SECTION C: IMPACT ASSESSMENT

CHAPTER C4: TOPOGRAPHY, LANDSCAPE, GEOLOGY & TOPSOILS

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4.1 INTRODUCTION

This Chapter of the ESIA describes the potential impacts on the topography, landscape, geology and topsoil resources associated with the construction, operation and closure phases of the Oyu Tolgoi Project. The Chapter also describes the specific measures which have been implemented to "design-out" or avoid adverse impacts, and outlines the measures aimed to minimise, mitigate, offset or compensate for those impacts which have been identified as unavoidable. The management of topsoil through the construction phase, and the associated monitoring measures, is described in detail in *Chapter D4: Topsoil Management Plan*

The Mine Licence Area does not have any significant topographic features with Oyu Tolgoi set in a low-lying valley with small hills (see *Chapter B5: Topography, Geology and Soils*). The most prominent features in the landscape of the Project Area of Influence are the nearby hills and mountains some of which, such as the Javkhlant Mountain, are also sites of cultural and religious significance (see *Chapter B12: Cultural Heritage*). Given the lack of significant topography on the Mine Licence Area key features such as the shafts and the waste rock dump (WRD) will be visible from some distance, although, as the WRD develops around the southern part of the Mine Licence Area, it will be partially screen the mine infrastructure from the south. The pit, WRD, block cave subsidence and TSF will all result in changes to the local topography. In addition minor changes to the topography of the Area of Influence through subsidence in the area of the Gunii Hooloi borehole field from the dewatering of the underlying Cretaceous aquifer.

A key issue in relation to the topsoil of the Oyu Tolgoi Project Area of Influence is the susceptibility of the friable clay rich topsoil to erosion by wind and water in this fragile environment. This sensitivity is increased in all areas where overgrazing reduces the protection afforded by vegetative cover, where unsealed tracks are used by vehicles, and any areas of earthworks. Typically in the Gobi where soft ground is encountered on unsealed routes, drivers often progressively deviate from the route resulting wide swaths of damage to the local soils and flora.

Arid conditions, combined with regular strong winds and occasional flood events also contribute to the sensitivity of the area to topsoil erosion. Oyu Tolgoi recognises that topsoil is essential as a medium for growth and also contains the seed bank of grasses and other flora which germinates during the summer wet season. Furthermore given the arid environment, top soils take many years to develop, and therefore the conservation of the limited topsoil stratum (without the creation of excessive dust) is a key priority for Oyu Tolgoi. The construction works within the Mine Licence Area and at other locations such as the Temporary Domestic Airport have illustrated the issues with regards the protection and handling of topsoil and subsoil and enabled refinement of the methodology for managing topsoil.

Mining activities will result in significant cut and fill works together with the removal of large quantities of rock and overburden. These activities will result in permanent changes to the landscape, some of which are already manifest during the construction phase. In addition, mining will lead to the permanent removal of a geological resource. This will Result in a reduction in the mineral resources of the area which are available for future generations, and the deposition of the waste rock dump and the tailing storage facility will effectively result in these areas being unavailable for future open pit mineral exploitation.

4.2 SCOPE OF THE ASSESSMENT

4.2.1 Spatial Scope

The spatial scope of the impact assessment covers all the main elements of the Oyu Tolgoi Project Area of Influence, namely:

- The mine and its infrastructure within the Mine Licence Area, including the diversions of ephemeral watercourses;
- the infrastructure corridor from the mine to the Chinese border;
- the domestic and international airports; and

- the operational water supply system including the basin-wide aquifer that this will exploit.

4.2.2 Temporal Scope

The temporal scope covers the Project cycle from construction through operations to Project closure and the final long-term settlement of the land over the area of block caving, as well as potential settlement over the Gunii Hooloi aquifer.

4.3 SUMMARY OF ASSESSMENT

Actual and potential impacts on the topography, landscape, geology and topsoil arising from the construction, operation and closure of the Project are as follows:

- Construction of mine infrastructure including tailing storage facilities (TSF) and waste rock dump (WRD);
- Impacts associated with open pit;
- Block caving mining activities resulting in a surface subsidence zone;
- Creation of structures, such as the headwork for shafts and camps;
- Diversion of Undai and other ephemeral watercourses;
- Losses of topsoil from erosion by wind and water around, earthworks, topsoil stockpiles and restored areas;
- Construction of the Project Infrastructure including linear features such as the Oyu Tolgoi to Gashuun Sukhait road and power line (including borrow pits); and
- Potential subsidence impacts of the area overlying the Gunii Hooloi aquifer (see discussion in Section *C5.4.2*).

Impacts during closure will relate to legacy issues associated with the open pit, block caving, TSF, WRD and potential settlement associated with the drawdown in the deep aquifer which had been used to supply the Project's operational water requirements. Whilst the scope here assesses the closure at the end of the Project for which a preliminary closure plan is presented in the Oyu Tolgoi Mongolian Feasibility Study[1], the potential for early or forced closure is also considered by Oyu Tolgoi annually and the forced closure requirements are presented in the annual closure liability assessment report for the Project. This is discussed in further detail on *Chapter D21: Mine Closure Framework*. The Mine Closure Framework will be compliant with Mongolian requirements and international best practise.

The remainder of this Chapter describes the topography, landscape, geology and topsoil impacts which have been avoided through design together with potential areas of impact for which specific mitigation measures are proposed.

4.4 MITIGATION THROUGH DESIGN

By means of careful design and planning processes, the Oyu Tolgoi Project aims to prevent and mitigate, as far as practically possible, impacts on topography, landscape, geology and topsoil. The key design measures taken to avoid impacts have included:

- As areas are decommissioned e.g. the closure of the first cell of the TSF, progressive restoration and landscaping will be undertaken whilst under Oyu Tolgoi control, allowing vegetation to become established without any impacts from grazing by herd animals which will be excluded by the Mine Licence Area fence.
- Restoration of waste rock dump areas as soon as feasible. Stored topsoil will be used to rehabilitate the lower slopes of the waste rock facilities where the risk of losing the topsoil through windblown erosion is limited. At the end of the operational life of the open pit, as the waste rock facilities will not be used by underground mining operations, the remaining active areas will be stabilised and rehabilitated. This restoration will occur while the underground block caving is

[1] Oyu Tolgoi (2010), Preliminary Mine Closure Plan for Mongolian Feasibility Study. AMEC, 2010.

undertaken, with the aim to have the WRD stabilised and restored a significant time (decades) before the end of mine life.

- Mitigation of the impacts on the topography and landscape arising from the mine operations will focus on the design of the waste rock facility with the preferred design resulting in a similar profile to the Khanbogd Mountain or the steep-sided Javkhlant Mountain.
- Consideration of landscaping to lessen the visual impact of buildings, including the planting of trees (Oyu Tolgoi has an obligation under the Land Law to ensure that 10% of the area within the Mine Licence Area is planted with trees as a "green zone"). These plants are likely to be grown at Khanbogd at a nursery with a local well, and then transplanted to the Mine Licence Area and watered until established (grey water may be used). Once developed the impact on the Oyu Tolgoi water balance will be assessed, although the intention will be to use minimal water for this planting.

4.5 IMPACT ASSESSMENT

The impact assessment set out below describes how, for those impacts that cannot be avoided through design, the Project has sought to minimise, mitigate, offset or compensate for impacts. Each of these impacts is assessed in terms of the nature of the impact, the existing and planned mitigation measures, the potential significance, and the residual significance after mitigation measures have been implemented.

4.5.1 Infrastructure Construction (Mine Licence Area)

Sources of Impact

During construction, there will be impacts to topsoil resources within the Project area as areas are cleared and cut and fill activities are undertaken. Impacts on the local landscape and topography will result from the construction of angular buildings such as the head frames for the shafts (see *Figure 4.1*) which will be visible for a significant distance on most days. The construction of the first 2 km^2 cell of the Tailings Storage Facility (TSF) will alter the local landscape through the creation of long linear horizontal lines approximately 7 m high within a gently rolling landscape.

Figure 4.1: Oyu Tolgoi Shaft No. 1

The construction of the Undai diversion will comprise a low relief diversion structure which exploits the existing topography and therefore the landscape impacts will be limited, and only visible at close proximity.

Nature of Impact

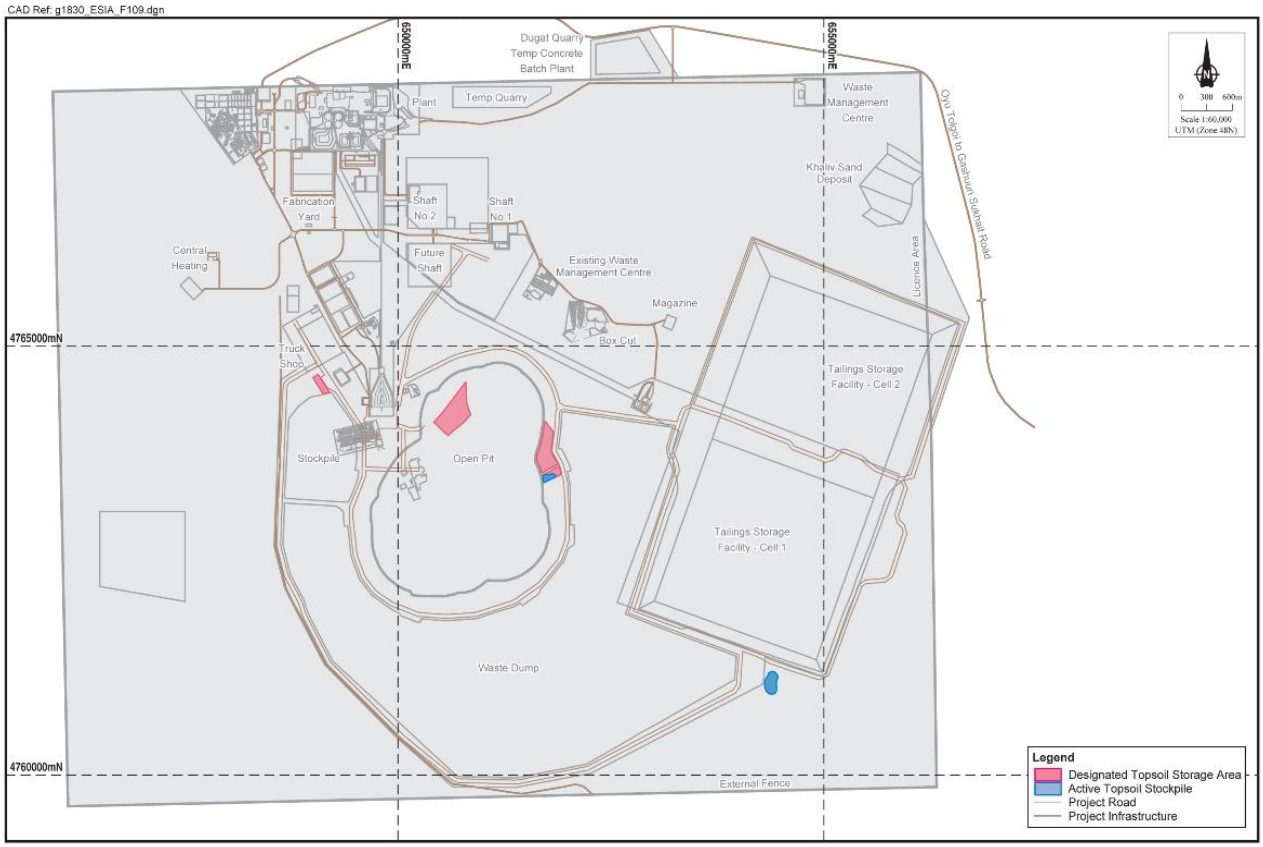
The development of the infrastructure in the Mine Licence Area requires extensive topsoil stripping. Some limited topsoil resources will be lost as they are buried under the WRD. The topsoil resources which are lost will be in areas where the topsoil volume and development is limited and removal is not warranted as the dry stripping of the topsoil would recover limited volumes and have the negative impact of generating significant quantities of dust.

Following the lessons learnt from the topsoil stripping at sites such as the temporary domestic airport, Oyu Tolgoi has prepared topsoil stripping maps, which detail topsoil to be stripped in advance of the development of the WRD and TSF and other infrastructure. This stripping plan utilises the topsoil mapping undertaken as part of the baseline assessment (see *Chapter B5: Topography, Geology and Soils; Section 5.8*). Specific areas of land take (and topsoil disturbance) under the construction programme will involve:

- 2.04 ha for the processing plant;
- 1,226.8 ha for the Tailings Storage Facility (TSF) and other ponds;
- 92.3 ha for temporary stockpile area;
- 932.6 ha for the main Waste Rock Dump;
- 60.0 ha for segregated oxide part of the Waste Rock Dump (very low grade ore);
- the temporary and permanent accommodation areas will impact 53.4 ha; and
- the internal road and pipelines will disturb 85.4 ha.

During construction, the accommodation and processing plant areas, TSF and WRD will require levelling, using a cut and fill technique, to create a suitable base for construction.

Figure 4.2: Construction Phase Topsoil Storage Areas



The creation of the Undai diversion will also result in the clearance of topsoil, with this topsoil used to landscape the new diversion. Any excess topsoil will be stored in storage areas located within the Mine Licence Area outside of the active construction areas, i.e. in areas where there will not be a requirement to move the topsoil again until it is used for site restoration (see *Figure 4.2*). Where longer term storage is required Oyu Tolgoi will utilise areas where disturbance will be minimal such as down southeast of the WRD. This area also has the advantage that it will be in the lee (i.e. downwind) of the WRD and therefore potential for wind erosion of the stockpiles will be reduced. Topsoil will be removed from the storage areas as required for later use in the restoration of construction (and later some of the operation) impacts. These impacts will vary between the short-term and localised, to long-term where permanent structures are constructed.

The construction area and ultimately the whole Mine Licence Area will be fenced for security purposes and this will prevent livestock and large wildlife from entering the area. As a consequence the impact of grazing animals on plants within the fenced area will be avoided, which will have a positive impact on topsoil, allowing the surface crust to stabilise and topsoil and organic material to be preserved.

Mitigation Measures

During the construction phase, the area and depth of topsoil removal will be undertaken in accordance with the soil maps prepared by Oyu Tolgoi. The soil stripping approach will be communicated clearly to the contractor and supervised to ensure compliance with the specified strip depth and thereby minimise the potential dilution of the topsoil with sub-soils. This builds on lessons learnt from previous topsoil stripping and these procedures have been shown to work well. For example, sandy loam topsoil will be excavated to a depth of 15-20 cm, or; within the depth of the main root layer and moved to a dedicated stockpile area. Topsoil will be stockpiled and used as soon as feasible to restore impacted areas as they are closed. All measures will be implemented in accordance with the Oyu Tolgoi Topsoil Management Plan (*Chapter D4*), the key points of which are summarised below:

- Quantify topsoil volumes and types to be removed and define storage locations;
- Construction of dedicated topsoil storage areas, designed to minimise wind and water erosion of the topsoil;
- Removal of all topsoil where feasible from the mining areas and areas of infrastructure development before work commences;
- Storage of topsoil in dedicated topsoil stockpiles which where practicable will be aligned parallel to the prevailing wind and be less than 2 m high with a collection drain to capture topsoil removed by water run-off;
- Treatment of the surface of topsoil stockpiles to prevent erosion. This may include temporary seeding to develop a surface cover;
- Avoid unnecessary traffic movements off designated routes; and
- Restore any damaged areas as quickly as feasible to minimise erosion. This will include the use of a hydro-seeding truck to facilitate the re-establishment of vegetation.

Oyu Tolgoi's management of losses of soil through dust emissions will involve avoiding stripping soil during periods of moderate to high wind speeds and if appropriate use of water as a dust suppressant. Any actions to control dust through water suppression will be balanced against the Oyu Tolgoi objective of minimising water use on site and where needed and appropriate, other non-water dust palliatives would be used (see also *Chapter D2: Atmospheric Emissions Management Plan*).

The potential for mitigation of the impacts on landscape and topography is limited and will be focused on landscaping of features. Nevertheless, some localised landscape impacts are unavoidable due to the need to build large surface infrastructure such as headgear. These features will be visible from the immediate environs, some herder camps and from the surrounding hills such as the Khanbogd and Javkahlant mountains. The infrastructure will not be visible to the residents of Khanbogd due to the presence of the intervening high ground of the Khanbogd Massif.

Impact Significance

Impacts associated with cut and fill activities are considered to be **minor adverse**, subject to suitable erosion control techniques including vegetation, armouring and, depending on the location and the local requirements, use of topsoil stabilisers (see *Chapter D4: Topsoil Management Plan*).

The impacts of stockpiling excess topsoil for site restoration will vary between the **short-term** and **localised**, to **medium** to **long-term** where restoration cannot start until areas which are used for a number of years (e.g. individual cells of the TSF, or quarries) are closed.

The security fencing preventing large grazing animals entering the Project area will have a **positive** impact on topsoil in areas where there is no disturbance from Oyu Tolgoi Operations.

4.5.2 Infrastructure Construction outside the Mine Licence Area

Source of Impact

Outside of the Mine Licence Area, there will be minor impacts on topography along the road from Oyu Tolgoi to Gashuun Sukhait associated with the construction of, or modification of, some minor cuttings and embankments. Other sources of impacts on the local landscape and topography will be associated with the construction of buildings at Gashuun Sukhait and in the Gunii Hooloi borehole field and power lines to China and Gunii Hooloi.

All infrastructure construction will require soil clearance in advance of earthworks and the stockpiling of this for later use in landscaping and restoration. The construction of the road will require the excavation of up to 20 borrow pits for construction materials (see ***Figure 4.3***). These will be located adjacent to the road and located along the route from the Mine Licence Area to the edge of the SGSPA (i.e. will be present in the IBA).

Nature of Impact

The Gashuun Sukhait border crossing will be upgraded to include new buildings and infrastructure. These buildings will be smaller in size and extent than the ones currently built on the Chinese side of the border and it is likely the new buildings will be largely obscured and/or their visual impact diminished by the backdrop of the larger buildings across the border.

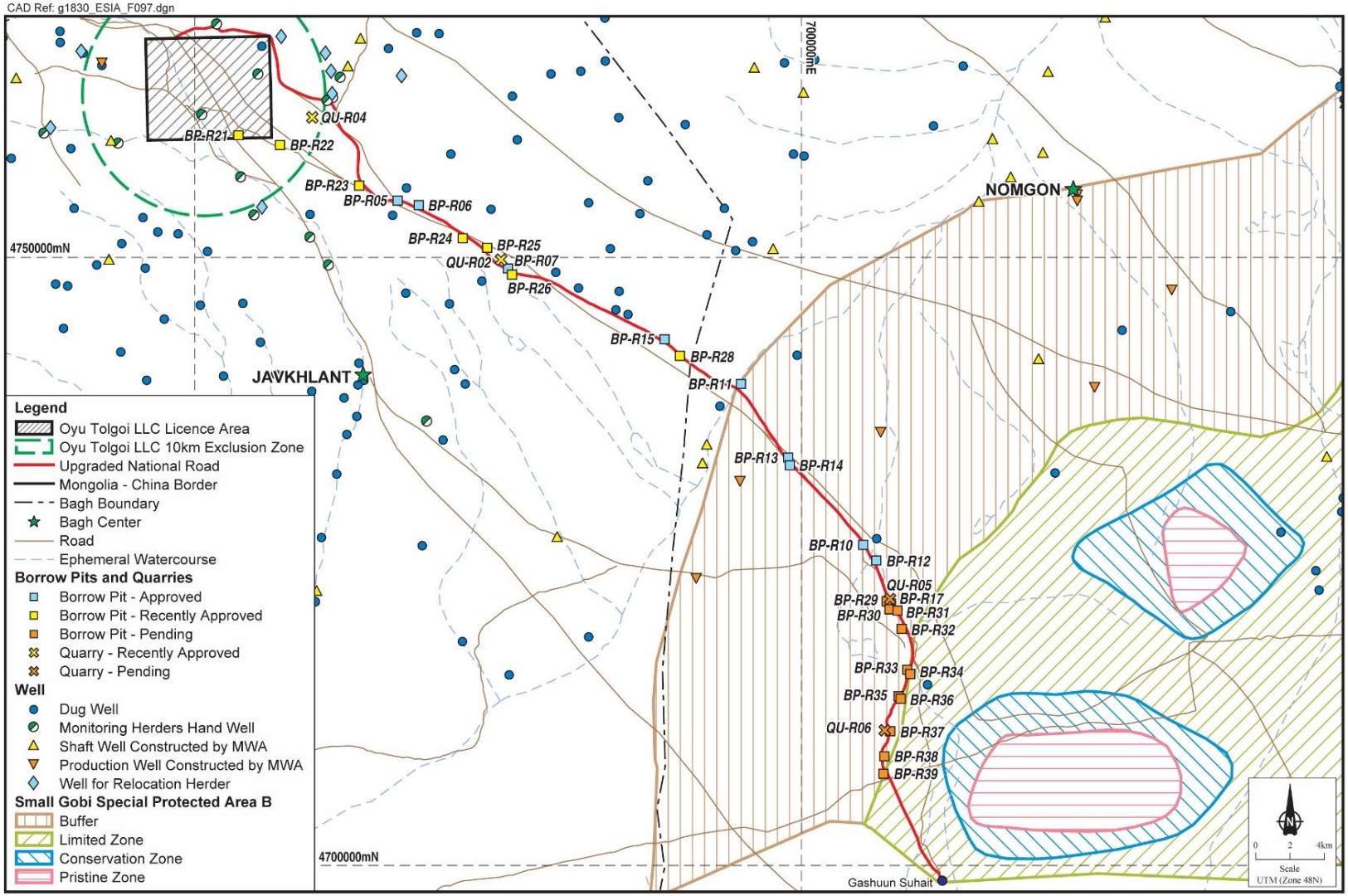
Power lines are being constructed along the infrastructure corridor which comprises an area of generally rolling landforms; the power lines and their pylons will be visible from a significant distance and represent the first such power lines in this region of the South Gobi. These power lines will continue across the border into China, in due course it is understood that the power lines will be handed over to the Mongolian Government.

A smaller power line will be constructed along the Gunii Hooloi pipeline approximately following the route of the pipeline down the spine of the borefield. Although this is expected to be a simple single or double line mounted on single posts, the power line will be visible over some distance.

The water supply pipeline will run parallel to this power line but will be buried. Once installed, the surface of the pipeline route will be reinstated and there will be a negligible residual impact on the local landscape or topography associated with the access track along the route. Topsoil will be excavated from the pipeline route and stockpiled locally prior to being reinstated as part of the remediation of the pipeline route. At the well heads and also at the intermediate pumping stations small buildings will be constructed which as they are on the higher ground through the Gunii Hooloi basin will be visible for some distance. The construction of the water supply lagoons will result in some minor topographic changes due to the earthworks on this slightly elevated area. Similar to the features associated with the Gunii Hooloi borefield, the Temporary Domestic Airport buildings and in due course the Permanent Airport buildings are also in an area of gently rolling topography and will be visible for some distance. Once the permanent airport is operational the Temporary Domestic Airport buildings will be removed and the area subject to a restoration programme.

Access roads will require the clearance of topsoil from the routes, this topsoil will be used to landscape the borrow pits used for the road construction and road verges. The roads, particularly the road to Gashuun Sukhait with its associated sealed surface, embankments and cuttings, will form visible features on the landscape when viewed from elevated areas, but generally will not be significant landscape features. The straightening and sealing of the Oyu Tolgoi to Gashuun Sukhait road, which will also be used by the public, will have a positive impact as it will remove the plumes of dust associated with vehicles using the existing route and lead to a reduction in the visual impacts. Once constructed the operation of the Oyu Tolgoi to Gashuun Sukhait road will be handed over to the GoM.

Figure 4.3: Location of Borrow Pits and Quarries along the Oyu Tolgoi to Gashuun Sukhait Road



Mitigation Measures

The potential for mitigation of the impacts on landscape and topography is limited and will be focused on landscaping of features, such as pump houses in Gunii Hooloi, to lessen the visual impact of the buildings. A number of the potential adverse landscape impacts have been designed out or minimised e.g. through burying the GH water supply pipeline (necessary to place the pipeline below the level of topsoil freezing) and limiting the height of the power line and cables. Although there is a limit to the ability to design out potential adverse landscape impacts for the infrastructure outside the Mine Licence Area as items such as pylons need to be a statutory height for safety. Some localised landscape impacts are unavoidable and will be visible from the immediate environs, including some herder camps and from the surrounding hills such as the Khanbogd and Javkahlant mountains. With the exception of some sections of the borefield power line the infrastructure will not be visible to the residents of Khanbogd due to the presence of the intervening high ground of the Khanbogd Massif.

While the sealing of the Oyu Tolgoi to Gashuun Sukhait road will reduce the potential for soil erosion and dust generation on this route; several other routes used by Oyu Tolgoi will remain unsealed. These include the access roads for the power line and Gunii Hooloi borefield, the Khanbogd to Oyu Tolgoi route and longer distance routes such as transportation routes to Ulaanbaatar and other parts of Mongolia. Oyu Tolgoi vehicles will be restricted to the designated routes and designated speeds through driver training and enforced by vehicle tracking technology being employed by Oyu Tolgoi. Any actions to control dust through water suppression will be balanced against the Oyu Tolgoi objective of minimising water use on site and where needed and appropriate, other non-water dust palliatives would be used (see also *Chapter D2: Atmospheric Emissions Management Plan*)

All borrow pits will be subject to rehabilitation. Oyu Tolgoi's programme of remediating borrow pits has already commenced, with successful remediation of borrow pits on other parts of the Project Area of Influence. An example of this is the restoration of the borrow pits created during the sourcing of materials for the construction of the Temporary Domestic Airport. These have been restored using topsoil recovered from the airport site, and the lessons learnt from this operation are being used on the Oyu Tolgoi to Gashuun Sukhait road construction. These lessons include the advance mapping of topsoil to determine which topsoil will be stripped, and where and how they will be stored and consequently used for the restoration, and the use of vegetation, armouring and topsoil stabilisers to minimise wind erosion and enhance the stability of the surface of the restored topsoil.

The assessment of the borrow pit location has been subject to a staged approach and each location covered in the applicable DEIA, which includes community consultation, environmental assessment and establishment of avoidance, impact mitigation and restoration requirements. Prior to any work activities on any undisturbed land (including for borrow pits), a land disturbance permit (LDP) is required to be presented by the Contractor who will be undertaking the work. As part of the LDP procedure, the following checks are undertaken:

- Community engagement to seek final agreement on the work and identification of any community mitigation requirements;
- Confirming chance find procedure for any cultural and/or paleontological artifacts;
- Demarking the area;
- Undertaking detailed flora inspection of site and identification of any special measures; and
- Agreeing contractor commitments for final restoration of the site.

At any stage in the Land Disturbance Permitting process a site may be deselected due to community, environmental or other concerns. During works inspections will be undertaken to confirm all mitigations and management is undertaken and at the end of the work – site is subject to audit and sign-off

Impact Significance

Impacts associated with and cut and fill activities along the Oyu Tolgoi to Gashuun Sukhait road and borrow pit excavation and infrastructure outside the Mine Licence Area will be **permanent** although considered to be **minor adverse** given their size and low topography. The impact will be mitigated where feasible through the use of screening by earth bunds and/or natural topography. At all excavations and, along the road, all verges will be restored with topsoil to allow flora to become re-established and to stabilise the topsoil against wind erosion (see Topsoil Management Plan TSM08).Open Pit and Underground Mining

Source of Impact

During the operational phase, primary impacts will be on the landscape, topography and geology and will be centred on the open pit. The operational phase is unlikely to involve any major additional earthworks therefore impacts on topsoil are likely to be negligible or minor at the most. The key activities associated with the mining activities are:

- Lowering of the local land surface through the development of the open pit;
- Block caving and ultimately the creation of a subsidence zone over the block cave area; and
- Removal of the mineral resource.

Nature of Impact

The operation of the mine will result in the opening up of the large permanent pit which will cover an area of over 2 km^2 and extend to a depth of 800 m in 15 m high benches. These will impact the local topography and landscape; although only be visible in close proximity to the pit.

To the north of this, the removal of ore through the block caving is likely to result in a subsidence zone later in the mine life as the caving propagates to the surface. Initial estimates are that this subsidence zone will cover an area of over 8 km^2 and be characterised by a depression surrounded by a circular cliff-like feature with an overall cliff height in excess of 20 m, which might be manifest as a single cliff or multiple smaller cliffs. Depending on the nature of the surface manifestation of this feature, the impact will be on topography and landscape; and also on hydrogeology and hydrology (see Section C5), and potentially present a potential community safety issue if cliffs are unstable once herders are allowed back into the area following mine closure and restoration.

Excavation of the pit and the underground mine will remove the geological resources from these areas as well as some surrounding host rock. This is a permanent and irreversible impact which is essentially balanced by the positive impact on the Mongolia economy of the Project.

The resources being mined are heavily faulted and are located at the eastern distal end of a faulting zone along which some seismic activity has been recorded (see *Chapter B5, Section 5.7*). Given the distance from the main faults, and the lack of any significant seismicity in the area, mining activities are considered unlikely to result in any significant movement on this fault system (e.g. movement resulting in a seismic event greater than the background levels expected for this area).

Mitigation Measures

A detailed Mine Closure and Rehabilitation Framework to meet the Rio Tinto Closure standard and in line with the IFC mine closure guidance set out in the Sectoral Mining EHS Guidelines and the EU Mine Waste Directive (2006/21/EC) is currently being developed and is planned to be completed during 2012. This will include a funding mechanism for mine closure cost coverage in line with international good practice (see *Chapter D21: Mine Closure Framework*. This will include consideration of the topography and landscape and the management of the surface manifestation of the subsidence over the area of block caving. The detailed Mine Closure and Rehabilitation Framework will be submitted to, and approved by the Ministry of Nature Environment and Tourism and the Ministry of Mineral Resources and Energy.

Impact Significance

The impact associated with mining of the geological resource is **permanent** and balanced by the positive impact on the Mongolia economy from the Project. The impact on the topsoil resource is **minor adverse**, and will be managed through the implementation of the Topsoil Management Plan.

4.5.3 Waste Rock Dump and Tailing Storage Facility

Source of Impact

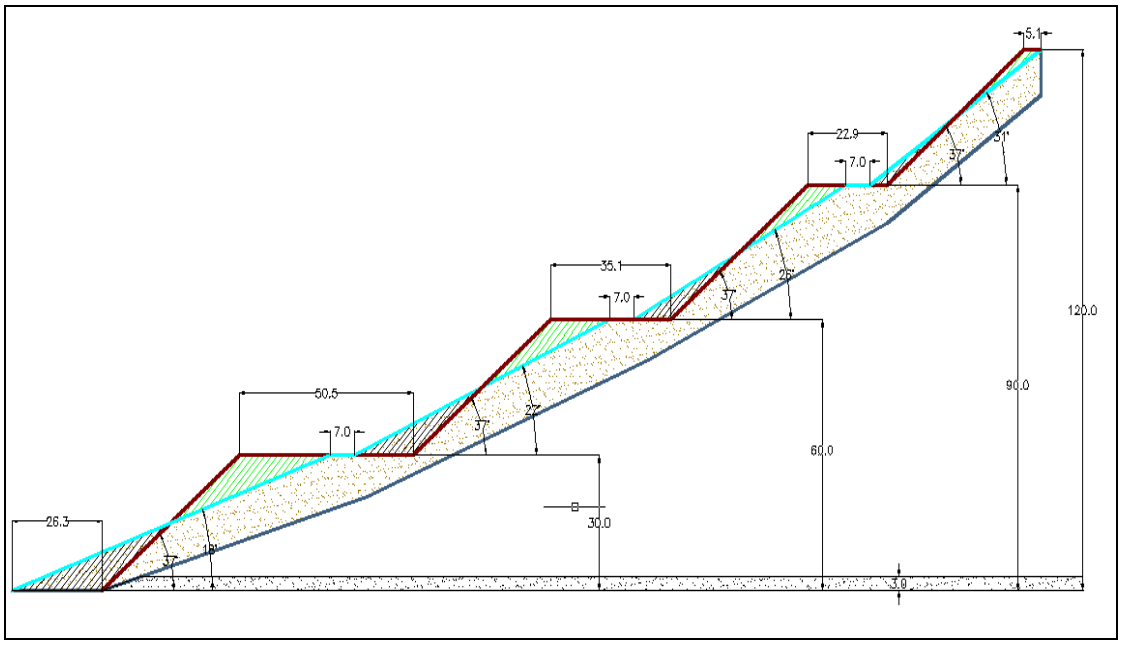
During the operational phase, primary impacts will be on the landscape, topography and geology and will be associated with:

- Raising of the local land surface through the creation of the WRD; and
- Addition of a second TSF cell.

Nature of Impact

The waste rock from the open pit will be placed in a waste rock dump (WRD). The WRD is planned to be on average 90 m in height above the surrounding topography. The WRD will be raised in 30 m benches with a natural angle of repose of approximately 37 degrees and then battered back to form an upward steepening slope with angles of 18 to 31 degrees with 7 m wide benches (*Figure 4.4*) retained for access.

Figure 4.4: Waste Rock Dump Profile



Key: Black horizon represents the construction topography, light blue horizon represents the closure topography and dark blue line the base of the protective NAF layer covering the WRD.

Note: The top 120 m bench is illustrative and unlikely to be used.

This will result in a hill with steep rock armoured sides and a flat top which is similar in profile to Javkhlant Mountain (*Figure 4.5)* located to the southwest of the Mine Licence Area.

Figure 4.5: Javkhlant Mountain

The first TSF cell will be approximately 7 m high and 2 km^2 in area. This relatively low structure will be less significant than the adjacent WRD. A second TSF will be opened, once the first is full and the original cell will be closed, capped and the surface restored through the placement of topsoil.

The land raising will be the dominant visual topographic impact during the operational phase, as the pit and subsidence zone will only be visible when the observer is very close at ground level (within a few 100 m).

Both the TSF and the WRD will restrict the future mining of any underlying geological resources. However, these areas have been drilled by Oyu Tolgoi and have been confirmed free of any commercial mineable resources.

During operations, there will be a progressive topsoil clearance through the expansion of the open pit and the waste rock facility. The construction of the second tailings storage facility will also require topsoil to be removed from this area. As with the construction phase, topsoil will be removed to designated stockpile areas. The depth of the topsoil excavated will be managed to avoid the impact of diluting the topsoil with deeper subsoil.

Mitigation Measures

The removal of topsoil will be undertaken in a controlled manner in accordance with the soil stripping plans which have been developed by Oyu Tolgoi using experience gained in early works, to ensure that they are not diluted with lower quality sub-soils. For example sandy loam topsoil will be excavated to a depth of 15-20 cm, or within the depth of the main root layer, and transferred directly to a dedicated topsoil storage area outside of the mining activities. Ideally these topsoil dumps will be stored for less than 2 years. At the end of the operational life of the open pit, as the waste rock facilities will not be used by underground mining operations, they will be stabilised and rehabilitated. Stored topsoil will be used to rehabilitate the lower slopes of the waste rock facilities where the risk of losing the topsoil through windblown erosion is limited.

Throughout the operational phase, as areas are closed e.g. the closure of the first cell of the TSF, progressive restoration and landscaping will be undertaken. This process will result in the restoration and landscaping of these areas with the Mine Licence Area while they are under Oyu Tolgoi control (i.e. within the fence around the Mine Licence Area). This will enable the stabilisation of the topsoil and subsequent re-vegetation to be undertaken without any impacts from larger grazing and herd animals.

Mitigation of the impacts on the topography and landscape arising from the mine operations will focus on the restoration of areas as they are completed/closed and battering back any significant slopes to enable topsoil to be placed on them and enable vegetation to become established. While the WRD will be too steep to enable topsoil to be placed on the flanks, the benches will be reduced as the sides are re-profiled upon the closure of the WRD. The resultant profile will be similar to the nearby steep-sided Javkahlant Mountain.

Impact Significance

Impacts to topsoil will be **minor adverse** as the majority of activities will be restricted to the areas created during the construction phase. Unsealed roads and the mining activities will generate dust which will be deposited on the surrounding landscape and which if significant and sustained could have a minor impact on topsoil quality.

The impacts of the construction of the TSF and WRD are considered to be **minor adverse**, subject to suitable erosion control techniques including vegetation, rehabilitation activities, and given that drilling has demonstrated that they will not result in the loss of future open pit mining opportunities.

4.5.4 Gunii Hooloi Abstraction

Source of Impact

During the operational phase, there is the potential that abstraction of groundwater from the Gunii Hooloi aquifer may result in a broad area of subsidence with the maximum potential subsidence being 0.7 m^2 in

[2] MaisonWhorleyParsons 2010, Assessment of Subsidence on Pipeline for Raw Water Supply System, 16 October 2010

the borehole field area. This potential subsidence is results from the reduction in pore pressures in the aquifer and surrounding clays (see *Section C5.4.2* for discussion of potential impacts on water features).

Nature of Impact

If subsidence does occur, it will occur slowly and the impact will decrease steadily away from the central cone of depression in the piezometric surface. The surface manifestation of this, if it occurs, will be a gentle lowering of the topography across the area which will almost be unperceivable on the scale of the basin and the Gunii Hooloi valley in which it sits, resulting in a change in topographic gradients of up to 0.03%.

Mitigation Measures

Oyu Tolgoi will undertake annual topographic surveys along the route of the pipeline to enable the early detection of any subsidence and be able to implement any necessary remedial works on its pipeline infrastructure.

Impact Significance

Given the lack of infrastructure (other than Oyu Tolgoi's water supply system), the consequence of any subsidence will be **negligible**. Any such settlement, as it occurs, will be gradual and given the unconsolidated nature of the sediments unlikely to cause any perceptible seismicity in this area. This compression in the aquifer will have the **positive impact** of increasing the yield of the aquifer and allowing more water to be released to the Project (see *Chapter B6, Section 6.5.6*) per unit of drawdown in the piezometric surface.

4.5.5 Khanbogd

Source of Impact

The development and growth of Khanbogd as the population increases will result in the need for the built environment to expand, and the construction of potentially taller buildings in the *soum* centre.

Nature of Impact

The development and growth of Khanbogd as the population increases will have an impact on the local landscape around this *soum* centre. It is anticipated that the community boundaries will expand and potentially taller (two to three storey) buildings could be erected in the *soum* centre. The expansion of the population of Khanbogd will result in more vehicles and therefore the potential for more damage to the topsoil structure in the surrounding area due to the erosion and expansion of existing tracks linking Khanbogd to the surrounding communities. In addition increased wealth and leisure time could lead to increased off-road exploration of the areas by residents, and increased waste generation which could lead to littering of the local environment.

Mitigation Measures

The involvement of Oyu Tolgoi in the South Gobi Development Council and the community liaison will be means by which Oyu Tolgoi may influence the development of Khanbogd and ensure that its development is focused and does not result in significant negative impacts on the local landscape and topsoil. This will include the construction of adequate waste disposal sites to prevent windblown scattering of litter across the area. Local community consultation will aim to ensure that that all residents are aware of the sensitivity of the local environment and issues associated with off-road driving.

Impact Significance

The impacts caused by the growth of Khanbogd will be **long term** (extending beyond the life of the mine) and **minor adverse**, as long as development is focused and minimises negative impacts on local landscape, and off-road driving is controlled to minimise the impact on local topsoil resources

4.5.6 Decommissioning

Source of Impact

The decommissioning of the Project will involve the following activities:

- Dismantling of the majority of the equipment for sale or scrap including the metal buildings;

- Decommissioning of the water supply network;
- Restoration of decommissioned areas; and
- Making safe cliffs and steep slopes.

The preliminary closure plan covering these aspects is presented in the Mongolian Feasibility Study[3] and relates to the Mine Closure Plan dated 2010. This is discussed in further detail in *Chapter D21: Mine Closure Framework*.

Nature of Impact

Decommissioning will involve the safe closure of the mine workings and dismantling of the majority of the equipment for sale or scrap including the metal buildings. Concrete and other buildings may be retained depending on the results of community consultation on the legacy of the Oyu Tolgoi Project. This work will lead to the removal of the largest infrastructure features on the site namely the headwork of the shafts. Prior to any dismantling all structures they will be cleared of all hazardous materials to avoid the risks of impacting topsoil and/or groundwater. Following decommissioning, the main features remaining on the site will comprise the open pit, block cave subsidence area, and closed WRD and TSF.

The closure of the mining operations will include the removal of the majority of the equipment and steel-framed buildings. The degree to which the concrete foundations are removed and the area landscaped will be subject to agreement with the local government (*soum* administration). All unpaved areas will be cleared and prepared (scarified) prior to topsoil being reinstated on them. Areas such as the waste disposal site will be closed, capped, and covered with subsoil and then topsoil during restoration. The open pit, upper slopes of the waste rock dumps and cliffs of the subsidence zone will be too steep to enable topsoil restoration as wind and water erosion would rapidly remove the topsoil. The top of the tailings storage facility will be restored as will the majority of the banks.

Decommissioning of the water supply network for the Project will include the removal of pumps, motors and other electrical infrastructure for recycling. Underground structures, such as the pipeline, will be left in place. The power line for the pumps through Gunii Hooloi will be removed (unless required otherwise by the *soum* administration), resulting in a decrease in impacts on the local landscape. Where practicable all areas where infrastructure is removed will be landscaped to match the local topography.

It is envisaged that the Permanent Airport and Gashuun Sukhait border crossing will have been handed over to the Government of Mongolia (GoM) and will therefore continue to be operated. Similarly the road infrastructure and power lines connecting to China will have been handed over to the Government of Mongolia and form part of the permanent regional infrastructure grid.

During decommissioning, any remaining stockpiled topsoil will be used to restore the areas which were cleared for the mining infrastructure. Impacts outside the Mine Licence Area will be minimal as the majority of the off-site infrastructure (e.g. airport, road and transmission line) will continue to be used and be operated and managed by the local government. Where infrastructure is removed, this will be followed by restoration of the area using, where possible, locally derived and stockpiled topsoil to ensure that the biodiversity (seed base) is the same as the surroundings.

Mitigation Measures

The Project area will be progressively restored with the topsoil that has been stockpiled or through suitable rock armouring where slopes are too steep for topsoil. Where technically feasible pit walls will be made safe as will any cliffs which have developed due to the subsidence over the block caving.

Landscape impacts will be reduced through the dismantling and demolition of all buildings and structures and removal of all above-grade concrete footings and foundations will be undertaken unless alternate arrangements are made to transfer certain facilities to local groups (government or private) under mutually acceptable agreements covering the transfer of long-term liability.

This restoration will result in a decrease in the level of Project impact on the topography and landscape of the area. All works will follow Oyu Tolgoi's Mine Closure Plan which will seek to restore as far as possible the local topography and landscape. The objective will also be to enhance any features which are

[3] Oyu Tolgoi (2010), Preliminary Mine Closure Plan for Mongolian Feasibility Study. AMEC, 2010.

important for herders and their animals and fauna and flora, such as springs, to encourage the re-establishment of the fauna and flora across the Project Area of Influence.

In the event of an early or forced closure this closure programme would be undertaken in accordance with the forced closure requirements set out in the annual closure liability assessment report prepared by Oyu Tolgoi[4], and in accordance with the *Mine Closure Framework* presented in *Chapter D21*.

Impact Significance

The overall decommissioning will have a **positive impact** on topsoil, as topsoil is moved from stockpiles and restored, however this process will be vulnerable to wind erosion and restoration will need to be managed carefully to prevent its loss and maximise the colonisation of the area by native plants. The removal of much of the infrastructure will have a **positive impact** on the local landscape, further enhanced by restoration and landscaping with the remaining topsoil stockpiles.

The impact of the open pit, waste rock dumps and cliffs of the subsidence zone being too steep to enable topsoil restoration will be **residual** and **permanent**.

The potential impacts to topography, landscape, geology and topsoil are summarised in *Table 4.1* below.

[4] Sustainability East Asia LLC, January 2011, Oyu Tolgoi Mine Decommissioning Liability Estimate, for Oyu Tolgoi.

Table 4.1: Summary of Impacts: Topography, landscape, geology and topsoil

Impact	(1) Receptor/ Beneficiary	(2) Phase	(3) Impact Categorisation	(4) Potential Significance	Design and Mitigation Measures	Management Plan	Residual Significance
Visual Impact of project structures outside the Mine Licence Area such as power lines and scattered low-level structures	*Soum* residents	C, O	**Scale**: Local **Duration**: Long Term **Type**: Negative	**Consequence**: Minor **Likelihood**: Certain **Significance**: Moderate Adverse	▪ Use of landscaping where feasible around low buildings.	D4: Topsoil Management Plan	Minor Adverse
Visual Impact of project structures inside the Mine Licence Area during Construction of mine infrastructure	*Soum* residents	C, O	**Scale**: Local **Duration**: Long Term **Type**: Negative	**Consequence**: Minor **Likelihood**: Certain **Significance**: Moderate Adverse	▪ Use of landscaping where feasible for smaller structures. ▪ Screening of the infrastructure by the WRD. ▪ Use of 10% of the residential area in the Mine Licence Area for tree planting which will serve as a partial screen and lessen the visual impact.	D4: Topsoil Management Plan	Minor Adverse
Loss of topsoil resource across the footprint of the Project	Soil resources	C, O	**Scale**: Local **Duration**: Long Term **Type**: Negative	**Consequence**: Minor **Likelihood**: Certain **Significance**: Moderate Adverse	▪ Detailed mapping of topsoil and planning which soils are to be stripped and preserved for future restoration. ▪ Careful removal of topsoil and stockpiling topsoil in dedicated storage areas in advance of the construction. ▪ Stabilisation of stockpiles to minimise erosion. ▪ Avoidance of off-road driving or other activities which needlessly create conditions which can lead to soil erosion.	D4: Topsoil Management Plan	Minor Adverse
Impact of windblown dust on surrounding topsoil quality	Soil resources	C, O	**Scale**: Local **Duration**: Short (C) /Long Term (O) **Type**: Negative	**Consequence**: Minor (C) / Negligible (O) **Likelihood**: Likely **Significance**: Negligible	▪ Use of dust control measures such as armouring, dust suppressants or watering where appropriate and feasible. Water is to be used only where effective and to not be the primary control mechanism due to its scarcity. ▪ Avoidance of off-road driving or other activities which needlessly create conditions which can lead to dust generation.	D4: Topsoil Management Plan D11: Transport Management Plan	Negligible

Impact	(1) Receptor/ Beneficiary	(2) Phase	(3) Impact Categorisation	(4) Potential Significance	Design and Mitigation Measures	Management Plan	Residual Significance
Localised changes to topography and landscape through cut and fill/ levelling/ borrow pit excavation	*Soum* residents	C, O	**Scale**: Local **Duration**: Permanent **Type**: Negative	**Consequence**: Minor **Likelihood**: Certain **Significance**: Moderate Adverse	▪ Mine plan optimisation. ▪ Grading of slopes around the mine infrastructure where feasible to screen the structures. ▪ Survey and use of natural topography to screen operations. ▪ Restoration of borrow pits once closed. ▪ Use of vegetation, armouring and top soils stabilisers to minimise erosion.	D4: Topsoil Management Plan	Minor Adverse
Changes to mine topography through excavation of pits, and creation of waste dumps	*Soum* residents	O	**Scale**: Local **Duration**: Long Term **Type**: Negative	**Consequence**: Moderate **Likelihood**: Certain **Significance**: Moderate Adverse	▪ Restoration of slopes as far as feasible taking account of slopes and erosion potential, to be sympathetic with surrounding landscape and have minimal potential for erosion. ▪ Early implementation of rehabilitation activities.	D8: Waste Management Plan D21 Mine Closure Framework	Minor Adverse
Generation of revenues from conversion of geological resource and sale of processed ore/concentrate	*Soum* residents; residents of Omnogovi; Mongolian Government	O	**Scale**: National **Duration**: Long Term **Type**: Positive	**Consequence**: Positive **Likelihood**: Certain **Significance**: Major Positive	▪ Maximisation of revenues, employment opportunities, services and other provisions through the generation of income from Oyu Tolgoi. ▪ Ensure that any areas to be used for WRD or TSF are drilled to establish that there are no shallow resources which the development will sterilise.	D16: Influx Management Plan	Major Positive
Changes to topography and seismicity arising from the settlement of sediments in the Gunii Hooloi Basin	*Soum* residents	O	**Scale**: Local **Duration**: Long Term **Type**: Negative	**Consequence**: Negligible **Likelihood**: Unlikely **Significance**: Negligible	▪ Ensure abstraction of groundwater from the Cretaceous aquifer is undertaken in manner that ensures drawdown over the aquifer is evenly spread.	D7: Water Resources Management Plan	Negligible

Impact	(1) Receptor/ Beneficiary	(2) Phase	(3) Impact Categorisation	(4) Potential Significance	Design and Mitigation Measures	Management Plan	Residual Significance
Removal of infrastructure and restoration of land	*Soum* residents and topsoil resources	D	**Scale**: Local **Duration**: Long Term **Type**: Positive	**Consequence**: Positive **Likelihood**: Certain **Significance**: Positive	▪ Decontamination of all buildings and equipment prior to demolition and dismantling to ensure the protection of the environment and human health. ▪ Ensure that restoration is appropriate and adequate and undertaken in a manner that minimises the potential for erosion of slopes and topsoil by wind or water.	D12: Hazardous Materials Management Plan D21 Mine Closure Framework D4: Topsoil Management Plan	Positive
Areas too steep to allow restoration of topsoil cover	*Soum* residents	D	**Scale**: Local **Duration**: Long Term **Type**: Negative	**Consequence**: Moderate **Likelihood**: Certain **Significance**: Moderate Adverse	▪ Ensure slopes (e.g. waste rock dumps, open pit walls) are stable, and their presence does not result in further erosion of topsoil.	D21 Mine Closure Framework D4: Topsoil Management Plan	Minor Adverse