessment and Management of Environmental and Social Risks and Impacts) – Pollution Prevention and Resource Efficiency: Mandates that during the design, construction, and operation of the Project, the Client shall apply pollution prevention and control technologies and practices consistent with good international industry practice (GIIP), as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety (EHS) Guidelines. Specifically, the Client is required to avoid the release of hazardous substances into the environment, minimize the generation of hazardous waste, and actively remediate or contain historical contamination pathways within the Project's area of influence to ensure that no Project activities cause a net degradation of baseline environmental conditions.

AIIB ESS1 – Occupational Health and Safety (Community and Worker Health, Safety and Security): Explicitly requires the Client to provide workers with a safe and healthy working environment, taking into account risks inherent to the particular underground construction sector and the specific chemical, physical, and vapor hazards present in the work areas. The Client shall, in addition, give due regard to the labour and working-condition requirements applicable under the AIIB ESF.

In direct alignment with the provisions of AIIB ESS1, this plan codifies the technical and operational directives of the World Bank Group / IFC General EHS Guidelines (2007) – Section 1.7: Contaminated Land.

Soil and groundwater analytical results shall be systematically benchmarked against internationally recognized pathway-specific screening levels. In the absence of localized risk-based standards, US EPA Industrial Worker Soil Regional Screening Levels (RSLs) and US EPA Vapor Intrusion Screening Levels (VISLs) shall be applied to address direct dermal, ingestion, and confined-space inhalation pathways.

### ***Other Relevant International Guidance***

IFC Environmental, Health and Safety (EHS) Guidelines (2007, updated) – Provide technical guidance on groundwater protection, soil management, hazardous materials handling, and construction dewatering.

### 2.3.1 Contaminated Land Screening Logic and Standards Hierarchy

In accordance with the IFC EHS Guidelines (2007), and in the absence of nationally established contaminated-land screening criteria in Azerbaijan, a risk-based concentration (RBC) approach has been adopted.

To bridge the statutory mandates of Azerbaijani national legislation with international Lender requirements, a clear, three-tiered decision-making hierarchy shall be applied to all soil and groundwater analytical data. This matrix establishes a definitive boundary between geogenic background conditions, regulatory environmental compliance, and worker occupational health safeguards:

1. TIER 1 – National Statutory Baseline (Azerbaijani MACs):

All primary analytical parameters shall first be compared against Azerbaijani State Standards (GOST / AZS) Maximum Allowable Concentrations (MACs) to characterize environmental compliance (given in Appendix-A).

- If concentrations fall BELOW national MACs, the material is classified as Class A (Inert / Secondary Raw Material) and cleared for unrestricted on-site reuse or routine disposal.

- If concentrations exceed national MACs, a Tier 2 evaluation is automatically triggered to determine whether the exceedance represents an active anthropogenic contamination release or a geogenic baseline anomaly.

## 2. TIER 2 – Geogenic Variance & Waste Classification (US EPA Industrial RSLs)<sup>1</sup>:

Where parameters exceed national MACs, they shall be benchmarked against US EPA Industrial Worker Soil Regional Screening Levels (RSLs) for non-volatile fractions (heavy metals, PAHs, heavy TPH C10–C35).

- If the parameters exceed national MACs but remain statistically uniform across all boring depths and match regional geogenic characteristics (e.g., geogenic Arsenic on the Absheron Peninsula), the material is classified as Class B (Impacted / Non-hazardous industrial waste) and evaluated for structural backfill or non-hazardous terrestrial placement.

- If parameters exceed both national MACs and US EPA Industrial RSLs, the matrix triggers a Tier 3 Critical Occupational Hygiene Protocol.

## 3. TIER 3 – Confined Space & Occupational Health Safeguards (US EPA VISLs)<sup>2</sup>:

TIER 3 – Enclosed Space Inhalation & Wet-Matrix Occupational Safeguards:

Because national MACs do not account for specialized subsurface construction exposure pathways, groundwater and volatile soil matrices shall be dual-screened using targeted US EPA risk-based values based on the physical phase of the contaminant:

A. Volatile Organic Compounds (VOCs / Vapor Phase): All volatile parameters (e.g., Benzene, Chloroform) in both soil and groundwater shall be screened against US EPA Vapor Intrusion Screening Levels (VISLs) under a commercial/industrial scenario to mitigate acute inhalation risks within tunnels, shafts, and station boxes.

B. Non-Volatile Constituents (Heavy Metals / PAHs / Heavy TPH in Saturated Media): Because workers operating within NATM faces or managing wet mucking cycles face prolonged dermal contact and accidental incidental ingestion of contaminated groundwater, non-volatile groundwater parameters shall be qualitatively compared against US EPA Industrial Tapwater RSLs. This comparison is applied strictly as a conservative operational proxy for occupational hygiene—not as a drinking water compliance standard—to dictate personal protective equipment (PPE) requirements for wet works.

The hierarchy explained above is given as a flowchart in Figure 2.

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<sup>1</sup> Construction worker soil tables are available at <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>

<sup>2</sup> Composite worker air tables are available at <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>

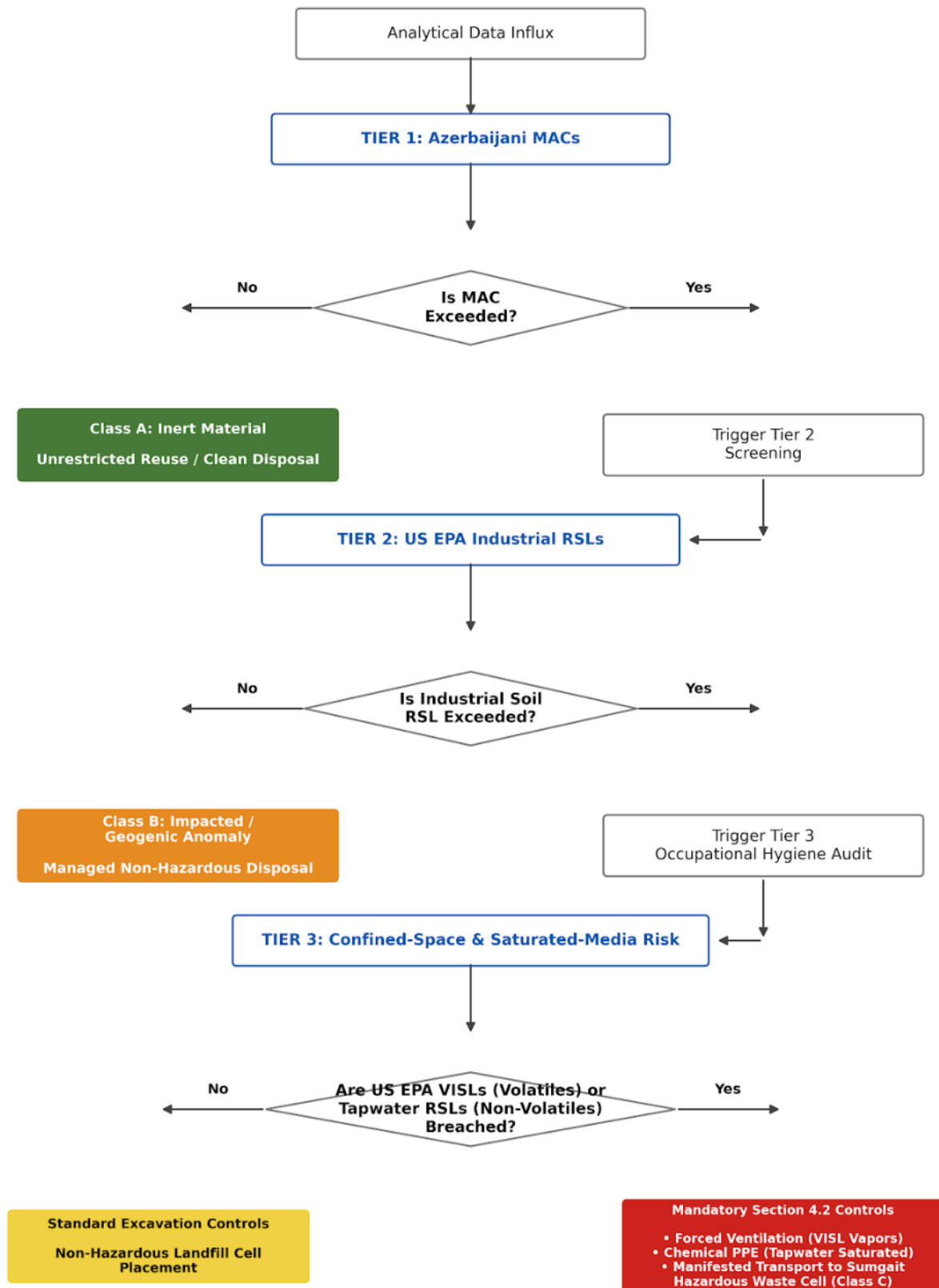


Figure 2: Contaminated Land Screening Flowchart

### 2.3.2 The Role of Waste Acceptance Criteria (WAC) in Off-Site Disposal Routing

While US EPA Industrial RSLs and VISLs establish the operational limits for worker health and safety on-site, the final routing of all excavated materials for off-site disposal is strictly governed by Waste Acceptance Criteria (WAC) and Toxicity Characteristic Leaching Procedure (TCLP) parameters.

WAC testing changes the evaluation from a total chemical concentration to a leachable fraction analysis, assessing the rate at which contaminants could migrate from the soil matrix into the surrounding environment under acidic landfill conditions.

WAC parameters take role at two distinct critical milestones during project execution:

- **Pre-Construction Allocation (Generator Knowledge):** During the pre-construction investigative drilling phase outlined in Section 4.1, composite samples from areas exceeding national MACs shall undergo full EU-WAC or US EPA TCLP testing. The leachable thresholds for heavy metals, total organic carbon (TOC), phenols, and dissolved solids will dictate whether the material is legally cleared for reuse, accepted at the non-hazardous cells of the Tullantıları İdarəetmə Mərkəzi MMC (Waste Management Center Limited Liability Company, WMC LLC) in Sumgait.
- **Compliance Verification & Landfill Acceptance:** Prior to any Class B or Class C material leaving the active project shafts, the Contractor must compile the WAC laboratory analytical profile to fulfill the statutory requirements of Azerbaijan Cabinet of Ministers Resolution No. 41 (Waste Passportization). The receiving licensed facility in Sumgait utilizes these specific WAC certificates as a legal gating mechanism; any haulage truck arriving without a corresponding WAC/TCLP profile matching the facility's strict boundary limits will be legally rejected at the weighbridge gate.

## 3. ROLES AND RESPONSIBILITIES

### 3.1 Overview

An integrated approach to contaminated land assessment management involves a range of stakeholders, including Baku Metro (PIU), the Contractor (and their subcontractors), government ministries, local governorships and municipalities, and members of the public. It also requires robust processes regarding information dissemination, training, roles and responsibilities, management actions, monitoring, control, and corrective actions to ensure continual improvement.

### 3.2 Key Roles and Responsibilities

The key roles and responsibilities for the implementation of the CLAMP for the PIU and contractor during pre-construction and construction phases are outlined below in Table 1.

**Table 1: Key Roles and Responsibilities**

| Role                                         | Responsibilities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Baku Metro Project Implementation Unit (PIU) | <ul style="list-style-type: none"> <li>Overall responsibility for implementation of this Plan, regulatory liaison, approval of waste disposal routes, and ensuring compliance with national and lender requirements.</li> <li>Responsible for overseeing the pre-construction and construction phases of the Project,</li> <li>Ensure roles and responsibilities are clearly identified and allocated within the PIU,</li> <li>Ensure reporting to AIIB.</li> </ul>                                                                                                                                                                                                                                                    |
| PIU Health and Safety Specialist             | <ul style="list-style-type: none"> <li>Ensure Project compliance with Project standards and other requirements set out in this Plan.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| PIU Environmental Specialist                 | <ul style="list-style-type: none"> <li>Overall responsibility for the elaboration and implementation of the Plan.</li> <li>Ensure Project compliance with Project standards and other requirements set out in this Plan during the pre-construction and construction stages.</li> <li>Assurance of the Contractor's preparation and implementation of the Plan, as outlined in the ESMP. Monitoring of the Contractor's implementation to ensure that it continues to be suitable and sufficient.</li> <li>Development, monitoring and revision of the Plan during the pre-construction and construction and stages.</li> <li>The PIU Environmental Specialist will approve the Plan prior to construction.</li> </ul> |
| Supervision Contract Manager                 | <ul style="list-style-type: none"> <li>Responsible for supervising the construction Contractor to ensure that recommendations and requirements are met, as set out in the Plan,</li> <li>Review of contaminated land investigations, verification of soil classification, approval of mitigation and monitoring measures.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                   |
| Contractor's Project Manager                 | <ul style="list-style-type: none"> <li>Responsible for overseeing the construction of the Project, including planning and delivery. The Contractor's Project Manager will approve the Plan prior to construction,</li> <li>Allocate all necessary and required resources for the Plan.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                      |

| Role                                   | Responsibilities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Contractor's Health and Safety Manager | <ul style="list-style-type: none"> <li>Responsible for evaluating the risk associated with contaminated land incidents and must have appropriate training.</li> <li>Day-to-day implementation, safe excavation and handling of contaminated soil, worker protection, temporary storage, transport and disposal, record keeping.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Contractor's H&S Specialist            | <ul style="list-style-type: none"> <li>To ensure all safety measures are implemented at the site,</li> <li>To give tool-box training to the personnel every morning,</li> <li>Report the activities daily to the H&amp;S manager</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Contractor's Social Lead/CLO           | <p>Social Lead will;</p> <ul style="list-style-type: none"> <li>Ensure compliance with this Plan,</li> <li>Prepare social sections of the monthly reports (report for social requirement and register) which will include information on the implementation of this plan.</li> <li>Inform, investigate and report community relation incidents,</li> <li>Ensure community complaints are registered and followed by Project requirements.</li> <li>Undertake community/social risk assessments for all disposal sites.</li> </ul> <p>CLOs will;</p> <ul style="list-style-type: none"> <li>Responsible for community safety issues of this Plan,</li> <li>Deliver and/or participate in safety awareness training for local children and adults,</li> <li>Raise community awareness of safety issues through meetings and classroom lessons,</li> <li>Meet local communities in advance of significant impact occurring to describe activities and explain risks,</li> <li>Ensure grievances received are registered and followed up by Project requirements.</li> </ul> |
| Contractor's Environmental Lead        | <ul style="list-style-type: none"> <li>Responsible for the preparation and implementation of the Plan, on behalf of the Contractor, prior to and during construction. The Plan will set out the systems, processes and procedures, resources, roles and responsibilities of the Contractor, and their sub-contractors.</li> <li>On-site supervision, sampling, air and vapour monitoring, training and incident response.</li> <li>Keeping the environmental records,</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Contractor's Environmental Specialist  | <ul style="list-style-type: none"> <li>To do daily environmental inspections,</li> <li>Warning people who do not comply with the environmental instructions,</li> <li>Ensuring to take the environmental precautions at the construction site,</li> <li>Reporting the activities daily to the Environmental Lead.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Sub-Contractors                        | <ul style="list-style-type: none"> <li>Subcontractors are bound to apply all procedures and measures specified by Contractor in the Plan and Project Requirements. Contractor will make sure that the subcontractors are working in compliance with the requirements of the Plan and will be controlling the performance of all Subcontractors with regard to the Plan</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Role      | Responsibilities                                                                                                                                                                                                                                                                                                                         |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Employees | <ul style="list-style-type: none"><li>• S/he is responsible for the implementation of the topics covered by the training by participating in the training related to the plan.</li><li>• Complying with the Plan/instructions</li><li>• Following the instructions prepared by the inspectors regarding the Plan requirements.</li></ul> |

## 4. CONTAMINATED LAND ASSESSMENT MANAGEMENT PLAN

### 4.1 Before Construction

The characterisation campaign set out in this Section shall cover the full Green Line alignment (Y-14 to Y-17 station boxes, TBM and NATM drive corridors, shafts and ancillary areas) and shall be completed prior to issuance of the tender documents. Spoil classification and disposal routing shall subsequently be updated on the basis of the actual screening and laboratory results.

Prior to commencement of TBM drives, NATM and station box excavations, the following activities shall be undertaken:

- Review of historical land-use data and previous site investigation results to identify zones potentially affected by petroleum hydrocarbons, PAHs and heavy metals.
- Targeted soil and groundwater sampling in high-risk areas, including former industrial and oil-related sites.
- Baseline intrusive drilling shall be completed at Stations Y-14 and Y-17 and along the TBM corridor as a mandatory pre-entry requirement prior to physical site entry. Within the high-risk Y-15/Y-16 corridor, boreholes shall be located at maximum intervals of 100 m and shall be subject to continuous core logging.
- Laboratory analysis for TPH, BTEX, PAHs, Heavy Metals, and TCLP/WAC leaching tests.
- Screening results against risk-based criteria given in Section 2.3:
- Development of site-specific health and safety procedures, including PPE requirements, ventilation design and emergency response plans for hydrocarbon vapours.

#### 4.1.1 TBM Works (20–25 m depth)

Because the TBM is deep and linear, strategically placed “deep control points” along the alignment, plus a few at launch/retrieval is recommended. Recommended approach:

- a) Deep investigative boreholes (1 deep borehole every 500 m along the TBM alignment plus launch and retrieval areas).
- Focus on:
  - TBM launch shaft area
  - TBM reception area
  - High-risk corridor segments (near historic oil zones, old depots, pipeline corridors, reclaimed land)
    - Increase density where historical evidence indicates higher risk. (Y-15 and Y-16 are hot spots confirmed by ESIA Chapter 12).
- b) Depths and sampling
- Drill to at least 5 m below TBM invert (to bracket the horizon and check below).
- Collect soil samples at:
  - near-surface fill (for handling/stockpiles if generated)
  - suspected impacted layers (smell/staining and high PID)

- at/around tunnel horizon (e.g.,  $\pm 2-3$  m above and below TBM level)
- Install standpipe monitoring wells at selected boreholes screened across the TBM-relevant aquifer horizon.

c) Groundwater strategy

At each deep borehole/well:

- record standing water level
- purge and sample (low flow EPA sampling method) groundwater for dissolved VOCs/BTEX and petroleum parameters
- If suspected hydrocarbon groundwater:
  - include field screening (PID headspace, visual sheen, odour)
  - consider LNAPL check (interface probe) at key wells if free product is plausible.

d) Site-specific campaign and permit controls

The TBM drive between Y-15 and Y-16 crosses former petroleum industrial land where free-phase hydrocarbons have been identified.

- A site-specific pre-excavation drilling and soil gas/groundwater sampling campaign shall be completed along the TBM path on this segment before drive commencement, with borehole spacing reduced relative to (a) and interface probe gauging for LNAPL at all wells.
- Entry to the TBM shield, cutterhead chamber and shaft cavities shall be governed by the Contractor's Permit to Work system. No confined space permit shall be issued unless real-time atmospheric testing for  $O_2$ , LEL,  $H_2S$ , CO and total VOC (PID) is maintained for the duration of the permit.
- Campaign results shall be issued to the Contractor's tunnelling and OHS teams before drive commencement and attached to the confined space permit for the relevant chainage.
- Emergency response protocols shall be prepared for TBM cutterheads boring through unmapped fuel pipelines or migrating free-phase hydrocarbon plumes.

#### 4.1.2 Open-cut Station Excavations

Recommended approach per station box:

a) Targeted station boreholes / trial pits

A practical minimum is:

- 1 borehole per 5 points per  $m^2$ .
- Depth:
  - to 3 m below planned excavation
- If the site has known oil history or strong indicators:
  - add 2 additional boreholes on the "suspected source side" (e.g., near roads/industrial boundary/ waste dumping areas)

b) Soil sampling intervals

- Made ground / fill: sample at least one interval in fill (often most impacted)
- Every 1.0–1.5 m down to formation level (or at changes in lithology)

- At the base of excavation (most relevant to worker exposure + seepage)

c) Shallow groundwater / seepage

Even if permanent groundwater is deeper, open cuts may encounter:

- perched water
- utility leakage
- Seasonal rise

Therefore:

- If groundwater is encountered, install min 3 groundwater wells per station:
  - take at least three representative groundwater sample per station (or per dewatering sump during pre-works test)
- If not encountered:
  - document “no groundwater at time of drilling” and rely on contingency trigger procedures.

#### 4.1.3 Sampling Details

To preserve sample integrity and guarantee that laboratory analytical data is legally and technically defensible, all pre-construction and tactical excavation sampling shall adhere to strict Good International Industry Practice (GIIP) quality assurance/quality control (QA/QC) protocols:

- Mandatory Analytical Suite: All soil and groundwater samples collected along the alignment shall be analyzed by an internationally accredited laboratory for a comprehensive, multi-parameter contamination suite, including:
  - Volatile Organic Compounds (VOCs): Full volatile suite targeting Benzene, Toluene, Ethylbenzene, Total Xylenes (BTEX), Naphthalene, and chlorinated solvents (such as TCE and PCE) to govern enclosed-space inhalation triggers.
  - Semi-Volatile Organic Compounds (SVOCs): Full Target Compound List (TCL) for Polycyclic Aromatic Hydrocarbons (PAHs), including Benzo(a)pyrene, Chrysene, Fluoranthene, and Pyrene to track dermal and incidental ingestion risk in saturated media
  - Hydrocarbon Fractions: Total Petroleum Hydrocarbons (TPH) must be analyzed specifically via the Aliphatic/Aromatic split methodology, broken down into the 6 EPA risk-based carbon bands.
  - Heavy Metals: Total Arsenic (As), Lead (Pb), Cadmium (Cd), Total Chromium (Cr), Nickel (Ni), Zinc (Zn), and Mercury (Hg).
  - Leaching Characteristics: Waste Acceptance Criteria (WAC) and Toxicity Characteristic Leaching Procedure (TCLP) for landfills.
- Sample Containment and Storage Controls: Samples targeting volatile organics (VOCs/Light TPH) must be collected using zero-headspace techniques in dedicated, airtight glass jars with Teflon-lined caps to eliminate volatilization loss.
  - Immediately upon collection, all sample containers must be labeled with a unique sample ID, depth matrix, GPS coordinate, date, and time.

- Samples must be immediately placed into insulated field cooling chests (cool boxes) maintained at a strict temperature of  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$  using frozen ice packs. Samples must be kept dark and chilled continuously until laboratory log-in.
- Holding Times and Chain of Custody (CoC):
  - All samples must be transferred to the accredited testing laboratory under a signed, unbroken Chain of Custody (CoC) manifest.
  - To prevent sample degradation, the maximum holding time between field extraction and laboratory extraction/preservation shall not exceed 48 hours for volatile parameters (VOCs/BTEX) and 7 days for semi-volatiles and metals.

#### 4.1.4 Mitigation Measures

Based on the analytical profiles and structural risk zones delineated during the pre-construction intrusive soil and groundwater investigations, the following targeted mitigation measures shall be finalized and integrated into the project design prior to the commencement of physical works:

- Design of Ventilation Systems for Tunnels and Paths: The specific baseline concentrations of volatile organic compounds (VOCs) and light petroleum fractions detected during the drilling campaign shall be directly utilized by engineering teams to calculate and design the capacity, air-exchange rates, and layout of forced-draft mechanical ventilation systems for tunnels and shafts to control hydrocarbon and solvent vapors.
- Preparation of Emergency Response Procedures for High VOC Concentrations: Utilizing the localized contamination boundaries identified in the field (specifically around the legacy corridors of Stations Y-15 and Y-16), the Contractor shall establish site-specific emergency response and evacuation protocols tailored to handle sudden chemical gas ingress or explosive atmospheres.
- Training of Workers on Contaminated Soil Recognition: Before any subsurface excavation begins, a mandatory training program shall be deployed for all field personnel. This training will focus explicitly on visual/olfactory recognition of the specific petroleum fractions found during the pre-construction testing, alongside safe handling protocols and personal hygiene standards.

## 4.2 During Construction

To provide simultaneous protection against both occupational toxicity (chemical poisoning/vapor inhalation) and acute safety hazards (fire and atmospheric explosions) during subterranean activities, the Project enforces a dual-instrument gating framework. Photoionization Detectors (PID) for Total VOC monitoring and multi-gas loggers equipped with Combustible Gas Indicators (LEL Meters), H<sub>2</sub>S and CO gas cells shall be monitored continuously at all active TBM drive faces, NATM headings, and deep open-cut station excavations.

Operational thresholds, field response protocols, and mandatory engineering controls are linked according to the following integrated hierarchy:

LEVEL 1: Routine Awareness & Enhanced Ventilation Threshold

- **Triggers (Either Criteria Met):** PID readings sustain **>5 ppm but <25 ppm** Total VOCs, or
  - LEL meter readings sustain **>2% but <10% LEL** (typically indicating low-level biogenic Methane or trace fuel vapor).
  - H<sub>2</sub>S readings reach  $\geq 1$  ppm but remain  $< 5$  ppm, or

- CO readings reach  $\geq 25$  ppm but remain  $< 50$  ppm.
- **Mandatory Field Actions:** Subterranean work continues under standard operations. The Contractor's Environmental Lead and OHS Officer must immediately double the operational capacity of the forced-draft auxiliary ventilation fans to dilute air concentrations. Routine physical inspections shall be launched to check local dewatering sumps and muck piles for structural containment performance. Where  $H_2S$  concentrations reach or exceed 1 ppm, the use of appropriate respiratory protective equipment (RPE) shall be mandatory.

LEVEL 2: Controlled Restriction & Compound-Specific Verification Threshold

- **Triggers (Either Criteria Met):** PID readings sustain  $\geq 25$  ppm but  $< 50$  ppm Total VOCs, or
  - LEL meter readings sustain  $\geq 10\%$  but  $< 20\%$  LEL.
- **Mandatory Field Actions:** The Contractor shall immediately suspend all non-essential activities and restrict access to the affected shaft, tunnel heading, or excavation segment to specialized crews only.
  - *If triggered by LEL ( $\geq 10\%$ ):* All active hot works (welding, torch cutting, structural grinding) are legally suspended, and all non-explosion-proof electrical circuits must be isolated.
  - *If triggered by PID ( $\geq 25$  ppm):* Because the PID cannot differentiate compounds, the Contractor must instantly pull a compound-specific colorimetric gas detector tube (e.g., Dräger tube for Benzene). If Benzene levels breach the ACGIH TLV (0.5 ppm), all remaining personnel must immediately use full-face respirators with organic vapor/multi-gas cartridges and chemical-resistant protective suits.

LEVEL 3: Exclusion & Mandatory Emergency Evacuation Threshold

- **Triggers (Either Criteria Met):** PID readings breach  $\geq 50$  ppm Total VOCs, or
  - LEL meter readings breach  $\geq 20\%$  LEL.
  - $H_2S$  readings reach or exceed 5 ppm (STEL), or
  - CO readings reach or exceed 50 ppm.
- **Mandatory Field Actions:** The Contractor shall immediately enforce an unconditional, full evacuation of all personnel from the subterranean sector. Work shall be stopped immediately and the affected area shall be evacuated when  $H_2S$  reaches 5 ppm (STEL) or CO reaches 50 ppm. The TBM drive or NATM excavation face must be shut down, all ignition sources must be cut off, and the emergency response team must be activated. The area will remain sealed under a strict "No Entry" order until fixed and portable atmospheric monitoring grids confirm that concentrations have dropped safely and continuously below Level 1 boundaries. If LEL levels ever climb to  $\geq 40\%$  LEL, municipal emergency management structures must be immediately engaged for regional boundary isolation.

#### 4.2.1 Mitigation Measures

- **Forced Ventilation and Continuous Gas Monitoring:** The Contractor shall maintain active forced-draft auxiliary ventilation within all confined spaces—specifically active TBM headings, NATM tunnel faces, and deep shaft bottoms. Continuous real-time atmospheric monitoring grids must remain online to track.
- **Dust suppression measures to prevent inhalation of contaminated particulates:** During open-cut station box excavations (such as Stations Y-14 through Y-17) and muck handling cycles,

localized water-spraying, misting canons, or eco-friendly dust suppressants shall be continuously deployed. This active moisture management is mandatory to control airborne dust and prevent workers or surrounding urban communities from inhaling potentially contaminated soil particulates.

- Controlled loading, covering and transport of contaminated soil: All soil classified as Class B (Impacted) or Class C (Hazardous) must be loaded within designated, controlled mucking zones according to SDMP.
- Immediate isolation and investigation of any free-phase hydrocarbons encountered: If unexpected mobile free-product, heavy oil pooling, or a distinct chemical sheen is encountered at an excavation face or within dewatering sumps, the Contractor shall immediately isolate the localized work zone. Excavation at that specific face shall be temporarily paused to evaluate free-phase hydrocarbon boundaries and implement targeted containment extraction before resuming routine works.
- While this CLAMP defines the atmospheric triggers, monitoring frequencies, and environmental action levels governing contaminated subterranean zones, the technical execution specifications for worker health and chemical safety fall under the jurisdiction of the Contractor's separate, dedicated Site-Specific Occupational Health and Safety Plan (OHSP). To prevent administrative document duplication and maintain appropriate safety governance, the Contractor's Health and Safety Manager shall ensure that the following operational details are going to be fully detailed within the project OHSP prior to physical excavation:
  - Respiratory Protection Equipment (RPE) Standard Operating Procedures: Definition of the precise cartridge ratings, filter classification types (e.g., multi-gas/organic vapor cartridges with particulate pre-filters), and maximum usage log life for half-face and full-face respirators deployed whenever Level 2 or Level 3 thresholds are breached.
  - Decontamination Station Design: Engineering layouts, wastewater containment systems, and hygiene sequencing for dedicated worker decontamination units located at the surface perimeter of high-risk shaft heads, ensuring that personnel exposed to petroleum fractions can transition safely without tracking residues into public-facing construction compounds.
  - Occupational Medical Surveillance Framework: Establishment of a formal health tracking protocol managed by a qualified occupational physician, including mandatory baseline medical evaluations prior to subterranean deployment, periodic pulmonary/respiratory clearance checks, and targeted biological exposure monitoring for personnel assigned to high-risk volatile zones.

### 4.3 Specific LNAPL Management Protocol

Given the presence of free-phase Light Non-Aqueous Phase Liquids (LNAPL) identified in baseline investigations within the Station Y-15 excavation basin, specialized operational controls are mandated under the CLAMP to prevent fire/explosion hazards, occupational exposure, and environmental migration:

Field Identification & Screening:

- Visual sheen and olfactory checks shall be performed for every excavator bucket.
- Continuous field gas screening using handheld PIDs (for VOCs) and LEL meters (for combustible hydrocarbon vapors) shall be maintained at the excavation face.

Occupational Health & Safety (OHS):

- Intrinsically safe (explosion-proof) lighting and equipment shall be mandated in LNAPL excavation zones.
- Workers handling LNAPL-saturated materials must wear chemical-resistant coveralls, nitrile gloves, and organic-vapor respiratory protection.
- Mechanical extraction ventilation shall be deployed if PID readings exceed 25 ppm or LEL exceeds 10%.

Free-Phase Liquid Recovery & Dewatering:

- Free LNAPL floating on groundwater in open excavations shall be recovered immediately using surface skimmers, vacuum trucks, and oleophilic absorbent booms.
- Dewatering fluids from LNAPL zones shall pass through an on-site Oil-Water Separator (OWS) before temporary storage in lined tanks. Discharge to municipal sewers or open ground is strictly prohibited.

Spoil Segregation, Stability & Disposal:

- LNAPL-saturated soil is automatically classified as Class C (Hazardous Waste).
- Prior to loading for transport, LNAPL spoil must undergo the Paint Filter Test (EPA 9095B). Free liquids must be stabilized on-site using pozzolanic binders (quicklime or cement) until no liquid drains.
- Stabilized LNAPL spoil shall be stored on dedicated double-lined (1.5mm HDPE) bunded pads, covered with heavy-duty tarpaulins, and transported under a hazardous Waste Passport (Resolution No. 41) to the licensed hazardous cell at WMC LLC in Pirəkəşkül.

## 5. MONITORING AND REPORTING

### 5.1 Monitoring

#### 5.1.1 Entry-Based Monitoring (Pre-Work Checks)

Before starting work in a new face, shaft, or excavation stage:

- Measure PID (VOCs)
- Measure LEL (% explosive gas)
- Measure O<sub>2</sub>, CO, H<sub>2</sub>S (confined space safety)

#### 5.1.2 Continuous / Task-Based Monitoring in Confined Spaces

During:

- TBM advance
- NATM advance
- Enclosed station box excavation
- Dewatering and slurry handling
  - Use:
    - Fixed or portable LEL monitors
    - Portable PID instruments

#### 5.1.3 Post-Construction Residual Groundwater Monitoring

Following the physical completion of civil works and the termination of active construction dewatering at each underground station box, the Project shall transition into a mandatory post-construction environmental verification phase to track potential residual contamination or plume migration:

- **Monitoring Duration and Frequency:** The Contractor (or a designated independent environmental specialist) shall maintain and monitor selected permanent groundwater standpipes at each station layout for a minimum duration of twelve (12) months post-construction. Sampling rounds shall be executed on a strict quarterly baseline.
- **Trigger Value-Based Response Framework:** All analytical groundwater results from the post-construction phase shall be systematically benchmarked against the Tier 3 risk concentrations (US EPA Vapor Intrusion Screening Levels [VISLs] and Industrial Tapwater RSLs as defined in Section 2.3). If any post-construction sampling round flags a verified baseline breach or an active rebound of volatile/hydrocarbon fractions, an intermediate contingency investigation shall be triggered to assess structural barrier integrity, verify localized plume stabilization, or deploy targeted extraction polishing if necessary.
- **Regulatory Close-Out Approval:** Upon the successful completion of the 12-month post-construction monitoring cycle showing stable or declining contaminant trends, a comprehensive Contaminated Land Close-Out Report shall be compiled. This final technical report must be formally submitted to the Ministry of Ecology and Natural Resources (MENR) for official review, endorsement, and final regulatory environmental sign-off of the station boundaries.

### 5.2 Key Performance Indicators (KPIs)

The performance of the Contaminated Land Assessment Management Plan will be monitored through a set of Key Performance Indicators (KPIs). KPI results will be reviewed regularly by the Environmental

Lead and relevant discipline leads and will be used to support corrective actions and periodic review of the CLAMP.

Table 2 summarises the key performance indicators (KPIs) and associated key monitoring actions that can be used to assess the progress and effectiveness of proposed mitigation.

**Table 2: Key Performance Indicators and Monitoring Measures**

| No | Monitoring Area                                         | KPI Description                                                                | Measurement / Record Source                             | Acceptance Criteria                                                  | Monitoring Frequency      | Responsible                            |
|----|---------------------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------|----------------------------------------------------------------------|---------------------------|----------------------------------------|
| 1  | Site Contamination Assessment Report                    | New work areas tested before entry                                             | Assessment reports                                      | 100% tested                                                          | Before excavation         | Contractor's Environmental Lead        |
| 2  | Gas Testing Records                                     | Percentage of completed tests                                                  | Test results                                            | 100% completed                                                       | Daily                     | Contractor's Health and Safety Manager |
| 3  | Unauthorized entry without pre-work atmospheric testing | Number of unauthorized entry                                                   | Work Permit                                             | 0 unauthorized entry                                                 | Daily                     | Contractor's Health and Safety Manager |
| 4  | Gas detection equipment calibrated                      | Percentage of calibrated equipment                                             | Calibration records                                     | %100 completed                                                       | Daily                     | Contractor's Health and Safety Manager |
| 5  | Gas exceedance events                                   | Number of gas exceedance events                                                | Incident records                                        | Corrective action for all gas exceedance events                      | Weekly                    | Contractor's Health and Safety Manager |
| 6  | Occupational exposure                                   | Number of limit exceedance                                                     | Exposure monitoring records                             | Corrective action for all limit exceedance events                    | Weekly                    | Contractor's Health and Safety Manager |
| 7  | Environmental Releases                                  | Uncontrolled release or unauthorized terrestrial dumping of Class B/C material | Incident reports, site inspection logs, waste manifests | Zero (0) confirmed contaminated material releases to the environment | Continuous / Daily Review | Contractor's Environmental Lead        |

| No | Monitoring Area               | KPI Description                                                                     | Measurement / Record Source                          | Acceptance Criteria                                                    | Monitoring Frequency   | Responsible                                                              |
|----|-------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------------------------|------------------------|--------------------------------------------------------------------------|
| 8  | Subterranean Explosion Hazard | Atmospheric gas spikes crossing the Level 3 absolute safety limit during excavation | Continuous TBM / NATM telemetry data and gas loggers | Zero (0) LEL exceedances $\geq 40\%$ during TBM advance or shaft works | Continuous / Real-time | Contractor's Health and Safety Manager                                   |
| 9  | Training                      | Percentage of employee working in contaminated area                                 | Training attendance records                          | 100% trained                                                           | Monthly                | Contractor's Environmental Lead & Contractor's Health and Safety Manager |

### 5.3 Audit & Assurance Process and Record-Keeping

To ensure that the CLAMP remains fully effective and that its objectives are consistently implemented by the workforce and subcontractors, a continuous review and audit mechanism shall be established. During the construction phase, the Contractor shall be responsible for implementing and maintaining this process.

### 5.4 Reporting

- Maintenance of a Contaminated Soil Register including:
  - Location and volume of contaminated excavations;
  - Analytical results;
  - Classification.
- Monthly reporting to the PIU and Engineer summarising findings, incidents and corrective actions.
- In the event that construction activities interface with significant, high-risk contamination anomalies—such as the breaching of an active liquid-phase hydrocarbon plume (LNAPL) or a continuous Level 3 atmospheric or environmental exceedance at shallow depths where a verifiable pathway to the public exists—the following communication protocol shall apply:
  - Internal Escalation First: The Contractor shall not issue direct public notifications, media disclosures, or independent community statements regarding subsurface contamination findings. All chemical and atmospheric data shall be immediately transferred to the Baku Metro PIU and the Supervising Engineer within 24 hours of confirmation.
  - Integration with Project SEP and GRM: Any necessary community notification, risk communication, or safety awareness messaging regarding localized environmental

conditions shall be managed exclusively by the Baku Metro PIU. The disclosure process shall utilize the institutional channels already established under the overarching Project Stakeholder Engagement Plan (SEP) and Grievance Mechanism (GM).

- Public Notification Trigger: If monitoring detects off-site VOC migration or vapor concentrations exceeding the applicable US EPA VISLs near any residential or public building, the Baku Metro PIU shall issue a public safety notice and activate risk communication through the Stakeholder Engagement Plan (SEP) within 24 hours.

## 5.5 Review & Revision of CLAMP

Contractor will regularly update the CLAMP according to the requirements of the changing needs.

The CLAMP will be reviewed at least every 6 months to meet the new requirements. The following information obtained by progress reports, audits & inspections and compliance monitoring activities will provide input for the review process:

- Results of internal/external audits and inspections
- Evaluation of compliance
- Communication / Complaints
- Key performance indicators
- Changing circumstances, legal requirements, organization, environmental aspects and impacts
- Recommendations for improvement
- The revised plan will be approved by Project Management.

## 6. TRAINING

Spoil disposal training requirements shall be identified at the outset (e.g. using a Health Safety and Environment (HSE) Training Matrix), before construction works commence, and the matrix and a training plan will be developed to ensure the preparedness of the Contractor's environmental lead, environmental specialists, H&S specialist and employees. Training shall be delivered by a combination of external training organisations competent in the training topic and internally by the Baku Metro's PIU Environmental Specialist and Health and Safety Specialist and Contractor's Environmental Lead and Health and Safety Manager during the construction.

Training will be used to communicate business continuity and planning to all personnel. An annual training programme will be developed each year. The programme will be realistic to test contaminated land assessment management plan and procedures.

Induction trainings and job / activity-specific trainings shall cover:

- Risks associated with petroleum-contaminated soil and groundwater;
- Use of PPE and respiratory protection;
- Emergency response to vapour exceedances or spills;
- Reporting procedures.

## Appendix A MAC Tables for Soil

| Parameter Group / Heavy Metals | Azerbaijani MAC Threshold (mg/kg dry weight) |
|--------------------------------|----------------------------------------------|
| Arsenic (As)                   | 2                                            |
| Lead (Pb)                      | 32                                           |
| Cadmium (Cd)                   | 0.5                                          |
| Copper (Cu)                    | 33                                           |
| Nickel (Ni)                    | 4                                            |
| Zinc (Zn)                      | 23                                           |
| Total Chromium (Cr)            | 6                                            |
| Mercury (Hg)                   | 2.1                                          |

| Parameter Group / Hydrocarbons     | Azerbaijani MAC Threshold (mg/kg dry weight) |
|------------------------------------|----------------------------------------------|
| Total Petroleum Hydrocarbons (TPH) | 100                                          |
| Benzene                            | 0.3                                          |
| Toluene                            | 0.3                                          |
| Ethylbenzene                       | 0.3                                          |
| Total Xylenes                      | 0.3                                          |

