Almaty International Airport

Environmental and Social Impact Assessment Report - Chapter 9

September 2025

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Mott MacDonald Limited. Registered in
England and Wales no. 1243967.
Registered office: 10 Fleet Place, London
EC4M 7RB, United Kingdom

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	12/08/2025	MH/TW	DG/BG	KD/BM	Draft report
B	05/09/2025	DG	KD	BM	Updated report following external comments

Document reference: 100124651 | ESIA Report Chapter 9 | B

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Contents

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Acronyms and abbreviations

Abbreviation / Acronym	Definition
ACMs	Asbestos-containing materials
ALA	Almaty International Airport
BGL	Below Ground Level
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
C-ESMP	Construction Environmental and Social Management Plan
CSM	Conceptual Site Model
DEM	Digital Elevation Model
DBE	Design Basis Earthquake
DIV	Dutch Intervention Values
DSHA	Deterministic Seismic Hazard Assessment
ESIA	Environmental and Social Impact Assessment
FFF	Fire Fighting Foam
GEM	Global Earthquake Model
GSZ	General Seismic Zoning
MCE	Maximum Considered Earthquake
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PFAS	Per and polyfluoroalkyl substances
PGA	Peak Ground Acceleration
PSHA	Probabilistic Hazard Assessment
SMZ	Seismic Microzoning
TPH	Total Petroleum Hydrocarbons
UST	Underground Storage Tank
ZAF	Zailisky Alatau Fault

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9 Geology and soils

9.1 Introduction

9.1.1 This chapter of the Environmental and Social Impact Assessment (ESIA) reports the findings of an assessment of the likely significant environmental effects on geology and soils as a result of the Project.

9.1.2 The geology and soils topic comprises several sub-topics, namely: geology as resource (e.g. for minerals); soils as a resource; and also the potential for effects associated with land contamination that may arise through the disturbance of contaminants contained in the subsurface. Additionally, the consideration of seismicity and other natural ground hazards has also been included.

9.1.3 The site is currently an operational airport with only very limited soil resources present. The remainder of the site comprises hardstanding or buildings at surface. Soils when viewed as a resource are therefore scoped out of the assessment.

9.1.4 Similarly, the geology underlying the airport site has no particular designation under Kazakh legislation and the Project sits entirely within the existing airport boundary. Geology and associated minerals resources are therefore also scoped out.

9.1.5 Given the potential for contamination to have occurred due to the site's history as an airport including its former military airport usage, the effects associated with land contamination[1] have been assessed for the construction phase. Given the de-icing pad and the fuel farm activities, operational stage effects are also assessed.

9.1.6 Additionally, given the geological setting, the potential for seismic and other natural ground hazards has also been assessed.

9.1.7 An assessment of likely significant effects has been undertaken for each of the sensitive receptors identified in the study area. Where necessary, commitments to mitigation measures have been made to manage any impacts on receptors.

9.2 Methodology

Applicable guidelines and standards

9.2.1 The assessment has been undertaken considering relevant legislation, standards, and guidance as mentioned in **ESIA Chapter 3: Policy, legal and institutional framework**.

Area of Influence

9.2.2 The area of influence for geology and soils considers the area of the Project (i.e. where ground break will occur) and 250m beyond in the assessment of receptors. However, contamination sources up to 1km from the Project will be included in the assessment, where considered to be a significant contamination source, that could have an impact on onsite receptors (for instance through the migration of impacted groundwater).

[1] The terms land quality and land contamination have been used interchangeably in this report. Both relate to the presence of contamination in the subsurface that may exist in soils, water or gaseous phases.

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Methodological approach

9.2.3 This section of the chapter presents the methodology applied to the assessment of likely significant effects.

9.2.4 The methodology for assessing land contamination effects is two-fold. Firstly, the assessment is based upon the development of a conceptual site model (CSM) which looks at potential contamination sources, contaminant transport pathways, and the presence of sensitive receptors.

9.2.5 The second step is to assess the likely impacts that will occur during the construction and operational stages. This is undertaken by assessing potential changes in risks at two points; the first point comprises the beginning of construction during which the majority of ground disturbance will occur (e.g. demolition and foundation installation) and the second point considers the Project during the operational phase. The purpose of the split in this assessment is to differentiate between the temporary and permanent effects of the construction and operation of the Project.

9.2.6 The significance of effects of contamination will be assessed using the general methodology as outlined in Section 4.7 of **ESIA Chapter 4: ESIA scope and methodology**. It should be noted that the assessment of likely significant effects specifically excludes asbestos and radiological contamination.

Desk based Review

9.2.7 A review of desk based information was completed as part of the ESIA. These are derived from available information from both national and international sources and previous reports which cover the Project area as follows:

- Country Profile – Kazakhstan[2]
- Water Resources – Main river basins of Kazakhstan[3]
- Almaty International Airport Scoping Review Summary Report[4]
- Environmental & Social Due Diligence Assessment - Project Apple: Almaty International Airport[5]
- Environmental and Social Action Plan - Project Apple: Almaty International Airport[6]

9.2.8 As part of the 'Seismicity and natural hazards' review, several scientific papers have also been researched and information compiled to outline the hazards present and the proposed mitigation methods. The sources for the review have been included in the relevant seismic review section. It should be noted that a site-specific seismic hazard report has not been produced or obtained at this stage.

Limitations and assumptions

9.2.9 This section outlines all assumptions that have been made in this chapter as well as limitations of this study.

9.2.10 The available data on ground conditions (inclusive of soil and groundwater quality) are limited at the time of writing this chapter. This is due to the limited spatial coverage of existing ground

[2] Food and agriculture Organisation of the United Nations, 2012

[3] UN Development Programme Kazakhstan

[4] Almaty International Airport Scoping Review Summary Report, Mott MacDonald, 2025

[5] Environmental & Social Due Diligence Assessment - Project Apple: Almaty International Airport. Waterman, 2020a

[6] Environmental and Social Action Plan - Project Apple: Almaty International Airport. Waterman, 2020b

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investigations when compared to the Project. Furthermore, the range of analyses completed thus far do not currently cover all known potential onsite contamination sources. Similarly, there is no ground gas data available for the site at the time of writing this chapter.

9.2.11 Data gaps present are to be addressed during the preconstruction and construction phase through continuation of the existing groundwater monitoring and further ground investigation to cover the Project and improve understanding of soil and groundwater conditions present at the site. This forms part of the embedded mitigation as identified in Section 9.6.

9.2.12 Any risks associated with asbestos, toxic mould, or radiological contaminants are not assessed. Specialist advice should be sought from a suitably qualified contractor(s) with respect to risks from asbestos, where identified.

9.3 Baseline

Current baseline

Site description relevant to geology and soils

9.3.1 Almaty International Airport (ALA) is located on the north-eastern outskirts of Almaty. The area to the south of the airport is predominantly residential; the area to the west is mixed commercial and residential; and the area to the north and east are predominantly agricultural.

9.3.2 The Project comprises the following components:

- **Full depth reconstruction of main runway:** This area comprises the existing main runway of ALA (05L-23R), which is currently used as a taxiway due to deterioration. Soft landscaped areas are currently present in addition to hardstanding of the runway itself. In the surrounding area to the south are residential properties.
- **New taxiway:** The area of the new taxiway is currently a soft landscaped area. Approximately to the centre of the newly proposed taxiway is a fire station. Within the footprint are also roadways connecting into the main runway.
- **Fuel farm storage expansion and improvements to existing fuel farm:** An existing fuel farm is situated here with 13 tanks present and in use for storage of aviation fuel. The land comprises areas of hardstanding.
- **Full depth reconstruction of existing VIP apron:** The land comprises the existing VIP apron. To the east and south are areas of soft landscaping. Further west offsite are residential areas.
- **Aerodrome and ground handling village:** This component comprises predominantly hardstanding and a number of buildings. The permitter comprises areas of soft landscaping. To the north-east is the existing fuel farm.
- **Domestic terminal renovation:** This component is located directly north of the VIP apron and directly west of one of the parking rehabilitation areas. The site comprises the existing domestic terminal building.
- **New de-icing pad:** A de-icing pad is proposed to the east of the domestic terminal. It currently comprises predominantly soft landscaping in the south and to the west it comprises hardstanding.
- **New landside and airside warehouses:** This component is situated to north of the rehabilitation parking area and west of the aerodrome and ground handling village. It comprises an existing area of hardstanding with warehouses present.
- **Rehabilitation of parking stands:** This comprises four land parcels of existing parking stands, that are proposed to be rehabilitated. All areas comprise hardstanding.

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- **New head office and training centre:** The component is situated to the west of the airport and is just east of existing commercial properties. The land comprises hardstanding.
- **New in-flight catering facility:** This component currently houses unspecified buildings with a vertical storage tank. The site appears to be mainly hardstanding with a treeline forming the site perimeter.

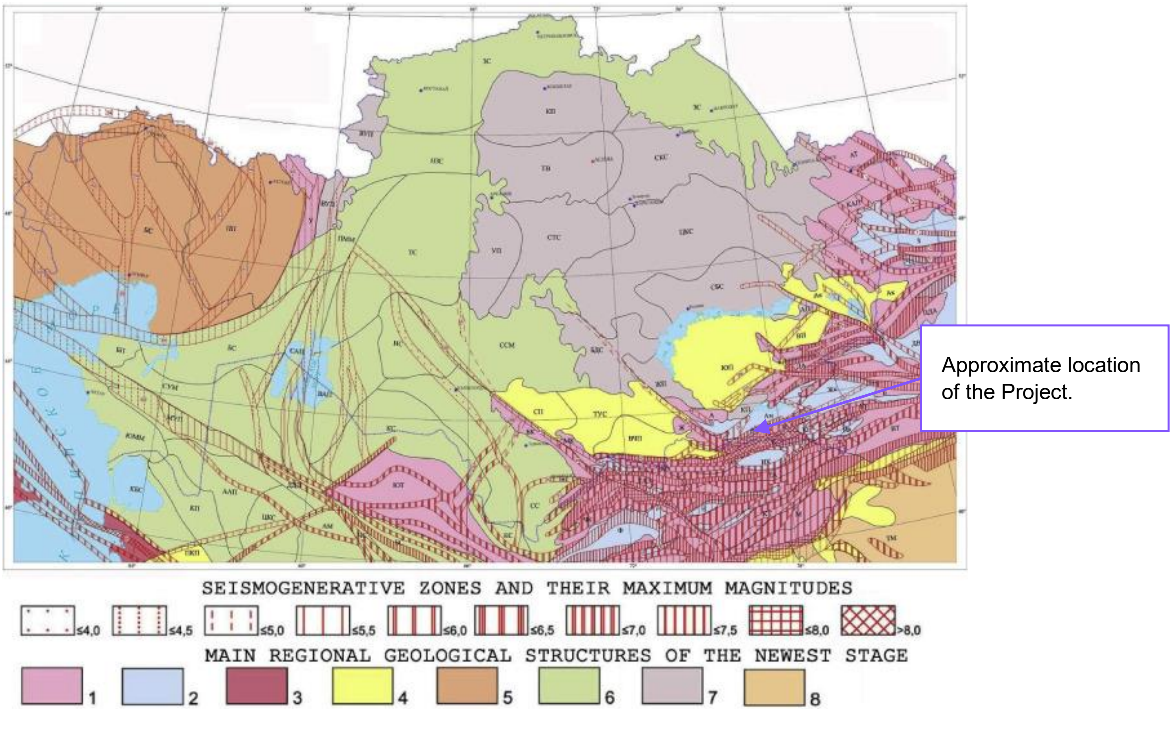
Seismicity and natural hazards

Regional and local seismic context and faulting

9.3.3 The Project lies at the foot of Zailisky Alatau (or Ile Alatau), the northernmost mountain range of the Tian Shan, an east-west orientated mountain belt formed via the collision of the Eurasian and Indian continental tectonic plates in the Cenozoic. This region is known for its seismic activity and history of powerful earthquakes, and accounts for approximately 12mm per year^{-1} of the north-south orientated crustal shortening (Zubovich et al, 2010)[7].

9.3.4 From Figure 9.1 and Figure 9.2, it is clear that the most active and potential for the highest magnitude earthquakes are the south-eastern areas of Kazakhstan, including Almaty and the Project.

Figure 9.1: Map of seismogenerative zones of Kazakhstan



Source: Silacheva et al (2017)[8]

[7] Zubovich, A. & Wang, Xiao-qiang & Scherba, Yuri & Schelochkov, Gennady & Reilinger, Robert & Reigber, Christoph & Mosienko, Olga & Molnar, Peter & Michajljow, Wasili & Makarov, Vladimir & Li, Jie & Kuzikov, Sergey. (2010). GPS velocity field for the Tien Shan and surrounding regions.

[8] Silacheva, Natalya & Kulbayeva, U.K. & Kravchenko, N.A.(2017). Probabilistic seismic hazard assessment of Kazakhstan and Almaty city in peak ground accelerations.

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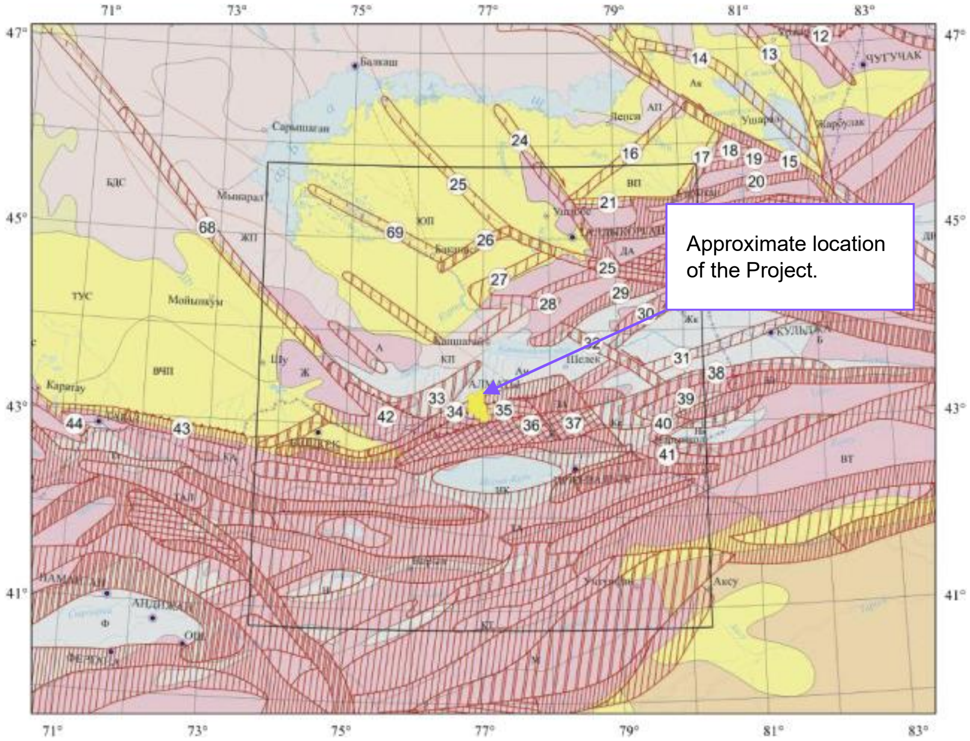
Figure 9.2: Clipping of map of seismogenerative zones around Almaty



Source: Silacheva et al (2017)[8]

9.3.5 Figure 9.3 identifies several major faults associated with the Tien Shan mountain belt to the immediate south of Almaty and the Project. The movements are generally categorised as reverse mechanisms, however, there have been some strike-slip movements too. Grützner et al (2017)[9] outlines the evidence for active faulting along the Zailisky northern flank and found fault scarps of 2 to >20m height along the Zailisky rangefront East of Almaty, suggesting the faults have been active and ruptured to the surface since the Last Glacial Maximum. Grützner et al (2017)[9] further speculate that the reasons for the lack of published evidence of faulting and seismic activity during the Holocene include:

- The Zailisky rangefront has been seismically inactive during or before the Holocene with deformation undergoing elsewhere.
- The Zailisky rangefront is seismically active, however there are large periods of inactivity between events and therefore any morphological evidence of activity has been eroded or deposited over.

[9] Grützner, Christoph & Walker, Richard & Abdrakhmatov, K. & Mukambayev, Aidyn & Elliott, Austin & Elliott, John. (2017). Active Tectonics Around Almaty and along the Zailisky Alatau Rangefront.

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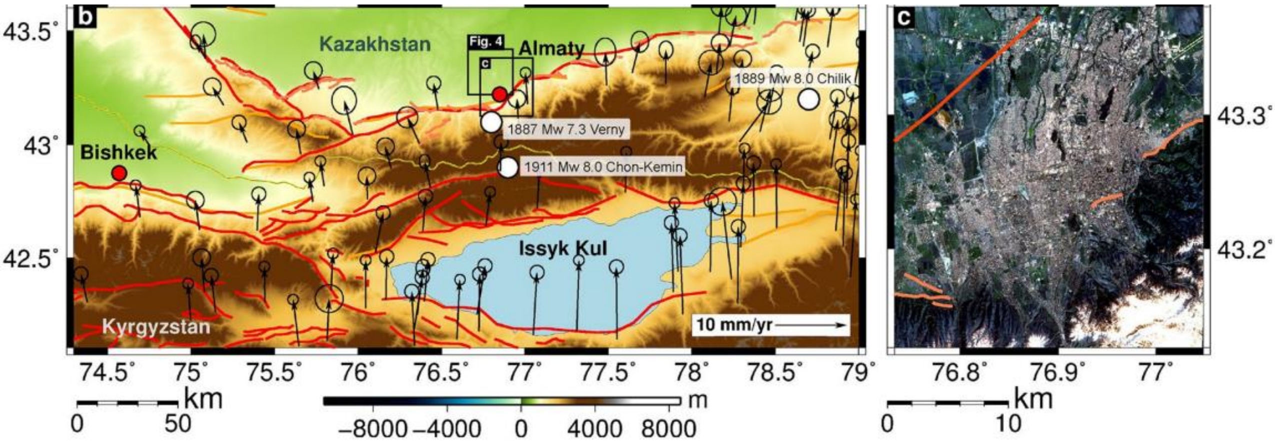
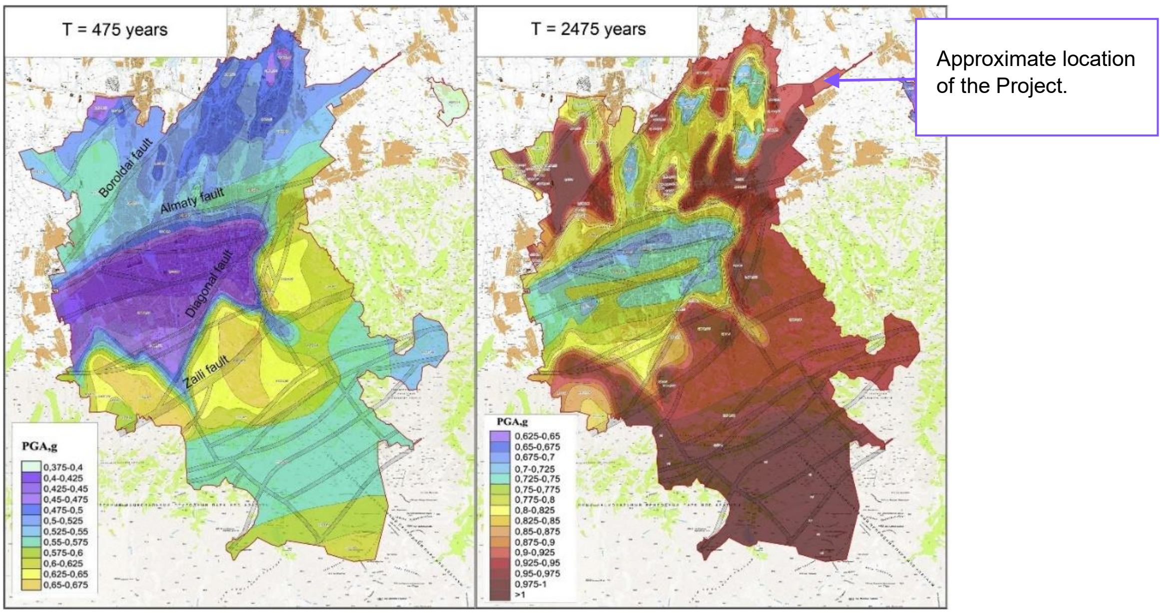
Figure 9.3: Tectonic setting of Almaty – showing faulting at a regional scale and at a local scale.



Source: Amey et al (2019)[10] Figure B - Tectonic setting of Almaty in the northern Tien Shan – Active faults from Mohadjer et al. (2016) shown in red and Grützner et al. (2017) in light orange (Amey et al, 2021)
Figure C – Faults identified within the city of Almaty – RGB Landsat image (2017) of the city of Almaty, active faults in light orange from Grützner et al. (2017)[9] and fault to the north of Almaty (mapped by Amey et al 2019) shown in dark orange.

9.3.6 The most active fault zone is the Zailisky Alatau Fault a right lateral strike-slip fault, which is associated historically with significant tectonic deformation and high seismic activity. Earthquake depths are typically between 15km to 30km depth (Grützner et al, 2017) [9]. There is a risk of minor faults splaying/branching off the major recorded faults which have since been 'buried' via the expansion of the city, uncategorised or unrecorded.

Figure 9.4: Seismic microzonation map given in terms of Peak Ground Acceleration (PGA) (g) and accounting for soil categories by seismic properties, and geotechnical zoning



[10] Amey, Ruth & Elliott, John & Hussain, Ekbal & Walker, Richard & Pagani, Marco & Silva, Vitor & Abdrakhmatov, K. & Watson, C. Scott. (2021). Significant Seismic Risk Potential From Buried Faults Beneath Almaty City, Kazakhstan, Revealed From High‐Resolution Satellite DEMs. Earth and Space Science.

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Source: Silacheva et al (2019) [11] The grey 'stripes' indicate main tectonic faults.

9.3.7 Figure 9.4 illustrates the recorded fault regime within Almaty, which identifies that the 'Almaty Fault' is the closest fault in proximity to the Project. Note however that the source of information for the placement/mapping of the faults in the city has not been provided, and in the absence of access to geological mapping, it is difficult to corroborate or validate the placement of these features.

9.3.8 Due to the expansion of Almaty city, there is a risk of the presence of 'buried' faults, the surface traces of which have been hidden by the development of the city. This makes it difficult to characterise the hazards present and subsequently affects the emergency planning procedures and any design elements on major infrastructure such as further development of the airport. This risk of 'burying' morphological features is applicable to the Project and its associated expansion works.

9.3.9 Amey et al (2019)[12] have utilised Digital Elevation Models (DEMs) to identify the presence of any topographic scarps of recent ruptures within the city. They further model a series of hypothetical scenarios (utilising the OpenQuake Engine) to assess the damage and loss to the city, based upon previous earthquakes, utilising the faults identified during the digital modelling exercise. Building upon previous studies by Grützner et al (2017)[9], a fault splay beneath the city has been identified, as well as a fault propagated fold to the immediate north of the city (dipping to the south beneath the city). Based on the models produced, the most damaging scenario would be an earthquake (modelling using a M_w 6.5) generated along the fault splay to the north of the city.

Historical earthquake data

9.3.10 The Project lies within the most seismically active region of Kazakhstan, and as such has been affected by some of the strongest earthquakes generated along the Tian Shan Mountain belt. Available historical records show that several large and destructive earthquakes have occurred in the area: including the following notable events:

- 1887 – Verny M_w 7.3 – epicentre was only a few kilometres west of the city centre. Precise location is unknown as the earthquake event pre-dated instrumentation monitoring, and no surface ruptures were recorded (blind thrust fault). It is understood that the earthquake generated many landslides (Grützner et al, 2017)[9].
- 1889 – Chilik M_w 8.0 to 8.3 – epicentre was located approximately 100km to the south-east of Almaty and generated approximately 175km of surface ruptures and up to 10m of surface slip (Abdrakhmatov et al, 2016)[13].
- 1911 – Kemin M_S – 8.2 – epicentre was located on the southern slope of the Zailisky Alatau and included up to approximately 200km of surface ruptures and more than 10m slip.

[11] Silacheva, Natalya & Kulbayeva, U.K. & Kravchenko, N.A. (2019). On the realization of seismic microzonation of Almaty (Kazakhstan) in ground accelerations based on the "continual" approach.

[12] Amey, Ruth & Elliott, John & Hussain, Ekbal & Walker, Richard & Pagani, Marco & Silva, Vitor & Abdrakhmatov, K. & Watson, C. Scott. (2021). Significant Seismic Risk Potential From Buried Faults Beneath Almaty City, Kazakhstan, Revealed From High‐Resolution Satellite DEMs. Earth and Space Science.

[13] Abdrakhmatov, K. & Walker, Richard & Campbell, Grace & Carr, Andrew & Elliott, A. & Hillemann, C. & Hollingsworth, James & Landgraf, A. & Mackenzie, David & Mukambayev, Aidyn & Rizza, Magali & Sloan, R.A.. (2016). Multi-segment rupture in the July 11th 1889 Chilik earthquake (M w 8.0-8.3), Kazakh Tien Shan, interpreted from remote-sensing, field survey, and palaeoseismic trenching: The Mw 8.0-8.3 Chilik earthquake.

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Seismic microzoning of Almaty

9.3.11 Kazakhstan's original building code for seismic design adhered to a deterministic approach/methodology only (Deterministic Seismic Hazard Assessment – DHSA). However, the procedure of Probabilistic Hazard Assessment (PSHA) has since been adopted to demonstrate compliance with Eurocode 8 requirements and has culminated in the generation of a series of 'probabilistic maps' which have been introduced into the Building Regulations 'Construction in Seismic Zones of the Republic of Kazakhstan' (Silacheva et al, 2019)[11].

9.3.12 Using this procedure as a basis, several probabilistic maps have been generated for General Seismic Zoning (GSZ) and Seismic Microzoning (SMZ). The main difference between the deterministic and probabilistic procedures is that the PSHAs are aligned with the seismic design principles outlined in Eurocode 8 standards and also express these in terms of seismic intensity as well as quantitative engineering parameters (Peak Ground Acceleration [PGA]).

9.3.13 PGA is defined as the maximum ground acceleration recorded during an earthquake at a specific location and is typically measured in units of 'g' (gravitational acceleration).

9.3.14 The Design Basis Earthquake (DBE) corresponds to a seismic event with a 10% probability of exceedance in 50 years, equivalent to a 475-year return period. This level of ground motion is typically used for the design of ordinary structures and aligns with the "significant damage" limit state. Alternatively, the Maximum Considered Earthquake (MCE), represents a more extreme scenario with a 2% probability of exceedance in 50 years, or a 2475-year return period. This is associated with the "near collapse" limit state and is used to evaluate the performance of critical infrastructure under rare but severe seismic loading. These return periods are consistent with international seismic design standards, including Eurocode 8, and form the basis for defining seismic actions in both probabilistic hazard assessments and performance-based engineering.

9.3.15 Probabilistic maps of GSZ and SMZ of Almaty city have been generated by Silacheva et al and are presented in Figure 9.4 to Figure 9.8.

9.3.16 The GSZ maps produced comprise a set of five maps, including:

- Map of PGA for practical use (Figure 9.7 and Figure 9.8);
- Probabilistic Maps of SMZ in terms of macroseismic intensity for two probabilities of exceedance (10% and 2 % in 50 years) (Figure 9.5 and Figure 9.6);
- Map of soil categories by seismic properties (factored in to Figure 9.4) and;
- Map of geotechnical zoning (factored in to Figure 9.4)

9.3.17 An additional set of maps have been produced including a map of V_s30 for Almaty (shear wave velocity in the top 30m), a map of average intensity increments, as well as seismic hazard maps for varying site conditions.

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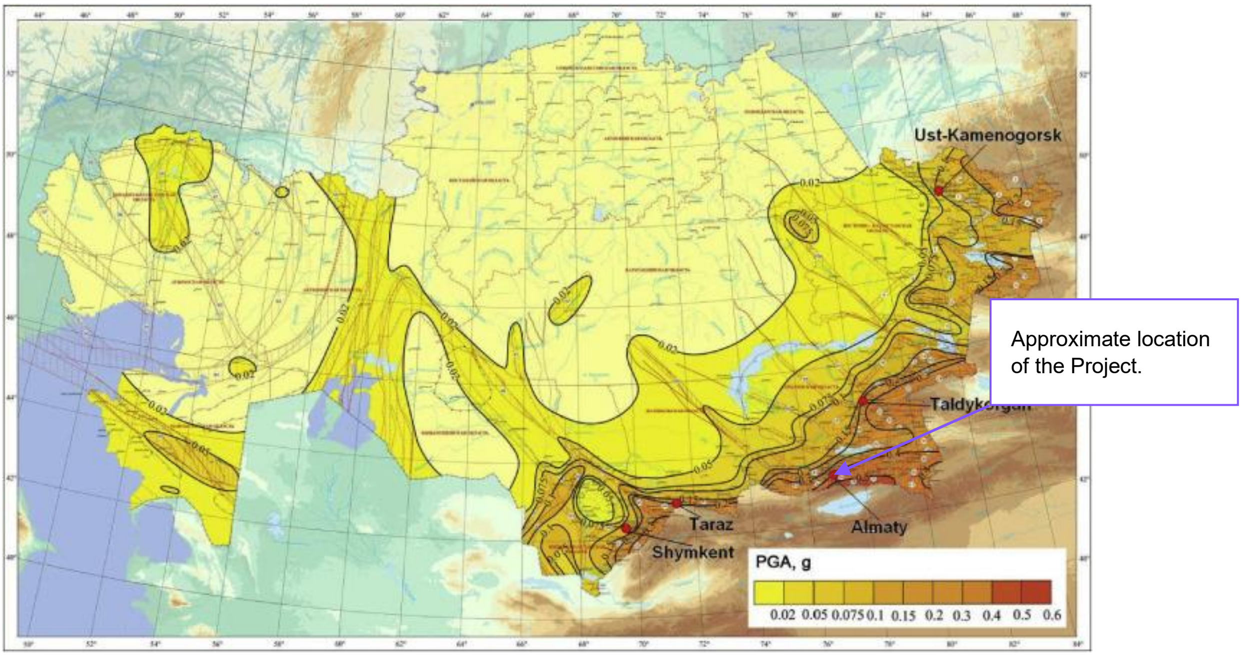
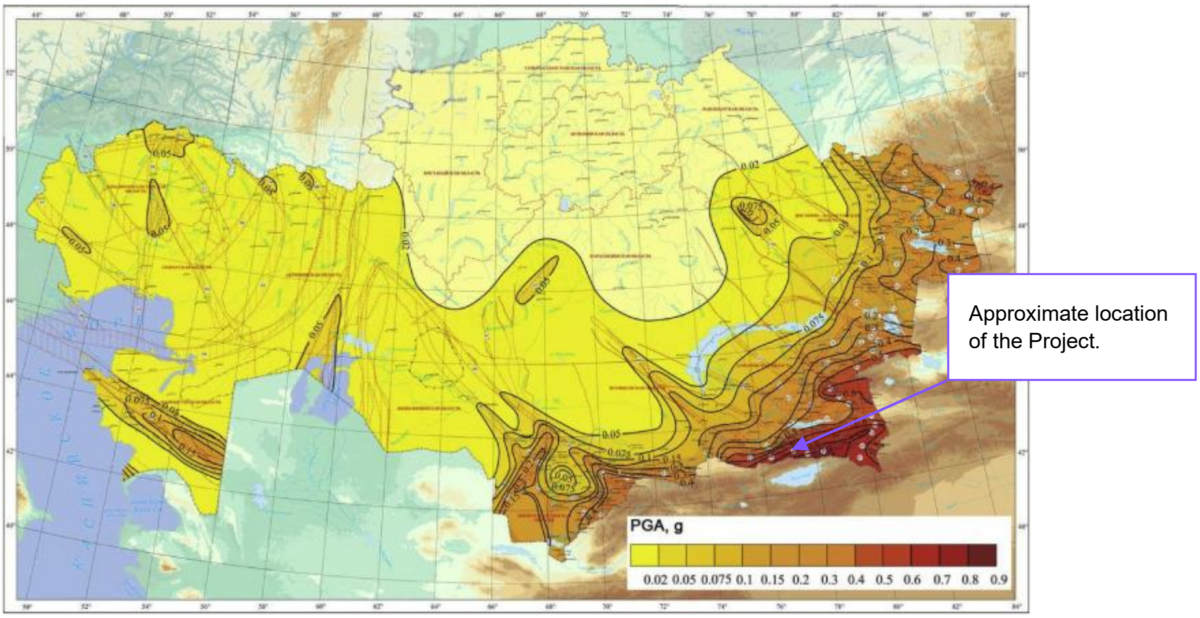
Figure 9.5: General seismic zoning map of the territory of Kazakhstan in PGA for probability of exceeding 10% during 50 years (return period 475 years)



Source: Silacheva et al (2017)[8]

Figure 9.6: General seismic zoning map of the territory of Kazakhstan in PGA for probability of exceeding 2% during 50 years (return period 2475 years)



Source: Silacheva et al (2017)[8]

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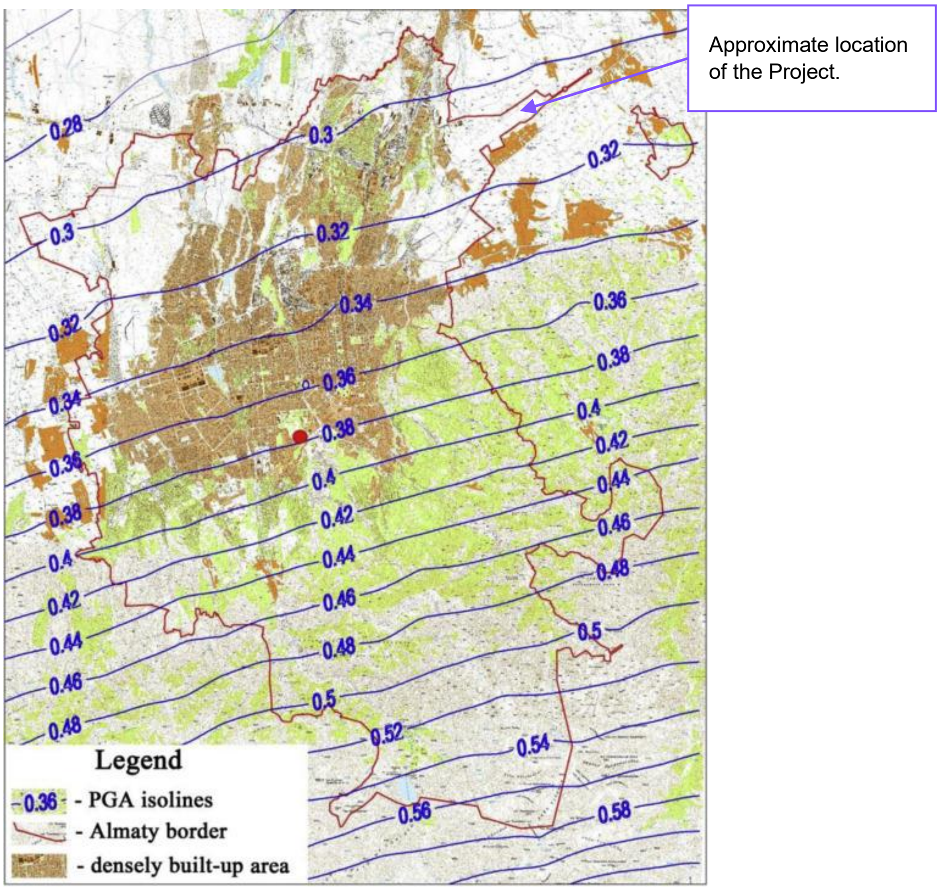
Figure 9.7: The Seismic Hazard Maps of the territory of Almaty city for probability of exceedance 10% in 50 years in PGA (recurrence period of 475 years)



Source: Silacheva et al (2017)[8]

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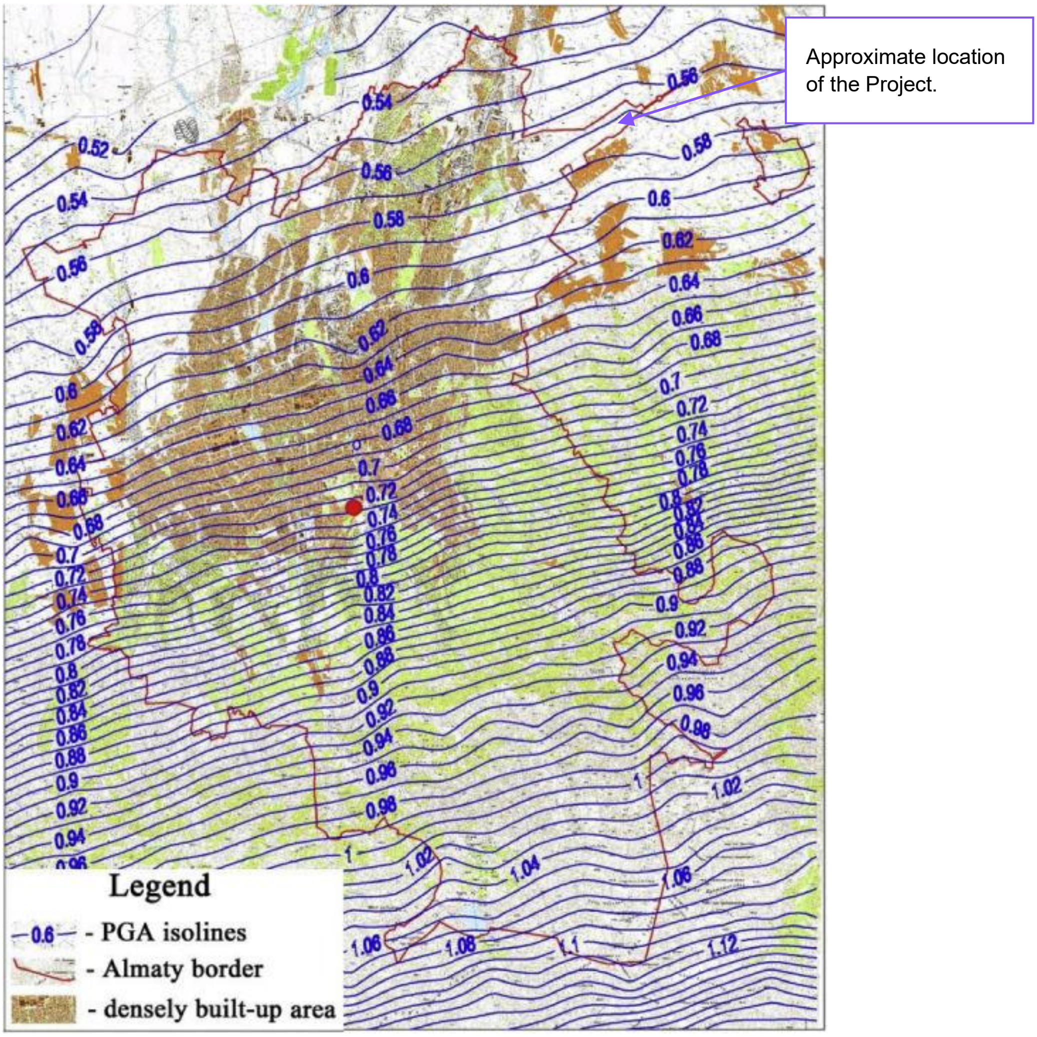
Figure 9.8: The Seismic Hazard Maps of the territory of Almaty city for probability of exceedance 2% in 50 years in PGA (recurrence period of 2475 years)



Source: Silacheva et al (2017)[8]

9.3.18 It is clear from the published studies that the maximum PGA values are concentrated within the area to the south-east of Kazakhstan, corresponding to the most seismically active regions, the ‘Kemin’ and the ‘North-Kungey’ seismogenic zones.

9.3.19 Table 9.1 lists the published PGA (g) values for either Almaty (on larger scale seismic hazard maps – GSZ) or, where possible, the Project (local seismic hazard maps – SMZ and OpenQuake).

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Table 9.1: Summary of PGA values in g recorded across different sources of literature or databases

	Source of Information			
PGA (g) Exceedance Criteria	**OpenQuake Map (2023 – accessed 2025)[14]**	**Silacheva et al (2017)[8]** **GSZ for Kazakhstan, accounting for rock and soil behaving similar to rock**	**Silacheva et al (2017)[8]** **SMZ accounting for the mean values of the geometric mean PGA for rock and soils behaving similar to rock grounds was carried out within the territory**	**Silacheva et al (2019)[11]** **Utilises the SMZ for Almaty, corrected by accounting for the Map of Soil Categories by Seismic Properties and the Map of Geotechnical Zoning**
	Figure in Report			
	N/A	Figure 9.5 & Figure 9.6	Figure 9.7 & Figure 9.8	Figure 9.4
PGA (g) exceeding 10% during 50 years (return period 475 years)	0.35	0.4	0.31	0.5 to 0.55
PGA (g) exceeding 2% during 50 years (return period 2475 years)	Not readily available through OpenQuake	0.7	0.57	0.9 to 0.95

9.3.20 In summary the available studies quantifying the seismic microzoning of Almaty indicate a significant spatial variability in ground shaking potential across Almaty, driven by several factors including the heterogeneous subsurface conditions, and proximity to faults. The variation is values of PGA are due to the source information being incorporated into the study. The most recent study (Silacheva et al, 2019)[11] utilises the seismic properties of the soil (affecting the shear velocity), and the geotechnical zoning research – which has produced the higher PGA values, however these may not be the most conservative estimates – Figure 9.4. The seismic microzonation maps differ from the background seismic hazard maps, which assume a uniform Vs_{30} = 800 m/s across the city. In addition from all the studies it is clear that the airport lies in an area of high seismic activity and the seismic hazard can be considered as high.

9.3.21 It is also worth noting that since the original seismic microzoning of Almaty was undertaken, the city limits are estimated to have doubled in size (Silacheva et al, 2017)[8] and thus the exposure and consequence of seismic events will have been altered.

Susceptibility to liquefaction and landslides

9.3.22 The Project site is built on an alluvial fan, within a deep sedimentary basin which is indicated to comprise saturated heterogeneous loose soft deposits, including pebbles, sandy loam, and loam. The nature of the subsoils beneath the Project will have an impact of the shear wave

[14] V. Silva, A. Calderon, M. Caruso, C. Costa, J. Dabbeek, M.C. Hoyos, Z. Karimzadeh, L. Martins, N. Paul, A. Rao, M. Simionato, C. Yepes-Estrada, H. Crowley, K. Jaiswal (2023). Global Earthquake Model (GEM) Seismic Risk Map (version 2023.1)

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velocity (V_s) of the ground, and this inherent variation in composition can lead to difficulties when predicting how the ground will behave during seismic events.

9.3.23 As discussed in Section 9.3.39 to 9.3.46', relatively shallow groundwater is anticipated to be present beneath the Project area of influence. During earthquake events, the violent shaking can cause rapid increases in pore water pressure, which in turn causes a sudden loss in shear strength of the surrounding soils. This in turn can induce significant settlements of overlying structures, and ground deformation.

9.3.24 Given the anticipated loose, and saturated deposits beneath the area of influence of the Project, there is a risk of a moderate to high liquefaction potential, and as such a detailed liquefaction potential assessment should be undertaken prior to construction works.

9.3.25 Additionally, the city's proximity to steep mountainous terrain increases the risk of being impacted by earthquake-induced landslides, which could disrupt access routes and critical services. Given these compounded geohazards, a detailed liquefaction assessment and slope stability analysis are essential prior to construction, alongside the implementation of ground improvement and seismic-resilient design measures.

Geology, hydrogeology and hydrology

Geology

9.3.26 The site is located in the foothill plain of Zailiysky Alatau, the Northern Tien Shan geomorphological region of Central Asia [15](Karatai Geoservice, 2020). The Project is expected to be underlain by a cover of made ground as part of the existing airport apron and construction materials associated with the existing buildings. Some small areas of soft landscaping are also present which include some limited amounts of topsoil.

9.3.27 The underlying geology is reported by Waterman (2020) in the 2022 ESIA. The report states the underlying geology to comprise Quaternary age alluvial deposits which variably comprise loams, sandy loams, quartz-feldspar sands of various sizes and pebble (gravelly) soils.

Hydrogeology

9.3.28 The underling soils are likely to contain useable groundwater resources (aquifers). However, there is no specific published mapping or designations relating to the presence or type of aquifers in the area.

9.3.29 There are groundwater wells on site which have been used for firefighting operations in the past. Currently no abstraction from these groundwater sources takes place, and it is understood that there is no permit in place for groundwater abstraction from the site.

9.3.30 It is understood that abstraction of groundwater by private companies takes place within the region, however, with water sourced from a confined aquifer at a depth of approximately 220m. The location of this abstraction is unknown. This was reported in the 2022 ESIA[16].

Hydrology

9.3.31 For further information on hydrology and existing site drainage reference should be made to **ESIA Chapter 14: Water resources**.

[15] Karatai Geoservice (2020), Geotechnical assessment of the airport.

[16] Mott MaDonald (2022), Almaty Airport Expansion, Environmental and Social Impact Assessment Report 100100464- 001- Rev E, dated January 2022.

Site history

9.3.32 Previous reporting for the site (Waterman, 2020a[17]) identifies the airport had a previous military use (and it is understood that this use is ongoing) and a use for aircraft maintenance. Based on current and historical lands uses, there is potential for contamination associated with site operations and maintenance activities on and in the vicinity of the site (for instance deposition of metals, degreasers/solvents, fuel and other volatile organic compounds).

9.3.33 According to information provided by ALA in the preparation of this ESIA (‘*Initial Incident Report*’, dated April 2024), a minor aviation fuel spill occurred at the site, during unloading operations on a railway overpass. The spillage quantity was not reported and is stated to have spilt to ground (it is unclear if this was to a soft landscaped area or to an area of hardstanding). No other incident reports or records were provided at the time of writing this report.

9.3.34 A fire system audit was undertaken in 2024[18] which outlines the use of fire fighting foams (FFF) at the fuel depot. FFF can contain per and polyfluoroalkyl substances (PFAS) which are a group of contaminants with increased regulatory scrutiny worldwide due to their persistent and toxic nature.

9.3.35 The report identifies that the total foam concentrate storage capacity is 30m^3 and that foam concentrate is currently stored in a single 5m^3 horizontal bladder tank. The report identifies that the depot makes use of a foam concentrate that does not contain fluorinated surfactants.

9.3.36 According to information provided by ALA during the preparation of this ESIA, an audit report from June 2025, documents the available FFF concentrate stored at the airport. It documents foam concentrate (kg) stored at three rescue stations on site, within reserve trucks and at a warehouse. The total amount of foam concentrate stored onsite amounts to 13,600kg. No formal records have been provided to identify the exact locations of the storage areas (except for the fuel farm covered previously) or of incident reports following use of FFF onsite. However, limited information from ALA stated there was an accident ‘*at take-off from RWY05R approx.800m after THR23L and 110m to the right side’.* Whilst the exact location is not known (however presumably on the existing runway), this may have been a likely location for use of FFF derived from the foam concentrate. Whilst the composition of the concentrate is unknown, it is likely that the FFF to have comprised of PFAS historically. The use of FFF containing PFAS is considered a potential contamination source.

9.3.37 There are existing hazardous waste storage facilities on site. A report provides pictures of these locations and identifies the following types of hazardous waste storage:

- Used oil barrels stored partially on hardstanding and partially of soft landscaped areas.
- Used batteries stored on hardstanding.
- Used filters and contaminated soil near the maintenance area (exact location unknown), which is stored within an outbuilding. Immediately in front of the outbuilding is soft landscaping. Another area is also identified to store the same materials, however is located on a hardstanding area.
- An underground storage tank (UST) is shown and is identified to be used for hydrocarbon waste storage in the gasoline station. The UST appears to be surrounded by concrete, with areas adjacent identified as soft landscaping.
- An oil trap is identified for emergency spills in the aviation fuel farm. The surrounding area is soft landscaped.

[17] Waterman, (2020), Environmental and Social Due Diligence Assessment, Almaty Airport.
[18] Almaty international Airport, Fire System Audit, October 2024, Revision C.

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- Areas for waste painting works (solidified paint) stored within a metal enclosure and an area used for storage of used lamps within a hardstanding area are also shown.

9.3.38 As of the time of reporting, no contamination mapping data has been made available by ALA to identify historical land uses or potential sources of contamination at the site.

9.3.39 No historical maps are available for the site.

Environmental designation/permits

9.3.40 No information surrounding any environmental permits relevant to soil quality or geological designations are noted to be relevant. It is, however, noted clause 6 and clause 8 of article 186 of the Environment Code of the Republic of Kazakhstan, impact monitoring is obligatory after emergency emissions into the environment.

Site ground investigation

9.3.41 Table 9.2 provides a summary of the available ground investigation that has been made available for this chapter. It is noted that there is currently limited soil geo-environmental testing available, which covers the fuel farm area and one location adjacent to the new taxiway. No groundwater analysis is currently available.

Karatai Geoservices ground investigation, 2020

9.3.42 A ground investigation was undertaken by Karatai Geoservices at ALA for the purpose of gaining geotechnical information at the location of the VIP terminal and Mechanical engineering buildings in February 2020.

9.3.43 The investigation comprised 43 boreholes to between 10m and 5m below ground level (bgl).

Table 9.2: Summary of encountered geology

Strata number	Description	Thickness (m)
1	Made Ground – Surfacing of asphalt, gravel, pebbles, clay and stone	0.50 to 0.70
2	Bulk soil – stiff and firm to stiff yellow grey organic clay	0.30 to 2.60
2a	Bulk soil – sandy cobbles with boulders	1.30 to 2.30
3	Stiff and firm to stiff yellow grey organic clay	0.80 to 2.90
4	Soft to firm yellow grey with layers of coarse sand and inclusion of carbonates. Ferruginous.	8.70 to 10.70
5	Firm to stiff yellow grey organic clay with inclusions of carbonates and coarse sand layers.	0.90 to 1.90
6	Coarse sand with inclusions of gravel and pebbles up to 20%	>1.70 (unproven)

9.3.44 Groundwater was struck in each borehole at depths ranging between 3.3 and 5.8m. Standing water levels in the boreholes during the fieldwork period was generally within 0.5m of the recorded strike.

9.3.45 The ground water level at the site was recorded at 2.8-4.1 meters below ground level. No inference of groundwater flow direction can be made from the ground investigation data.

9.3.46 No permanent water level monitoring points were installed as part of the investigation.

9.3.47 No soil or groundwater contamination analyses were undertaken, although soils and water were tested for the presence of sulphate and chloride, as these substances may pose a potential risk to building materials through chemical attack.

9.3.48 The presence of contaminants (e.g. hydrocarbon odours or visual oils) was not noted as part of the ground investigation.

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Soil and Groundwater Sampling and analysis – Fuel farm and New Taxiway, 2025

9.3.49 Nine soil samples were collected from the existing fuel farm and adjacent to the proposed new taxiway. A laboratory report by Scientific Analytical Center LLP completed the analysis of the nine soil samples, eight of which were collected at depths ranging from 1.80m to 3.40m from the fuel farm and one sample at 10.5m adjacent to the proposed taxiway. All samples were analysed for petroleum hydrocarbons, this is likely total petroleum hydrocarbon concentration that has been reported. The lab report provides an analysis of the data by comparing the results to the Dutch Intervention Values (DIV) for soil. None of the sample concentrations were shown to exceed the DIV.

9.3.50 All nine locations were installed with groundwater monitoring installations and were sampled and analysed for a range of metals, inorganics, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), PFAS (largely from FFF), and de-icing complex (Glycol).

9.3.51 The report provides an assessment of the results and compares the measured concentrations to the Maximum Permissible Concentrations (MPC) of the Republic of Kazakhstan and to the DIV (herein the assessment criteria), where values exist.

9.3.52 The results identify that VOCs within all samples to generally be below the level of detection. The only exception to this is in the case of measured concentrations of Benzene, Toluene, Ethylbenzene and Xylene (BTEX). BTEX concentrations are however shown to be below the adopted assessment criteria.

9.3.53 PCB concentrations were detectable within four of the nine monitoring locations. Concentrations were detectable at boreholes one to three and nine which are located at the fuel farm. Due to the types of PCBs analysed for, no assessment criteria are available for comparison.

9.3.54 PFAS and “Fire Foam” content in water were also analysed in groundwater samples. The PFAS test completed is stated to be Fluorobenzene. PFAS compounds are defined by multiple carbon and fluorine bonds. The carbon and fluorine bonds make PFAS chemically stable and persistent within the environment. In the case of Fluorobenzene its structure comprises a benzene ring with one fluorine. This compound is classed as an aromatic compound and lacks a fluorinated alkyl chain and the multiple carbon fluorine bonds, which are characteristic of PFAS. The measured concentration for Fluorobenzene is shown to be below the level of detection. The analysis completed should not be considered as a PFAS test. The analysis of “Fire Foam” presumably in groundwater samples is not defined. The report however states the test is for the “determination of surfactant content in natural and wastewater”. This test is unlikely to comprise any PFAS analysis due to the method of analysis (photometry), which would not provide the sensitivity required to reliably complete analysis for PFAS. The results are not provided within the laboratory report.

9.3.55 The results for testing of glycols were completed for two types of analyses of glycol defined as Type I and Type IV. Detectable concentrations of Type I glycol were noted to be present within all monitoring locations. Type IV glycol was detectable at all locations, except borehole six and nine. No assessment criteria are available for glycols. The report states that currently there are no formalised methods for recovery or control of de-icing agents (glycols) when used on the airfield. As a result, surface water runoff and infiltration to ground occurs.

9.3.56 The results for Total Petroleum Hydrocarbon (TPH) analysis within groundwater samples were absent from the laboratory report. However, the assessment within the report states TPH concentrations exceeded the DIV in two borehole locations (boreholes two and three) within the fuel farm location.

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9.3.57 Concentrations of inorganics and metals were shown to be generally low or below detection. Elevated selenium concentrations were however reported, but were considered to be associated with natural background concentrations, due to the absence of any credible onsite source. No concentrations were reported above the assessment criteria.

9.3.58 The report concludes that further analysis is to be completed as part of the ongoing monitoring works across the site. Continuation of the monitoring is stated to inform any requirements for remediation based on the contamination status.

Contamination conceptual site model

9.3.59 A contamination CSM has been developed using a source-pathway-receptor approach that is common in land contamination assessment. This uses existing baseline data summarised previously and uses a precautionary approach considering that contamination will be present beneath the site.

The following terms along with their definitions are given below:

- Source ‑ a contaminant or pollutant that is in, on or under the land and that has the potential to cause harm or pollution.
- Pathway ‑ a route by which a receptor is or could be affected by a contaminant.
- Receptor ‑ something that could be adversely affected by a contaminant, for example a person, waters, an organism, an ecosystem, or other receptors such as buildings, crops or animals.

Summary of contamination sources

9.3.60 Contamination sources either within the development boundary (on-site) or those present in the in the surrounding area (up to 1km from the development site) have been identified and are listed in Table 9.3.

Table 9.3: Summary of potential contamination sources

Sources	Potential contaminants of concern	Distance to footprint of Project
Spills of fuel during aircraft refuelling or other vehicle movements/usage	Petroleum Hydrocarbons	Within footprint
Spills and leakage from tanks on fuel farm	Petroleum Hydrocarbons	Within footprint
De-icing operations	Urea, ethylene, propylene glycol based fluids, sodium acetate, potassium acetate, sodium formate, potassium formate.	Within footprint
Vegetation spraying	Herbicides and pesticides	Within footprint
Use of FFF and fire station	PFAS	A number of storage areas located on site.
Electrical substations, transformers and oil filled cables	PCBs (Polychlorinated Biphenyls)	PCB containing transformers (Numbers 6, 72, 25, 10, 22, 26, 30, 31) in multiple locations.
Hazardous waste storage areas	Metals, petroleum hydrocarbons, fuels, oils, asbestos, degreasers such as chlorinated solvents	Within footprint
Light industrial land uses	Metals, petroleum hydrocarbons, fuels, oils, degreasers such as chlorinated solvents	Within footprint

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Sources	Potential contaminants of concern	Distance to footprint of Project
Underground storage tanks for fuel oils	Petroleum hydrocarbons	Within footprint
Unspecified industrial building	Metals, asbestos, petroleum hydrocarbons, fuels, oils, degreasers such as chlorinated solvents	Within footprint – at new in-flight catering facility

Pathways

9.3.61 The following contamination pathways have been considered and are summarised in Table 9.4.

Table 9.4: Summary of contamination pathways

Pathways
Human uptake through dermal contact, ingestion, inhalation of soils, dust and vapours
Windblown dust migrating to off-site receptors
Leaching of soils contamination into underlying aquifers
Migration of contaminants in groundwater
Migration of ground gases or vapours into buildings
Direct contact with contamination in soils or groundwater

Receptors

9.3.62 The existing geology and soil receptors that have been identified from the data review are shown in Table 9.5.

Table 9.5: Summary of receptors

Receptor	Type	Sensitivity
People Receptors	Airport site users – passengers	Medium
	Airport site users – workers	Medium
	Airport site users – residents	High
Environmental Receptors	Groundwater in the underlying alluvial soils	Medium
	Surface water	Medium
Built Environment Receptors	Existing or proposed airport infrastructure	Low

Future baseline

9.3.63 It is considered that there would not be a change to the existing baseline conditions should the project not go ahead.

9.4 Potential impacts

9.4.1 The proposed construction works are identified in **ESIA Chapter 2. Project description** and may be the source of potential impacts at the Project.

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Seismic and natural hazards

9.4.2 The potential seismic hazards and their risks affecting the Project can be divided into the following broad categories, including:

- Ground shaking – potential to cause significant structural damage or building collapse at the airport and related infrastructure
- Liquefaction potential – substantial ground settlement, tilting or collapse of structures and catastrophic failure of foundations.
- Fault movement/Blind Faults – surface rupture may have adverse implications in particular for linear infrastructure such as runways or underground utilities. Blind faults pose a risk as they are difficult to map and monitor as they are not exposed at the surface.
- Landslides – despite the Project being situated on relatively flat land, the Project's proximity to the Zailisky Alatau mountains to the south may result in earthquake-induced landslides extending to impact the Project.
- Secondary hazards, including fires or hazardous material spillage.
- Operational disruption in the event of an earthquake.

Land contamination

9.4.3 Table 9.6 outlines the potential impacts in respect of land contamination that may be caused by the construction and operation of the Project without appropriate mitigation in place. Temporary impacts are construction related, and permanent impacts are the permanent effects of construction and/or operation of the Project.

Table 9.6: Potential impacts in relation to land contamination from the Project

Activity	Impact	Receptors	Temporary / permanent
Excavation and movement (including off-site disposal) of potentially contaminated soils during construction.	Mobilisation or exposure of contamination through leaching, wind-blown dust, vapours or via direct contact.	People, groundwater, surface water, built environment	Temporary
	Reduction in soil contamination levels in the Project.	People, groundwater, surface water, built environment	Permanent
Construction vehicle and equipment maintenance and storage of fuels/oils for construction vehicles and equipment	Accidental spillages and leaks resulting in ground contamination	People, groundwater, surface water, built environment	Temporary
Operational vehicle, aircraft and equipment maintenance and storage of fuels/oils for operational vehicles, aircraft and equipment	Accidental spillages and leaks resulting in ground and/or groundwater contamination	People, groundwater, surface water, built environment	Permanent

9.5 Assessment of effects

9.5.1 The following section discusses the potential effects on receptors as a result of the land quality conditions at the site during both the construction and operational stages.

9.5.2 Seismic and other natural ground hazard effects are assessed at the operational stage as they apply to the completed Project.

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Temporary (construction) effects

Land contamination effects

9.5.3 The assessment considers those linkages between contamination sources, pathways and receptors that could generate significant effects and is based on available information and professional judgement. It is not necessary to quantify every pollutant linkage in detail at the present stage (a site-specific risk assessment will be undertaken which performs this function as part of the mitigation measures).

9.5.4 Instead the impact assessment considers the anticipated level of contamination likely during the construction period and the effects of any mitigation when applied (reported as residual effects in Section 9.7). Using professional judgment, this has been assessed using the categories of impact magnitude and receptor sensitivity given in **ESIA Chapter 4. ESIA scope and methodology**.

People receptors

9.5.5 The construction works may result in the creation of pathways for pre-existing contamination to migrate through disturbance of the ground and existing below ground structures during demolition together with the excavation, transport and stockpiling of potentially contaminated soils as well as the potential for volatile contamination in groundwater being exposed in excavations.

9.5.6 Adjacent sites in the vicinity of the construction work zones comprise wider operational areas of the airport, light industrial/commercial sites and residential sites. Impacts could occur via excavation and exposure of contaminated soils or groundwater which could migrate to and affect airport users that remain in operational areas or onto neighbouring sites or by vapour diffusion or wind-blown dust (affecting their occupants or users).

9.5.7 The works may also lead to the creation of new pathways (for example, service trenches) through which additional vapour migration into excavations, confined spaces and structures could occur, potentially resulting in the inhalation of noxious gases/vapours by construction workers or future maintenance or airport users and/or the build-up of vapours within structures.

9.5.8 These effects would be expected to be **adverse**, temporary and cover a relatively small spatial area (i.e. within and immediately adjacent to the site boundary). The people receptors that may be affected by contamination may be regarded as **low to high sensitivity** receptors and the magnitude of impact is considered to be **moderate**, resulting in **minor to major** adverse effects (varying as a result of the differing sensitivity of the receptors) as shown in Table 9.7.

Built environment receptors

9.5.9 The built environment relates to the proposed structures and existing structures or below ground services both in and adjacent to the footprint of the proposed works.

9.5.10 Temporary impacts from land quality could relate to the migration of new contaminants to existing structures (for instance the migration of hydrocarbons to potable water supply pipes) or the creation of additional vapour pathways.

9.5.11 These impacts would be expected to be **adverse**, temporary and cover a relatively small spatial area (within the site boundary). The existing and proposed built environment that may be affected by contamination may be regarded as **low sensitivity** receptors and the **magnitude** of impact is considered to be **moderate**, resulting in a **minor** effect which is not significant.

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Groundwater

9.5.12 For the assessment of likely significant effects in relation to groundwater refer to **ESIA Chapter 14: Water resources**.

Surface water

9.5.13 For the assessment of likely significant effects in relation to surface water refer to **ESIA Chapter 14: Water resources**.

Permanent and operational effects

Seismic effects

9.5.14 The seismic hazards relating to the site will need a significant design effort to understand the hazards and the associated vulnerability of the assets. Most of these hazards can be mitigated by good robust design as required by design standards. As such the effects of seismic hazards is presented in the residual effects assessment.

Land contamination effects

People receptors

9.5.15 At the end of the construction period, temporary pathways will largely have been stopped as the Project infrastructure will be in place and excavations and soil handling will have ceased. The situation with respect to people receptors will be very similar to the existing baseline conditions (i.e. pre-development) as the site is already an operational airport. In the absence of mitigation, permanent effects are therefore judged as **negligible**.

Built environment receptors

9.5.16 Permanent effects relate to the long-term contact of the built environment with the existing ground conditions. In the absence of mitigation, permanent effects are judged as **negligible** i.e. the existing baseline site conditions would remain broadly the same and the site is already an operational airport.

Groundwater

9.5.17 For the assessment of likely significant effects in relation to groundwater refer to **ESIA Chapter 14: Water resources**.

Surface water

For the assessment of likely significant effects in relation to surface water refer to **ESIA Chapter 14: Water resources**.

9.6 Mitigation

Seismic hazard mitigation

Construction and operational mitigation

9.6.1 Probabilistic seismic hazard estimates expressed in engineering parameters are essential tools for effective seismic microzoning, risk assessment, and the strategic planning. These inputs are already integrated into Kazakhstan’s national building codes and regulatory frameworks, which govern the design and construction of infrastructure to withstand expected ground motions and associated hazards.

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9.6.2 Kazakhstan's national seismic monitoring infrastructure, including real-time data acquisition and international integration, provides a strong foundation for ongoing risk management. It is expected that the Project will utilise the latest seismic data, microzoning inputs, and engineering standards to ensure long-term safety and resilience.

9.6.3 Seismic design for the Project will follow national building codes and international standards to ensure resilience to earthquake-related hazards. These standards and regulations include:

- Eurocode 8 – Design of structures for earthquake resistance
- Building Regulations – Construction in Seismic Zones of the Republic of Kazakhstan

9.6.4 No additional mitigation measures are proposed under the Environmental and Social remit. It is expected that all seismic risk-related design and construction measures will be addressed through compliance with national building codes and engineering standards. Emergency preparedness and disaster management planning are also governed by national frameworks and institutional responsibilities.

Land contamination mitigation

Construction mitigation

9.6.5 Mitigation measures are to be incorporated into a Construction Environmental and Social Management Plan (C-ESMP) to ensure that potential impacts from contamination are mitigated during construction. This would likely include for soils measures to prevent dusts associated with earthworks as well as appropriate hazardous materials storage.

9.6.6 Monitoring reports[19] and the ESAP compliance report relating to ongoing works at the airport show that similar measures have been successfully employed during previous works, therefore these actions comprise extensions of the current compliant measures being used.

9.6.7 Embedded mitigation measures are provided in Section 2.7 of **ESIA Chapter 2: Project description** and are outlined below for geology and soils.

9.6.8 Existing mitigation for the Project:

- Soil and Groundwater quarterly monitoring
- New drainage network

9.6.9 Planned mitigation will include:

- Spill prevention
- Continuation of quarterly monitoring
- Soil remediation as part of the fuel farm upgrade
- Finalise the implementation of the recommendations and mitigation measures arising from the fuel farm assessment
- Production of map of potential contamination associated with the airport
- Action plan for soil and groundwater remediation

9.6.10 The embedded mitigation (existing and proposed) will inform the management of construction related impacts for geology and soils. Remediation of soils will be completed based on ground investigation findings. The requirements of ground investigations are further detailed below.

[19] Almaty Airport Reconstruction Program (with a new passenger terminal construction (Environmental & social Review and Audi, SE Solution (Pty)

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Ground investigation and risk assessment

9.6.11 A ground investigation is being undertaken to assess soil and groundwater quality in areas where contamination is known or suspected. The current scope prioritises locations with identified contamination risks, such as the fuel farm, in alignment with baseline findings. While the investigation supports construction planning, monitoring will continue through the construction phase.

9.6.12 The investigation is focused on key contamination sources, primarily the fuel farm, which is one of the components of Project Horizon. Ground investigation activities commenced in May 2025 and have included soil and groundwater sampling and testing, as described in Section 9.3 of this chapter.

9.6.13 Should contamination be encountered in other Project Horizon components during construction, a targeted ground investigation will be undertaken to assess soil and groundwater quality in line with Kazakhstan regulations and lender requirements. The information from all investigations should be used to inform the need for any additional site-specific mitigation over and above that already included in the C-ESMP, and to determine the need for remediation to protect end users.

9.6.14 At the time of writing the current Environmental and Social Waiver Conditions specifically required the following to be undertaken:

- Conduct additional soil and groundwater investigation and share the sampling plan with the Senior Lenders by July 31, 2025.
- Submit map of potential contamination associated with the Airport to the Senior Lenders by August 31, 2025.
- Share the soil and groundwater monitoring report with the Senior Lenders by August 31, 2025.
- Prepare and submit to the Senior Lenders a time-bound, costed, action plan, in a form and substance acceptable to the Senior Lenders, for soil and groundwater remediation by 30 September 2025.
- Prepare a draft time-bound action plan (excluding budget), in a form and substance acceptable to the Senior Lenders, for upgrading and preventative maintenance programme for the fuel tank farm ensuring the facility complies with good international industry practices (GIIP) in terms of spill prevention, atmospheric emissions, fire risk management and occupational health and safety by July 30, 2025.
- Prepare the final action plan and budget for upgrading and preventative maintenance programme for the fuel tank farm by September 30, 2025.
- Finalise the implementation of the recommendations and mitigation measures arising from the fuel farm assessment according to dates outlined in the action plan.

9.6.15 These actions are considered reasonable for the continued assessment of contamination at the fuel farm site.

9.6.16 Where contamination is identified, depending upon risk assessment outcomes, some form of remediation could be undertaken to protect receptors (e.g. source removal, or provision of appropriate cover soils or installation of vapour barriers). Such investigations and assessment would be undertaken in accordance with Kazakhstan and prospective Lender guidelines. Where local guidelines do not exist, then internationally recognised guidelines on contamination investigations and assessment of soils and groundwater contamination should be used in agreement with the Lender’s technical advisors.

9.6.17 Ground Investigation should target known source areas of contamination. The following elements should be included within the scope of ground investigation:

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- Review of any further historical ground investigation information, pertaining to geological conditions and soil and groundwater conditions.
- Completion of a ground investigation comprising boreholes and/or trial pits at suitable grid spacing in areas of proposed ground break and known onsite sources of contamination.
- Available groundwater monitoring wells should continue to be monitored (e.g. fuel farm location).
- Post fieldwork monitoring should continue to be undertaken quarterly as already agreed.
- Soil and groundwater laboratory testing for the following contaminants as previously identified in the previous independent monitoring reports is recommended. The agreed suites are as follows:
  – Oil products (petroleum hydrocarbons)
  – Organic carbon %
  – Firefighting foam
  – Glycols in terms of anti-icer (Type I and Type IV)
  – Metals (As, Cu, Cd, Hg, Pb, Ni, Zn, Se, Cr3+,Cr6+)
  – Volatile Organic Compounds (VOCs)
  – PFAS (Per and poly fluoroalkyl substances)
  – PCB (Polychlorinated biphenyls)
  – PAH (Polycyclic aromatic hydrocarbons).
- Risk assessment report to compare soil and groundwater quality to local and internationally recognised standards (e.g. Russian standards, United States Environmental Protection Agency, Dutch or UK standards) where local standards are not available.
- Should any significant soil or groundwater contamination be recorded by the investigation then a remediation options appraisal and strategy should be completed to mitigate any identified unacceptable risks.

9.6.18 Risks associated with asbestos-containing materials (ACMs), toxic mould, and radiological contaminants have not been assessed within the scope of this ESIA. Where asbestos is suspected or identified, specialist advice must be sought from a suitably qualified contractor to assess and manage associated risks in accordance with national regulations and international best practice.

9.6.19 The findings of the assessments should be used to update the C-ESMP and other related documents relating to waste management and soils re-use.

Operational mitigation

9.6.20 As with the protection of water resources, preventative measures such as best practice site management and effective site planning/layout will be implemented to minimise the risk of any pollution incidents finding their way to ground. For a detailed list of measures reference should be made to **ESIA Chapter 14: Water resources**.

9.6.21 The following measures will be taken to reduce ground and groundwater contamination:

- Ensuring continued used of specific zones for loading and unloading (if concerning potentially polluting substances), including refuelling and maintenance of support vehicles.
- The water quality monitoring regime for both surface water and groundwater should be continued throughout the operational life of the Project.
- In case of an emergency spillage accident, emergency pollution prevention plans will be maintained to the appropriate international standards.

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- The management of de-icing fluids should be formalised through the design and construction of a dedicated de-icing pad.

9.7 Summary of residual effects

9.7.1 Residual effects are those that remain after mitigation and/or enhancement measures have been implemented. Table 9.7 summarises the potential effects and any residual effects as a result of the Project.

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Table 9.7: Summary of residual effects for geology and soils

Description of effect	Permanent or temporary	Sensitivity of receptor	Magnitude of impact	Significance of effect before additional mitigation	Additional mitigation	Residual effect	Proposed monitoring
Construction phase – Land Contamination							
People – airport passengers	Temporary	Medium	Moderate	Moderate Adverse (Significant)	Current ground investigation and remediation are focused on the fuel farm. If potentially contaminated material is encountered elsewhere, it will be recorded and assessed, with mitigation undertaken as needed in line with regulatory and lender requirements.	Negligible (Not Significant)	Continue fuel farm area quarterly groundwater monitoring
People – airport workers	Temporary	Medium	Negligible	Negligible (Not Significant)	Current ground investigation and remediation are focused on the fuel farm. If potentially contaminated material is encountered elsewhere, it will be recorded and assessed, with mitigation undertaken as needed in line with regulatory and lender requirements. Where asbestos or other hazardous materials (e.g. toxic mould, radiological contaminants) are suspected, engage a	Negligible (Not Significant)	Continue fuel farm area quarterly groundwater monitoring

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Description of effect	Permanent or temporary	Sensitivity of receptor	Magnitude of impact	Significance of effect before additional mitigation	Additional mitigation	Residual effect	Proposed monitoring
					qualified specialist to assess and manage risks in line with regulatory requirements.		
People – nearby residents	Temporary	Medium	Moderate	Moderate Adverse (Significant)	Current ground investigation and remediation are focused on the fuel farm. If potentially contaminated material is encountered elsewhere, it will be recorded and assessed, with mitigation undertaken as needed in line with regulatory and lender requirements.	Negligible (Not Significant)	Continue fuel farm area quarterly groundwater monitoring
Built environment	Temporary	Medium	Moderate	Moderate Adverse (Significant)	Current ground investigation and remediation are focused on the fuel farm. If potentially contaminated material is encountered elsewhere, it will be recorded and assessed, with mitigation undertaken as needed in line with regulatory and lender requirements.	Negligible (Not Significant)	Continue fuel farm area quarterly groundwater monitoring
Operational phase – Land Contamination							
People – airport Passengers	Permanent	Medium	Minor	Minor Adverse (Not Significant)	N/A	Minor (Not Significant)	Continue fuel farm area quarterly

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Description of effect	Permanent or temporary	Sensitivity of receptor	Magnitude of impact	Significance of effect before additional mitigation	Additional mitigation	Residual effect	Proposed monitoring
							groundwater monitoring
People – airport workers	Permanent	Medium	Minor	Minor Adverse (Not Significant)	N/A	Negligible (Not Significant)	Continue fuel farm area quarterly groundwater monitoring
People – nearby residents	Permanent	Medium	Negligible	Negligible (Not Significant)	N/A	Negligible (Not Significant)	Continue fuel farm area quarterly groundwater monitoring
Built environment	Permanent	Low	Minor	Negligible (Not Significant)	N/A	Negligible (Not Significant)	Continue fuel farm area quarterly groundwater monitoring
Operational phase – Seismic							
Built environment and people	Permanent	Not assessed	Not assessed	Not assessed	Ground investigation and construction according to design codes for earthquakes	Not assessed	None

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