SECTION A: INTRODUCTION AND BACKGROUND

CHAPTER A4: PROJECT DESCRIPTION

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4. PROJECT DESCRIPTION

4.1 CHAPTER OVERVIEW

This Chapter provides a summary of the principal features of the Oyu Tolgoi Project (the Project).

This Environmental and Social Impact Assessment (ESIA) is based on the initial construction of an open pit copper-gold mining operation at the Southern Oyu deposit, with a 100,000 tonnes per day (tpd) capacity ore concentrator and required infrastructure to support an ore processing capacity of 160,000 tpd of ore[1]. This is expected to be supplemented within four years by production from the Hugo North underground development based on block caving mining operations.

Increasing underground ore production will eventually require a corresponding expansion to the plant throughput capacity. Oyu Tolgoi LLC ("Oyu Tolgoi") is exploring an expansion to the plant to process up to 160,000 tpd of ore within the 27-year life of the Project. This expansion is subject to any necessary regulatory approvals and the identification and permitting of additional water resource requirements to provide the increased processing capacity. Water use requirements for this level of expansion have been discussed with the Government of Mongolia and once additional water resource performance data from the Gunii Hooloi aquifer is compiled, the necessary regulatory approvals for any additional water resource use for the concentrator throughput expansion (e.g., for increased water abstraction from the Gunii Hooloi aquifer) will be sought from the Government of Mongolia. Any further expansion beyond 160,000tpd remains speculative at this stage and subject to approval by OT, Ivanhoe and Rio Tinto.

This Chapter has been developed based on the Oyu Tolgoi Project Integrated Development and Operating Plan ("IDOP") 2011[2], IDOP 2010[3], the Mongolian Feasibility Study[4] prepared for the Project and the Investment Agreement ("IA") for the Project[5].

This Chapter addresses the following topics:

- Introduction and Project overview;
- Project development and Project history;
- Project layout;
- Open pit mining operations;
- Underground mining;
- Ore processing;
- Tailings management;
- Waste rock management;
- Water resources and water management;
- On-site and off-site Project infrastructure;
- Airport for the Project;
- Concentrate transportation to China;
- Power supply;
- Project construction;

[1] These represent average capacities to allow for maintenance downtime and other stoppages. As a result, the initial maximum capacity of the concentrator plant will be 110,000 tpd of ore to provide an average capacity of 100,000 tpd.

[2] Integrated Development and Operating Plan, 6 May 2011, prepared by AMEC.

[3] Integrated Development Plan: Technical Report, June 2010, prepared by AMEC.

[4] Mongolian Feasibility Study, Oyu Tolgoi Project, 2009. Oyu Tolgoi.

[5] Investment Agreement Between The Government of Mongolia and Ivanhoe Mines Mongolia Inc LLC and Ivanhoe Mines Ltd and Rio Tinto International Holdings Limited, 6 October 2009.

- Project operation; and
- Project closure and decommissioning.

This Chapter has been developed based on the Oyu Tolgoi Project Integrated Development and Operating Plan 2011[6], the Integrated Development Plan 2010[7] and the Mongolian Feasibility Study[8] prepared for the Project.

4.2 INTRODUCTION

In October 2009, Oyu Tolgoi (as proponent of the proposed project), Ivanhoe Mines Ltd ("Ivanhoe", the majority shareholder in Oyu Tolgoi) and Rio Tinto International Holdings Limited ("Rio Tinto", a strategic investor in Ivanhoe which currently holds 51% of Ivanhoe's share capital) signed an Investment Agreement ("IA") with the Government of Mongolia ("GoM"). The IA defines the fiscal and regulatory environment in which the proposed mining project will operate and brings the GoM into the Project as a 34% equity owner of Oyu Tolgoi, with the option to increase its equity holding by a further 16% after 30 years, provided that terms can be reached with Ivanhoe Mines Ltd. at that time. At the time the IA was signed, there remained a number of conditions precedent to the agreement becoming effective. The conditions precedent under the IA were satisfied on 31 March 2010. Since this point and as a result of the IA, development and construction activities have commenced.

The Oyu Tolgoi copper and gold project is a "greenfield" mining project located in the South Gobi Region (or Omnogovi *aimag*) of Mongolia and is being developed by Oyu Tolgoi, with an initial planned mine life of 27 years. Oyu Tolgoi was formerly named Ivanhoe Mines Mongolia Inc LLC (IMMI), and older studies referenced in this ESIA were undertaken under this name.

Oyu Tolgoi will develop a series of mineral deposits containing copper, gold, silver, and molybdenum. The series of deposits contain a currently identified resource of almost 40 Billion pounds (Blb) of contained copper and 20 Million ounces (Moz) of contained gold in the Measured and Indicated categories and another 40 Blb of contained copper and 25 Moz of contained gold in the Inferred category. Further deposits are expected to be identified along the Oyu Tolgoi mineralisation trend, and the known deposits have also not been closed off at depth (i.e. a lower depth to the series of deposits has not yet been identified). The deposits identified within the Oyu Tolgoi Mine Licence Area that form the basis for the Project's Integrated Development and Operating Plan are described in *Section 4.2.2* below.

4.2.1 The Scope of the Project for the Purposes of Impact Assessment

This ESIA is based on the initial construction of an open pit copper-gold mining operation at the Southern Oyu deposit, supplemented within four years by production from the underground development to establish block cave mining operations at the Hugo North deposit. Ore from the mining operations will be processed through a 100,000 tonnes per day (tpd) capacity ore concentrator with required infrastructure to support an ore processing capacity of 160,000 (tpd) of ore[9]. The development, construction, operation and eventual closure and decommissioning of the greenfield mining project described above and the attendant infrastructure as listed below comprise the "Project" for the purposes of this ESIA

Increasing underground ore production will eventually require a corresponding expansion to the plant throughput capacity. Oyu Tolgoi is exploring an expansion to the plant to process up to 160 000 tpd of ore within the 27-year life of the Project. This expansion is subject to any necessary regulatory approvals and the identification and permitting of additional water resource requirements to provide the increased processing capacity. Water use requirements for this level of expansion have been discussed with the Government of Mongolia and once additional water resource performance data from the Gunii Hooloi aquifer is compiled, the necessary regulatory approvals for any additional water resource use for the concentrator throughput expansion (e.g., for increased water abstraction from the Gunii Hooloi aquifer) will be sought from the Government of Mongolia. Any further expansion beyond 160,000tpd remains speculative at this stage and has not been approved by OT, Rio Tinto or Ivanhoe Mines.

[6] Integrated Development and Operating Plan, 2011. Oyu Tolgoi.

[7] Integrated Development Plan: Technical Report, June 2010. AMEC Minproc.

[8] Mongolian Feasibility Study, Oyu Tolgoi Project, 2009. Oyu Tolgoi.

[9] This is the average capacity, to allow for maintenance downtime and other stoppages the maximum capacity of the concentrator plant will be 110,000 tonnes per day of ore.

Oyu Tolgoi will develop supplementary information relating to additional impacts that could result from the proposed expansion and the mitigation measures to address them, including in respect of water resources use. As a greenfield mining project, Oyu Tolgoi requires extensive infrastructure to be constructed in addition to mining and ore processing facilities. The principal infrastructure elements that comprise the Project are identified below and further described in *Section 4.2.3*.

- **Water Borefield** in the Gunii Hooloi basin, together with a pipeline to the Mine Licence Area;
- **Water Treatment** to provide drinking water at the Oyu Tolgoi site;
- **Housing** for workers (both on-site and off-site);
- **Airport** adjacent to the Mine Licence Area;
- **Supporting Facilities** such as administration and logistics;
- **Concentrate Transport** to China via an upgraded and sealed road following an existing route; and
- **Power**, initially from on-site diesel generators and then through an electrical transmission line from China for a period of up to four years from the commencement of operations.[10]

Any resulting changes to the Project design (whether as part of the evolution of the detailed design, or for the planned expansion to 160,000 tpd or further expansion) will be managed as required, in accordance with Oyu Tolgoi's EHS Policy and the 2012 HSE Management System, including the notification and reporting provisions of the Management of Change procedures (*ESIA Chapter D1: Environmental and Social Management Framework*) and any required revisions to activity-specific management plans. A further discussion of the potential expansion of the Project is discussed in *Chapter C13: Cumulative Impacts*.

4.2.2 Currently Identified Oyu Tolgoi Deposits

Five deposits have been identified within the Oyu Tolgoi Mine Licence Area, comprising:

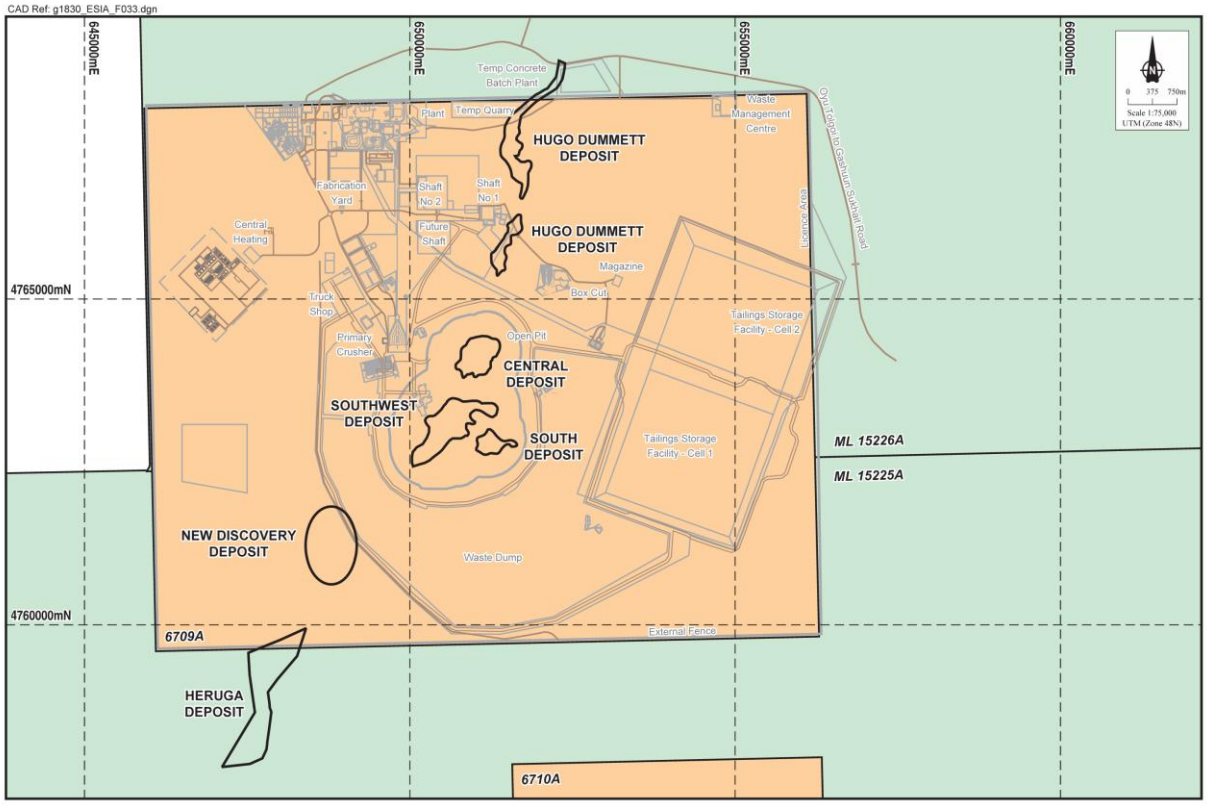
- Southwest;
- Central;
- Hugo South;
- Hugo North; and
- Heruga.

Southwest and Central together are referred to as the Southern Oyu deposit, and Hugo South and Hugo North together are referred to as the Hugo Dummett deposit.

For mine planning and for the purposes of this ESIA, the development of the Project will comprise the open pit stages at Southern Oyu and one underground block cave development at Hugo North. *Figure 4.1* illustrates the different mineral deposits and also indicates the Heruga deposit and a "new discovery deposit" which are not currently planned for mining and are therefore not addressed further in this ESIA.

[10] This ESIA addresses the potential impacts and mitigation related to initial electrical power for the Project, which is expected to be imported from the Inner Mongolian Autonomous Region in northern China. Oyu Tolgoi is in the process of designing and permitting a coal-fired power plant within the Mine Licence Area and the assessed environmental and social impacts and mitigation measures will be reported in a supplemental ESIA.

Figure 4.1: Oyu Tolgoi Mineral Deposits



4.2.3 Planned Operations

For the purposes of this ESIA, the Project description is based on the initial construction of a concentrator and infrastructure to support production of 100,000 tpd of ore. The predominant source of ore at start up is the Southern Oyu Open Pit complex (see *Figure 4.1*). In parallel to this surface construction, underground infrastructure and mine development is ongoing for the Hugo North underground block cave deposit. Stockpiling will allow the higher grade ore from Hugo North to displace the open pit ore as the contribution from the underground production ramps up to reach 84,200 tpd of ore.

Increasing underground ore production will eventually require a corresponding expansion to the plant throughput capacity. Oyu Tolgoi is exploring an expansion to the plant to process up to 160 000 tpd of ore within the 27-year life of the Project. This expansion is subject to any necessary regulatory approvals and the identification and permitting of additional water resource requirements to provide the increased processing capacity. Water use requirements for this level of expansion have been discussed with the Government of Mongolia and once additional water resource performance data from the Gunii Hooloi aquifer is compiled, the necessary regulatory approvals for any additional water resource use for the concentrator throughput expansion (e.g., for increased water abstraction from the Gunii Hooloi aquifer) will be sought from the Government of Mongolia. Any further expansion beyond 160,000tpd remains speculative at this stage and has not been approved by Oyu Tolgoi, Rio Tinto or Ivanhoe Mines.

Any such expansion would also be subject to a further environmental and social impact assessment to meet international industry practice and Rio Tinto environmental assessment requirements. Management Plans prepared based on this ESIA will be updated as necessary and revised to reflect impacts of the expanded project. A discussion of the potential expansion of the Project is discussed in *Chapter C13: Cumulative Impacts*.

The ore is planned to be processed through conventional crushing, grinding and flotation circuits. The concentrate produced will initially be trucked to smelters in China and is planned in future years to be transported by the developing Mongolian rail network, expansions to which are envisaged.

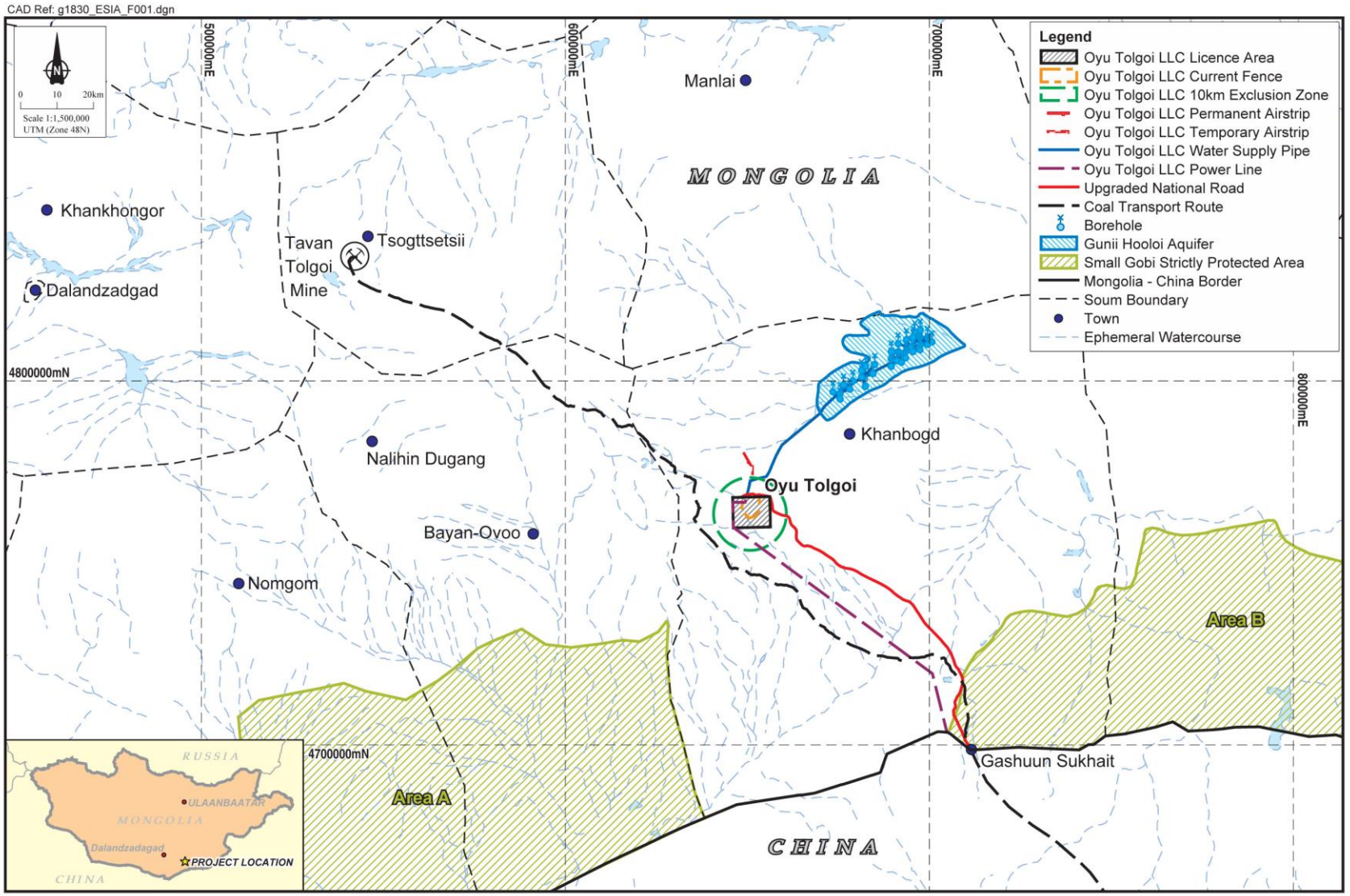
Project Infrastructure Components

Oyu Tolgoi is a remote "greenfield" mining project and therefore requires extensive infrastructure to be constructed in addition to the concentrating facilities. The principal infrastructure elements include:

- **Water Borefield:** Water demand for ore processing will be supplied from the Gunii Hooloi basin which extends 35-75 km north of the Oyu Tolgoi site. Bores will be developed in the southeast and the northeast areas of the borefield with storage lagoons along the supply pipeline designed to provide for emergency use in the event of any outage on the water supply pipe. Expansion of production capacity to 160,000tpa will require further evaluation and approvals for the increased water demand after ramp-up (currently envisaged for 2017) that would follow the full-scale commissioning of underground operations.
- **Water Treatment:** A permanent water treatment facility and bottling plant will be constructed to treat raw water from the Gunii Hooloi borefield to the Project's drinking (potable) and domestic water standards.
- **Housing:** On-site and off-site accommodation facilities will be constructed to support workers during the operations phase of the Project. Temporary facilities will also be constructed throughout the Project to support additional workforce requirements for construction and expansion demands (of up to 14,800 workers).
- **Airport:** The airport will be located approximately 7 km north of the Oyu Tolgoi mine site and will facilitate the transport of people and goods to the site from Ulaanbaatar and other points of departure. A temporary airport has been constructed to support the construction phase and this will be replaced by the permanent airport, which will be located on an adjacent site.
- **Supporting Facilities:** Administration, training, mine equipment maintenance, gatehouse, medical centre, fire station, heating plant, fuel storage and warehouse facilities, among others will also be constructed to support operational requirements over the life of mine.
- **Concentrate Transport:** The transport of bulk supplies and the delivery of copper concentrate to China will be by road to the point of sale at the Mongolian/Chinese border. Oyu Tolgoi is constructing a paved road to the border as part of the Project development. This is an existing road which will be upgraded by Oyu Tolgoi, and which will be a designated Mongolian national road. Once constructed the road is planned to be operated and maintained by the GoM.
- **Power:** Initial electrical power for the Project is expected to be sourced from the Inner Mongolian Autonomous Region, in northern China, following the use of on-site diesel generators during the pre-construction and construction phases. By the fourth year, in accordance with the terms of the IA with the Mongolian government, power must be sourced from a power station within Mongolia. Heating requirements for the Project will be met by on-site coal-fired boilers which will continue to be used throughout the Project life. Oyu Tolgoi is in the process of designing and permitting a coal-fired power plant within the Mine Licence Area. An environmental and social impact assessment to meet the applicable requirements of International Finance Corporation (IFC) Performance Standards and the European Bank for Reconstruction and Development (EBRD) Environmental Policy is currently being undertaken. Due to the fact that designs are not yet finalised and the assessment is still at an early stage, this will be reported as a Supplemental report to this current ESIA.

The key Project features are shown in *Figure 4.2* below.

Figure 4.2: Key Project Features and Locations



4.3 PROJECT DEVELOPMENT

The Integrated Development Plan 2010[11] (IDP10) sets out the basic commercial and technical aspects of the Project within the framework of a signed and effective Investment Agreement with the Government of Mongolia. This ESIA is based on the "Reserve Case" within IDP10, which is based strictly on Proven and Probable Mineral Reserves[12].

Table 4.1: Oyu Tolgoi Mineral Reserves Summary

Table 2.1.2 Total Oyu Tolgoi Project Mineral Reserve, 11 May 2010						
Deposit	**Ore (Mt)**	**NSR ($/t)**	**Cu (%)**	**Au (g/t)**	**Recovered Metal**	
					Copper (Mlb)	**Gold (koz)**
Southern Oyu Deposits						
Proven	127	21.38	0.58	0.93	1 399	2 994
Probable	828	10.81	0.48	0.27	6 980	5 229
Mineral Reserve (Proven + Probable)	955	12.21	0.49	0.35	8 380	8 223
Hugo Dummett Deposits						
Probable (Hugo North – Ivanhoe)	410	51.12	1.90	0.40	15 823	4 368
Probable (Hugo North – EJV Shivee Tolgoi)	27	55.57	1.85	0.72	1 032	531
Mineral Reserve (Probable) (All Hugo North)	437	51.40	1.90	0.42	16 855	4 899
Oyu Tolgoi Project Mineral Reserve						
Proven	127	21.38	0.58	0.93	1 399	2 994
Probable	1 266	24.84	0.97	0.32	23 835	10 127
Mineral Reserve (Proven + Probable)	1 393	24.52	0.93	0.37	25 234	13 121

Notes:

1. Metal prices used for calculating the Southern Oyu Open Pit NSR are copper $1.30/lb, gold $500/oz, and silver $9.50/oz based on long term metal price forecasts at the beginning of the Mineral Reserve work. The analysis indicates that the Mineral Reserve is still valid at these metal prices.
2. Metal prices used for calculating the Hugo North Underground NSR are copper $1.50/lb, gold $640/oz, and silver $10.50/oz based on long term metal price forecasts at the beginning of the Mineral Reserve work. The analysis indicates that the Mineral Reserve is still valid at these metal prices.
3. The NSR has been calculated with assumptions for smelter refining and treatment charges, deductions and payment terms, concentrate transport, metallurgical recoveries and royalties.
4. For the open pit processing and general Administration operating costs have been used to determine cut-off grades are: Southwest and Central Chalcopyrite $3.88/t, Central Chalcocite and Central Covellite $3.41/t.
5. Only Measured Resources were used to report Proven Reserves and only Indicated Resources were used to report Probable Reserves.

[11] Integrated Development Plan: Technical Report, June 2010. AMEC Minproc. (referred to as "IDP10").

[12] Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories. An Inferred Mineral Resource has a lower level of confidence than that applied to an Indicated Mineral Resource. An Indicated Mineral Resource has a higher level of confidence than an Inferred Mineral Resource but has a lower level of confidence than a Measured Mineral Resource. A Mineral Reserve is the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic and other applicable factors that demonstrate, at the time of reporting, that economic extraction can be justified. For further information refer to: http://www.cim.org/committees/cimdefstds_dec11_05.pdf

4.3.1 Project Development Budget & Timetable

In late 2009, the joint Ivanhoe Mines Ltd - Rio Tinto - Oyu Tolgoi Technical Committee conditionally approved commencement of full-scale construction of the Project. The budget for 2010 provided for an early start on a site-wide development programme to be conducted in parallel with financing of the Project.

In late 2010, the joint Technical Committee, the Oyu Tolgoi Board and the Ivanhoe Mines Board approved a 2011 budget of $2.4 Billion to accelerate construction and bring production forward to late 2012

4.3.2 Project Economic Context within Mongolia

Economic and fiscal forecasts have been derived from publicly available information contained within IDP10, the independent technical report prepared on the Project. Due to the accelerated construction schedule that has been developed and is being implemented for the Project, actual expenditure will also be accelerated and workforce numbers are in excess of those used in the financial model. For example, the IDP10 model assumes a peak construction workforce of 7,381, when in December 2011 the workforce reached 17,904 people, the effective peak construction workforce. Nonetheless, the IDP10 financial analysis does provide an indication of the magnitude of expenditure that is expected.

IDP10 financial projections are based on a 2013 start-up for operations - which is now being targeted for 2012. Latest World Bank data[13] for Mongolia provides a 2010 GDP figure of $6,083,047,865 based on a population of 2,756,001. Poverty levels are identified as 36.1% of the population living at or below the poverty line. Mongolia is a member country of World Bank International Development Association. It is one of eighty countries eligible for targeted poverty reduction support where Gross National Income is less than $1,175 per capita.

Based on an average annual cash flow to Mongolia for the construction phase, the IDP10 forecasts suggest that the construction of the Project (before commercial production commences) is increasing national GDP by approximately 15%. Commercial operation of the Project will increase national GDP by 30-40% over the existing level.

Based on an independent assessment of the economic impacts of the Oyu Tolgoi project, the table below provides a summary of key economic and fiscal changes expected to be caused by the Project[14].

Table 4.2: Operations Phase Economic and Fiscal Highlights

Economy ▪ By 2020 Oyu Tolgoi's impact will increase GDP by approximately one-third. ▪ Oyu Tolgoi is projected to lift GDP per person by MNT1.7 million (over $1000) by 2020. ▪ GDP growth is expected to peak at 22% in 2016. ▪ The average GDP growth rate from 2013-2020 is projected to be 11.7% compared to 7.7% without Oyu Tolgoi.
Exports and Imports ▪ Oyu Tolgoi will account for approximately half of exports in 2020. ▪ Oyu Tolgoi is expected to lift the value of real exports by 55 per cent and the value of real imports by 19 per cent by 2020. ▪ Oyu Tolgoi's share of total exports is projected to fall over time as other sectors in the economy grow.

[13] http://data.worldbank.org/country/mongolia

[14] The Development of the Oyu Tolgoi Copper Mine: An Assessment of the Macroeconomic Consequences for Mongolia, February 2011. School of Economic Studies, National University of Mongolia and BAEconomics Pty Ltd.

National Wages

- Real wages increase strongly because both household incomes and government expenditure rise which leads to an increase in the demand for labour by the services sectors.
- In 2020 real wages are expected to be 30 per cent higher because of Oyu Tolgoi.

4.4 PROJECT DEVELOPMENT HISTORY

The first evidence of mining in the area was in the Bronze Age, when the surface copper deposits of Oyu Tolgoi ('Turquoise Hill') were exploited. The historical remnants of this early mining are still apparent and represented by two small square pits on the hill and minor copper smelting slag in the surrounding hills.

During the 1980s, the Oyu Tolgoi district was explored as part of a joint Mongolian and Russian regional geochemical survey, during which the Central deposit area was identified as a molybdenum anomaly. During a subsequent visit in 1983, evidence of alteration and copper mineralisation was discovered at the Southern Oyu Deposit. In September 1996, a team of Magma Copper Company (Magma Copper) geologists visiting the area identified a porphyry copper leached cap nearby.

Magma Copper secured exploration tenements in late 1996, and shortly after this Magma Copper was acquired by BHP. Exploration was then continued by BHP until 1999 when a preliminary resource of 438 Mt, averaging 0.52% copper and 0.25 ppm gold was identified. BHP shut down its exploration in Mongolia in mid-1999. Its interests were acquired by Oyu Tolgoi subject to a 2% net smelter royalty; this royalty was subsequently acquired by Oyu Tolgoi in 2002, the same year as the Hugo Dummett deposit was discovered. Exploration is currently continuing.

4.4.1 Site Infrastructure Development over Time

Prior to 2007, site infrastructure at Oyu Tolgoi principally comprised a geological exploration camp, No. 1 Underground Shaft (under construction) and a temporary airstrip to service exploration activities[15]. The site construction effort ramped up in 2007 and comprised three activities:

- No. 1 Shaft completion and No. 2 Shaft commencing construction;
- Concentrator site excavations; and
- The camp infrastructure expansion.

The concentrator excavation reached 20% completion with the building outline excavated, and the primary crusher and tailings thickeners ready to commence construction. Oyu Tolgoi continued to build out the camp facilities at Oyu Tolgoi throughout 2007. The principal objective was the ability to support the construction workforce upon conclusion of an Investment Agreement with the Government of Mongolia which was anticipated to be concluded in 2007 or 2008.

The camp infrastructure and bed count were increased throughout 2007. The main camp was fully integrated, with a centralised power, communications, water, and sewerage system. Long-term generator power, multiple water wells, and a sewage treatment plant were installed to create a viable camp suited to the Gobi's harsh conditions. Additional utilities (piping and cabling) were installed to support future expansion of the camp and to support full construction. The total installed capacity of the three camp locations stood at 2,500 beds. Basic engineering was completed for the Gatehouse, Administration Building and Truck Shop before the construction work at Oyu Tolgoi was suspended in 2008 due to rapidly deteriorating world economics and delays with regards to the Investment Agreement.

Work to complete the site infrastructure restarted in 2009 and was ramped up further following the signing of the Investment Agreement.

[15] The initial exploration airstrip was located over the site of the planned open pit. As a result, this airstrip was relocated in 2010 to a new temporary location prior to the construction of the permanent airport.

4.4.2 Underground Development & Construction

Oyu Tolgoi completed the construction of No. 1 Shaft to the full depth of 1,380m in February 2008. Shaft No. 1 has a diameter of 7.3 m, is concrete lined to a finished diameter of 6.7 m, and includes a headframe, hoisting facilities, power station, air compressors and ventilation equipment. The design allows for future conversion to permit the shaft to be used as a permanent hoisting facility.

Following completion of the shaft load-out facilities in March 2008, two lateral characterisation drives were commenced at the proposed Lift 1 elevation of the Hugo North block cave mine. The drives enabled further resource drilling which provided geotechnical information to support completion of the mine design and become part of pre-production program for the development of the initial block cave. (An overview of the block caving mining method is provided in section 4.7.1 below.)

The drives are being developed laterally at 1,300 m level by Redpath Mongolia LLC, the Project underground mining contractor, utilising Oyu Tolgoi's fleet of underground mining equipment. The development included the establishment of the "station" at the 1,300 level and incorporated a substation, refuge chamber, pump station and heavy equipment workshop.

Other work conducted during late 2008 and early 2009 comprised the development of the pre-production development implementation plan. In November 2008, as a consequence of the rapidly deteriorating world economics and continued delays in finalisation of the Investment Agreement, underground operations were scaled back with a reduction of the workforce by 50%.

Construction of No. 2 Shaft started in 2007 with the excavation of the shaft collar. By December 2007, concrete work had been completed to a point 13 m below the surface. Shaft No. 2 will be a combined production/service shaft and is designed to accommodate two 54 tonne capacity skips and a cage with a payload capacity of 44 tonnes. The shaft will have a finished diameter of 10 m and will be sunk to an initial depth of 1,335 m. No work was undertaken on site for Shaft No. 2 during 2008; however detailed engineering progressed as planned, and work on the Shaft and associated infrastructure (conveyor and ventilation tunnels etc) restarted in the summer of 2010.

Figure 4.3: Shaft 2 in Construction, March 2011

4.5 LAYOUT

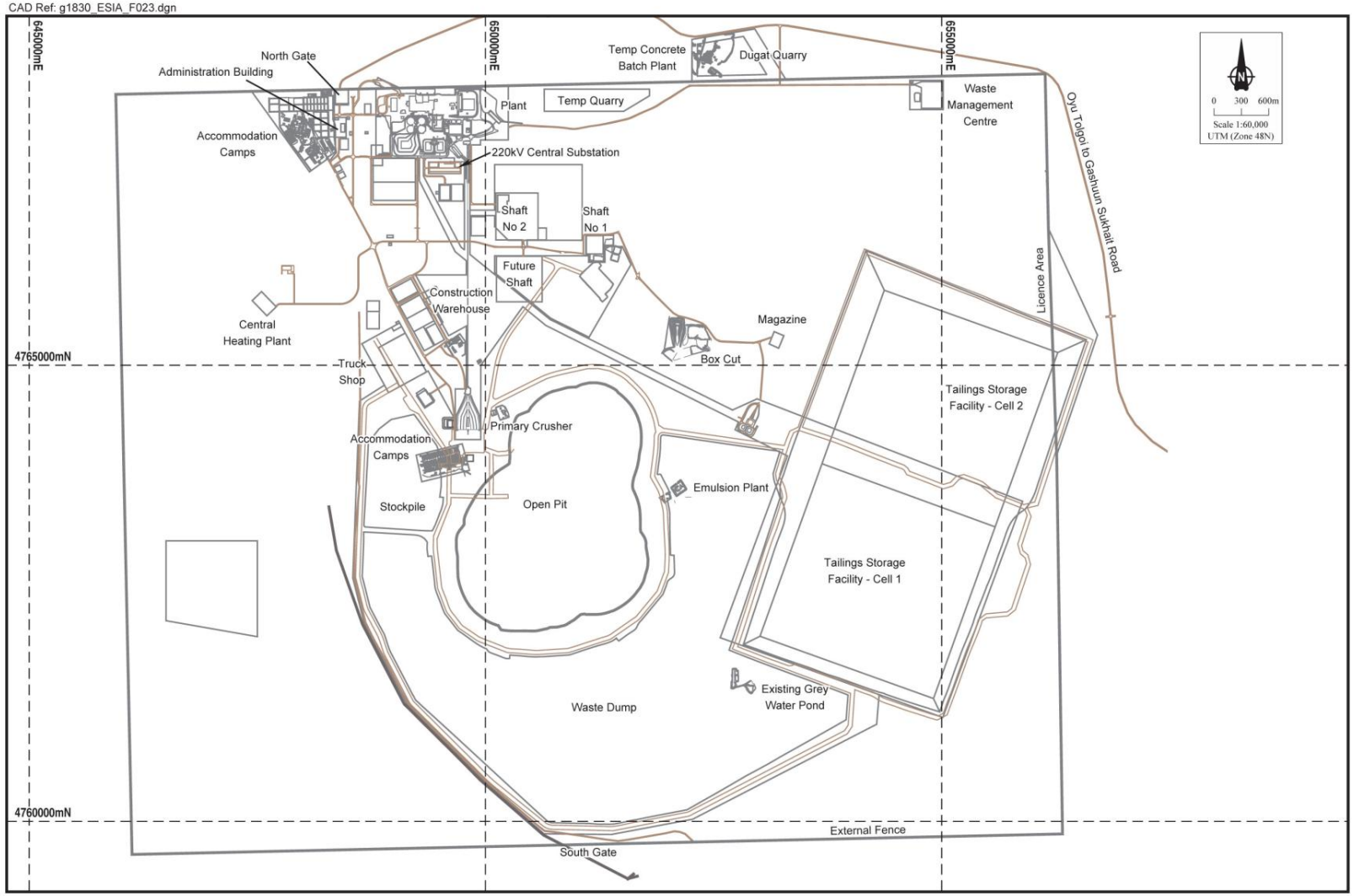
The mine, processing plant and associated infrastructure (tailings storage facility, waste rock dumps, etc) are located within the boundary of mining licence 6709A, although the north-(the Mine License Area) eastern corner of the Tailings Storage Facility extends some 500 metres outside the eastern boundary of the Mine Licence Area[16]. Several ephemeral water courses flow across the Mine Licence Area, of which the largest is the Undai. The exploration airstrip has been closed due to the requirement for the land for infrastructure and a new temporary airstrip and associated infrastructure constructed approximately 7 km north of the Mine Licence Area.

Some of the underground workings and the associated area of surface subsidence (due to the underground "collapse zone") will extend north out of mining licence 6709A into Entrée Gold Inc's Shivee Tolgoi JV Property mining licence area (see *Figure 4.10*).

The site layout showing the locations of the mines, deposits and key infrastructure for the planned Project is shown in *Figure 4.4* below.

[16] The planned extension of TSF Cell 2 outside the boundaries of the Mine Licence Area will be subject to regulatory approval.

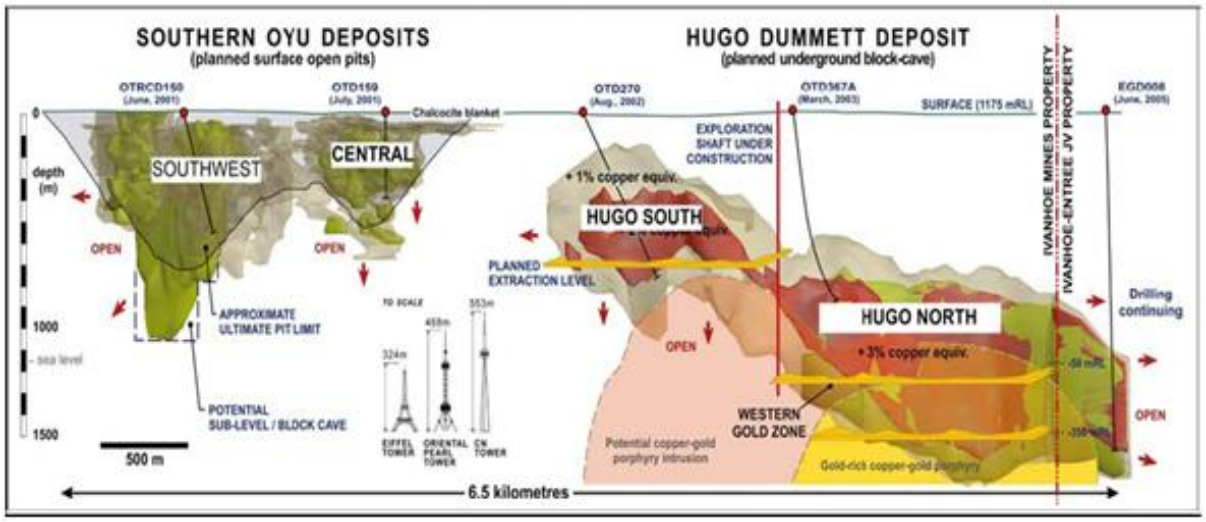
Figure 4.4: Planned Site Layout



4.6 MINING OPERATIONS

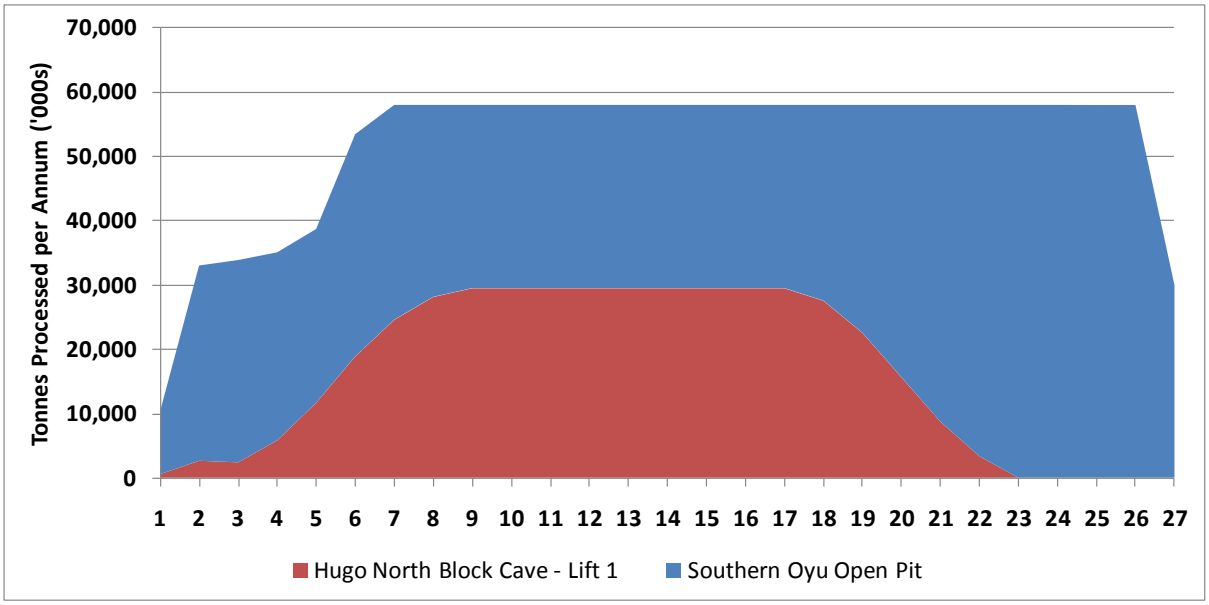
The proposed Oyu Tolgoi mining operations consist of an open pit (Southern Oyu Deposits) and underground mine (Hugo North Deposit) as shown in *Figure 4.5* below.

Figure 4.5: Profile of Ore Bodies



The Southern Oyu deposits are amenable to open pit mining, of which the gold-rich, near-surface Southwest zone will be the first mining development and will provide most of the plant feed for the first four years of mine life (2013 to 2017). The Hugo Dummett deposit is best suited to block-cave underground mining. The Hugo North ore is of higher grade than the open pit, so as the Project develops, underground production will be increased to displace production from the open pit as soon as possible.

Figure 4.6: Production Contribution by Deposit (based on IDP10 Reserve Case)



4.6.1 Open Pit Mine Design

The open pit is designed as a concentric series of 15 m high and 6 to 12 m wide “benches” which are successively excavated to extract the ore and to create a safe and stable slope profile. The open pit will be created using conventional blasting techniques (explained later in this section) to loosen the ore which

is then collected by a large mechanical shovel and deposited in a haul truck for removal from the open pit and subsequent transportation to the ore processing facility, or storage as waste rock (if metal concentrations are too low for economic ore processing) The benches form a series of roadways, allowing haul trucks to remove material from the open pit. The open pit will have a maximum planned depth of 770 m.

The open pit work has focused on the Southern Oyu deposits which are sub-divided into: Southwest, Central, South, Far South, Wedge, and Bridge. The footprints and design of the eight pit phases are shown as a schematic in *Figure 4.7* and *Figure 4.8*. This illustrates the successive stages of excavation that will be undertaken and gives an appreciation of the nature of the benches to be found in the open pit.

Figure 4.7: Open Pit Phases

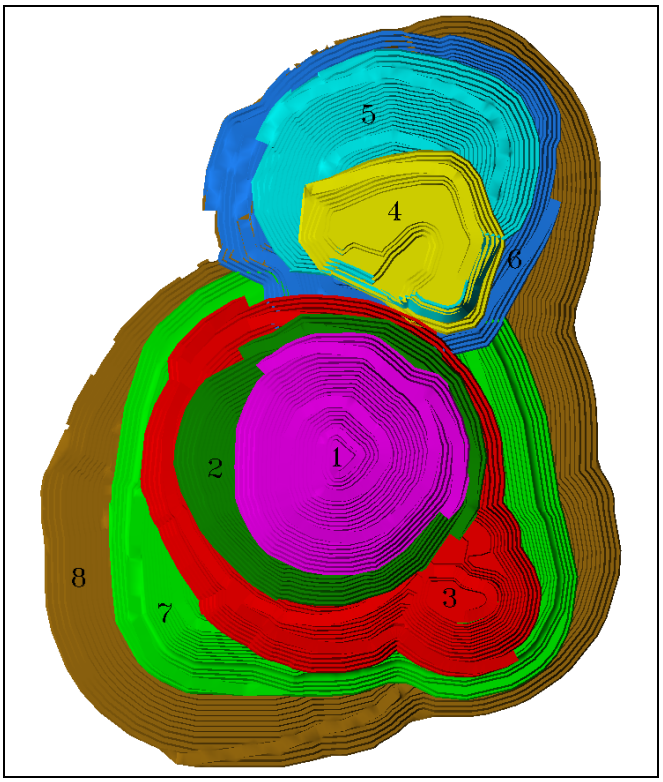
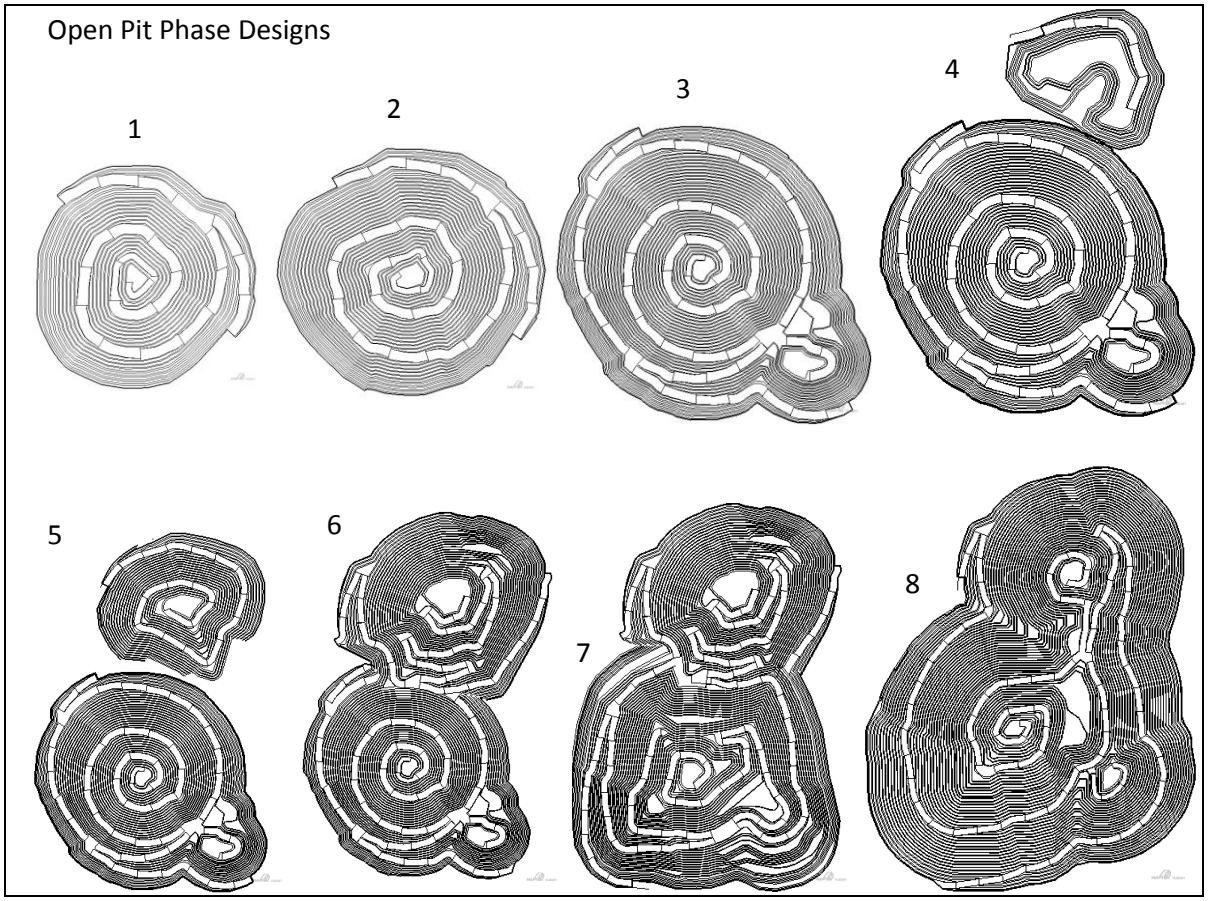


Figure 4.8: Open Pit Phase Design



4.6.2 Open Pit Operation and Equipment

Working Shifts

The open pit mining operations are scheduled for 350 days per year. The 350 days is based on the assumption that 15 days per year will be lost due to unscheduled delays such as weather conditions (e.g. during sand storms or extreme cold). The open pit equipment will operate 24 hours per day in two 12 hour working shifts.

Labour

Based on operation requirements, Oyu Tolgoi has prepared a comprehensive labour roster that includes local and expatriate personnel. Technical and senior professional positions are currently being advertised and a significant number of key expatriate personnel will be required to help with start-up, training and mentoring. There is a significant increase in the number of local and expatriate personnel required, starting in 2012, as seen in *Table 4.3* below

Table 4.3: Open Pit Start-up and Peak Labour

Labour Category	Dec 2011	Dec 2012	Dec 2013	Dec 2019
Contractor				
Expatriate	46	47	46	12
Local	175	181	179	83
Total Contractor Labour	**221**	**228**	**225**	**95**
Employee				
Expatriate	30	46	47	11
Local	175	384	397	478

Labour Category	Dec 2011	Dec 2012	Dec 2013	Dec 2019
Total Employees	205	430	444	489
Total Employee Labour	**426**	**658**	**669**	**584**
Total Expats	76	93	93	23
Total Local	350	565	576	561
National Hire Ratio	82.15%	85.86%	86.09%	96%

Mining Equipment

Open pit mining at Oyu Tolgoi is planned to be undertaken by conventional "truck and shovel" operations. The Oyu Tolgoi workforce will carry out drilling, loading, hauling, and dumping. Equipment maintenance will be undertaken by a Maintenance and Repair Contract (MARC) arrangement, and a contractor will provide blasting products and services. Planning is based on a mixed fleet of 34 m^3 diesel hydraulic shovels, 56 m^3 electric rope shovels and 290 t diesel trucks. *Table 4.4* below provides a summary of mining equipment planned to be used over the life of the open pit.

Table 4.4: Preliminary List of Equipment in Service

Equipment In Service	2011	2012	2013	2016	2021	2026	2031
	No.	No.	No.	No.	No.	No.	No.
Shovel 34 m^3 Diesel	2	2	2	2	2	2	2
Shovel 495 HR Rope Electric	-	2	2	2	2	2	2
220 t Class Truck	-	-	-	-	-	-	-
290 t Class Truck	14	27	27	27	32	33	44
Production Drill – 39R Electric	1	2	2	2	4	4	4
Production Drill – 39R Diesel	2	2	2	2	-	-	-
Dozer – D375-6	4	4	4	4	4	4	4
Dozer – D475-7	-	2	2	2	2	2	2
Grader – 16M Cat	2	3	3	3	3	3	3
Grader - 24M Cat	-	1	1	1	1	1	1
Front End Loader 18 m^3	2	2	2	2	2	2	2
Wheel Dozer	1	2	2	2	2	2	2
100 t Watercart	2	2	2	2	2	2	2
Tyre Changing Forklift	1	1	1	1	1	1	1
Integrated Tool Carrier	2	2	2	2	2	2	2
Excavator 4 m^3	1	1	1	1	1	1	1
Crane	1	1	1	1	1	1	1
Cable Truck	1	1	1	1	1	1	1
Blasting MMU	2	3	3	3	3	3	3
Flat Bed Crane	1	1	1	1	1	1	1
Low Loader / Trailer (110 t)	1	1	1	1	1	1	1
Lighting Towers	15	24	24	24	26	26	26
Personnel Carriers	3	5	5	5	5	7	7
Mine Lube Truck	3	3	3	3	3	3	3
Forklift	2	2	2	2	4	4	4
Secondary Drill	1	1	1	1	1	1	1
Mine Fuel Truck	3	3	3	3	3	3	3
Light Vehicles	31	32	32	32	32	28	28
Pit Pump	3	3	4	9	15	19	19

Equipment In Service	2011	2012	2013	2016	2021	2026	2031
	No.	No.	No.	No.	No.	No.	No.
Crane (120 t)	1	1	1	1	1	1	1
Low Bed Trailer / Tractor (250 t)	1	1	2	4	4	4	4
Trucks for Tailings (220 t)	-	3	3	3	2	-	-

The equipment in use peaks in year 23 and then progressively decrease as the pit is worked out.

Drilling and Blasting

Blast holes for ore and waste production drilling will be 17 m deep and 305 mm in diameter. A contractor will carry out blasting activities including supply and storage. It is assumed that ammonium nitrate fuel oil (ANFO) will be used in dry holes and heavy ANFO in wet holes (if any). Due to the prevailing rock conditions, 90% of blasting is expected to be in dry conditions. All material is assumed to require blasting, while free digging may be possible in the first or second benches. Due to the timing of the power supply construction, the initial two production drills are assumed to be diesel units with the second two to be electric units. As replacement units are required, these drills will be replaced with electric powered drills.

Loading and Hauling

The primary loading fleet will be two 34 m^3 bucket hydraulic shovels and two 56 m^3 electric rope shovels. In normal operation, one of the shovels will be mining mainly ore from the lower pit stage, and the other(s) will be stripping waste for the development of the next stage. One of the shovels will be moving between the pit stages to assist in mining the sub-grade material in the ore zones or stripping an upper pit stage.

In addition to the four shovels in preproduction, two 18 m^3 front end loaders (FEL) will be purchased to provide additional flexibility in ore / waste loading capacity and stockpile management.

Ore Control

The blast holes will be routinely sampled in all potentially mineralised areas. Assaying (testing) for copper, gold, and impurities will be performed in the site laboratory.

Open Pit Mine Dewatering

The open pit may collect water in its lowest level from local groundwater seepage, or rainfall. Pit dewatering will be performed by diesel-powered pumps from in-pit sumps to the process plant where the water will be used for ore processing make-up water.

The course of the Undai (both ephemeral surface flows and sub-surface flows) will be diverted around the open pit area to ensure continuity of flows without compromising mining operations. Waste rock dumps around the open pit and a diversionary dam embankment will be constructed to act as a diversionary barrier to surface flows, and a system of underground pipes will be installed to capture and divert subsurface flows around mining operations to rejoin the existing flow routes to the south of the open pit. Further details of this can be found in *Chapter C5: Water Resources Impact Assessment* and *Chapter D7: Water Resources Management Plan*.

4.7 UNDERGROUND MINING

Open pit mining will provide almost all ore for the processing plant for the first four years of operation, after which time underground mining from the higher-grade Hugo North deposit will start to displace the supply of ore from the open pit mining. Open pit operations are likely to be decommissioned soon after Year 27. Underground mining will require no further significant on-surface waste rock dumps as all material removed from underground mining will be processed as ore.

4.7.1 Mining Method

Mining will be undertaken by an advanced mining method referred to as “block caving”.

An Overview of Block Caving

Block caving is a high-tonnage underground bulk mining method generally applied to large homogeneous ore deposits. Ideally, the ore to be caved should be structurally weak, and the waste overburden should be weak enough to collapse over the ore without inducement as the ore is extracted.

Block caving involves excavation of natural support from beneath the ore, causing the structure of the ore body to fail and collapse into the excavated void under the force of gravity and local geo-mechanical stresses. The broken ore is then pulled out from under the caved section through a drawpoint arrangement, subsequently removing support from ore and overburden at increasing height above the initial excavation, and eventually extending the cave upward to the surface.

The attractive aspect of block caving is that only a relatively small portion of the ore must be drilled and blasted prior to extraction. Once the cave initiates, production continues without further primary drilling and blasting until the ore column above is exhausted.

The block cave mining sequence begins with access and infrastructure development, followed by excavation of the extraction level, and undercutting the ore. The sequence culminates in steady-state production from individual drawpoints.

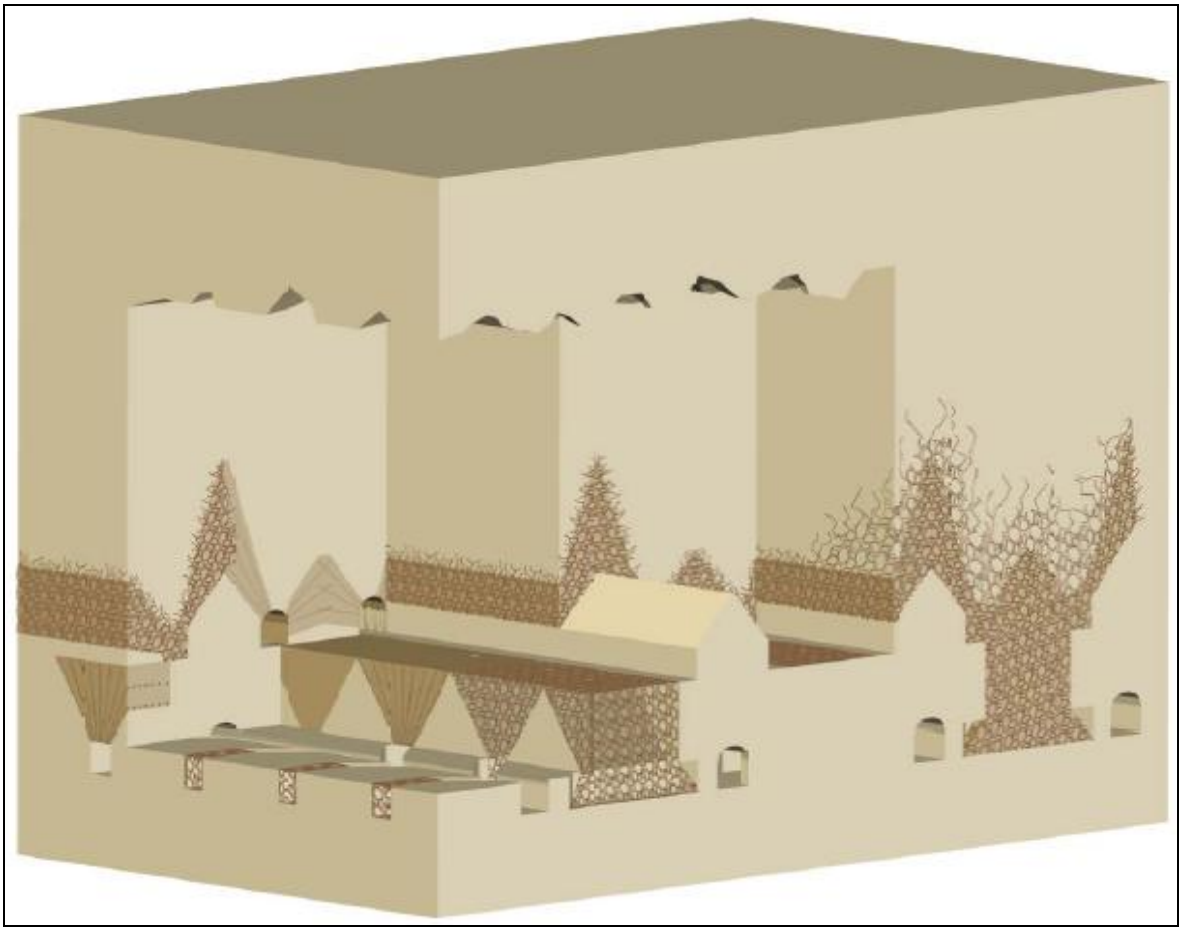
Ore in the column is diluted by material in adjacent columns and ultimately by overburden and adjacent waste rock. When the column drawdown is complete and drawpoint grade drops below a minimum value, the drawpoint is abandoned. Great care is taken in establishing uniform draw practices throughout the mine to maximise drawpoint life and minimise dilution and stress loading from underground workings.

Block caving is a capital-intensive mining method, requiring significant investment early in the mine life for infrastructure and primary development. Once in place, the method's high up-front costs are offset by high production rates and low operating costs (relative to other underground methods) over a considerable length of time, resulting in a low overall cost per tonne. Block cave mining is among the least costly of all underground mining methods per tonne of ore extracted.

Block caving has a number of positive attributes including no waste rock storage on the surface and no large open pits. One consequence of block cave mining, however, is the potential for surface subsidence or settling. Surface subsidence is caused as the material above the ore body gradually moves downward to replace the ore that has been mined.

Using industry standard engineering practices, it is possible to predict both the cave and subsidence zones based on ore body knowledge gained during exploratory geological investigations. However, the best understanding of caving and subsidence will come once mining begins.

Figure 4.9: Block Cave Schematic



Ore will be mixed with some adjacent waste rock, but careful control of the block caving process minimises the "dilution" to ore from non ore-bearing rock. When the concentration of ore in the rock falls below a minimum value, the individual drawpoint will be abandoned.

Draw control is the management, or control, of the cave draw down and is critical for both safe operation of the cave and maximum recovery of the ore with minimum dilution. Once undercutting commences, the cave must be kept moving at all times to prevent compaction of the cave waste and stress loading of surrounding development and infrastructure.

Caving with a flat footprint is a proven, safe, and low-cost mining method currently used at several operations around the world. Rio Tinto currently has established block caving operations at the Palabora copper mine in South Africa and the Northparkes copper mine in Australia.

Production Plan

The production schedule is broken into three phases: pre-production, production build-up, sustaining production.

- ***Pre-production*** is defined as the development required prior to initiating first drawpoint. This phase will be undertaken over a 5-year period.
- ***Production*** build-up commences once the first drawpoint is initiated during Year 1 of production. Production commences during Year 1 and production increases steadily until 84,200 tpd is reached at the end of Year 8 (2021) of production.
- ***Sustaining production*** is the period from the first year of full production through to the end of the mine life. Year 8 is the first year of full production. The last year of full production will be Year 16 (2029), with output tapering off to 16,000 tpd at the end of the mine life in Year 21.

Subsidence Evaluation

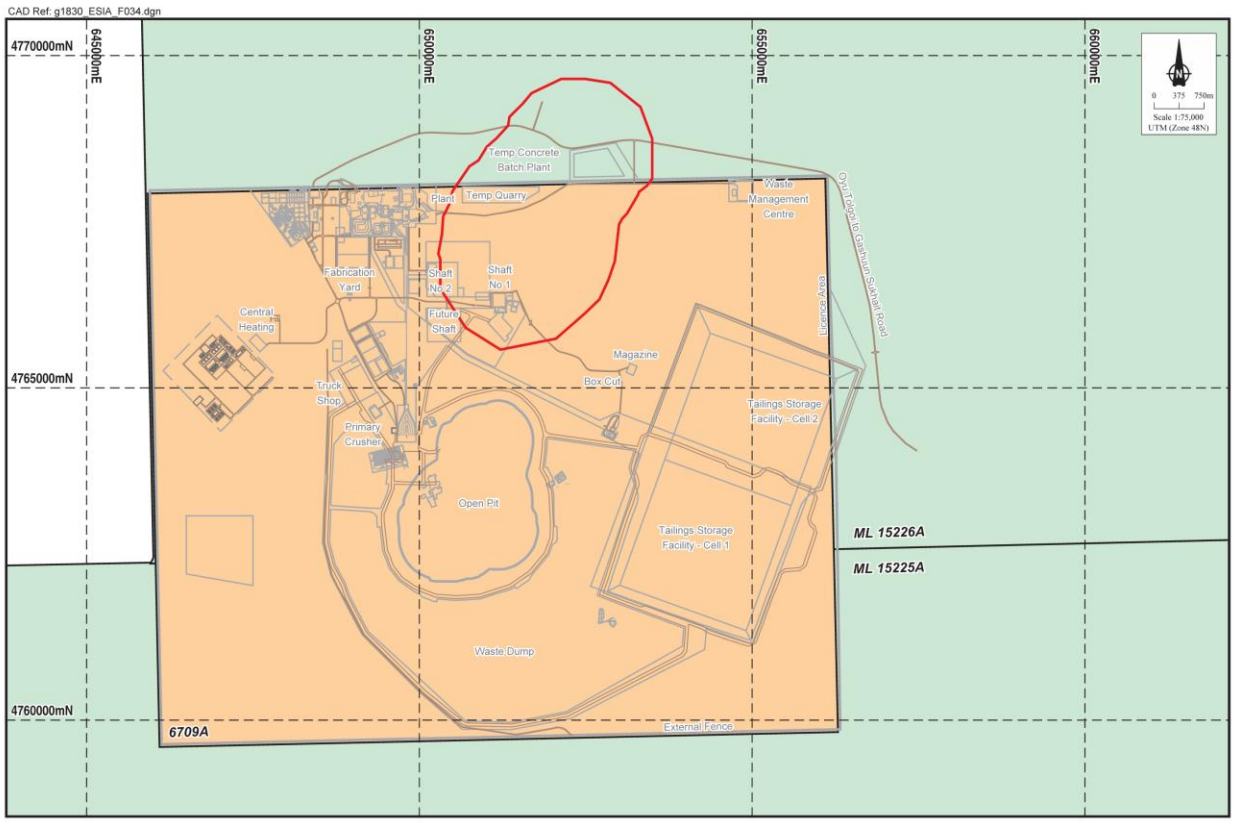
The subsidence zone from the extraction level to surface is projected to develop at an angle of 60º as set out in *Figure 4.10*. All planned infrastructure is outside this zone, except for Shaft No. 1, which is located inside the 60º subsidence area at the edge of the 65º subsidence line. It is assumed that Shaft No. 1 will be stripped of all conveyances once full production is achieved and will be used for ventilation only. Subsequent work by Oyu Tolgoi and Rio Tinto in 2010/11 has indicated that 50º is a more representative subsidence angle and this has been factored into detailed engineering and design planning.

It is not known precisely how the cave will propagate and be expressed as a surface depression with significant uncertainty with regards the shape of the subsidence zone and the character of any surface expression (cliffs or steep slope). The projection shown in *Figure* 4.10 merely illustrates the extent of surface area that the generalized subsidence projections set out. The main uncertainties lie in the structural integrity and fragmentation of the ore body once block caving commences. The on-going underground development programme, including underground excavation and drilling, will allow this model to be refined.

In practice the subsidence zone will be irregular and strongly influenced by fractures, fault lines and geological boundaries within the underground ore body. It is likely to have an elongated rather than circular shape. The drainage of any groundwater within the vicinity of the subsidence zone will be strongly influenced by the size of the subsidence zone and the surrounding zone of drawdown within which surface and groundwater will drain into the block cave. Any groundwater contamination from the oxidation of rock that is exposed to air and water will be captured within the zone of drawdown and subsidence zone.

Further information and assessment of this issue are included in the baseline *Chapter B5: Topography, Landscape, Geology and Soils* and the impact assessment *Chapter C4: Topography, Landscape, Geology and Soils*.

Figure 4.10: Project Block Cave Subsidence Zone



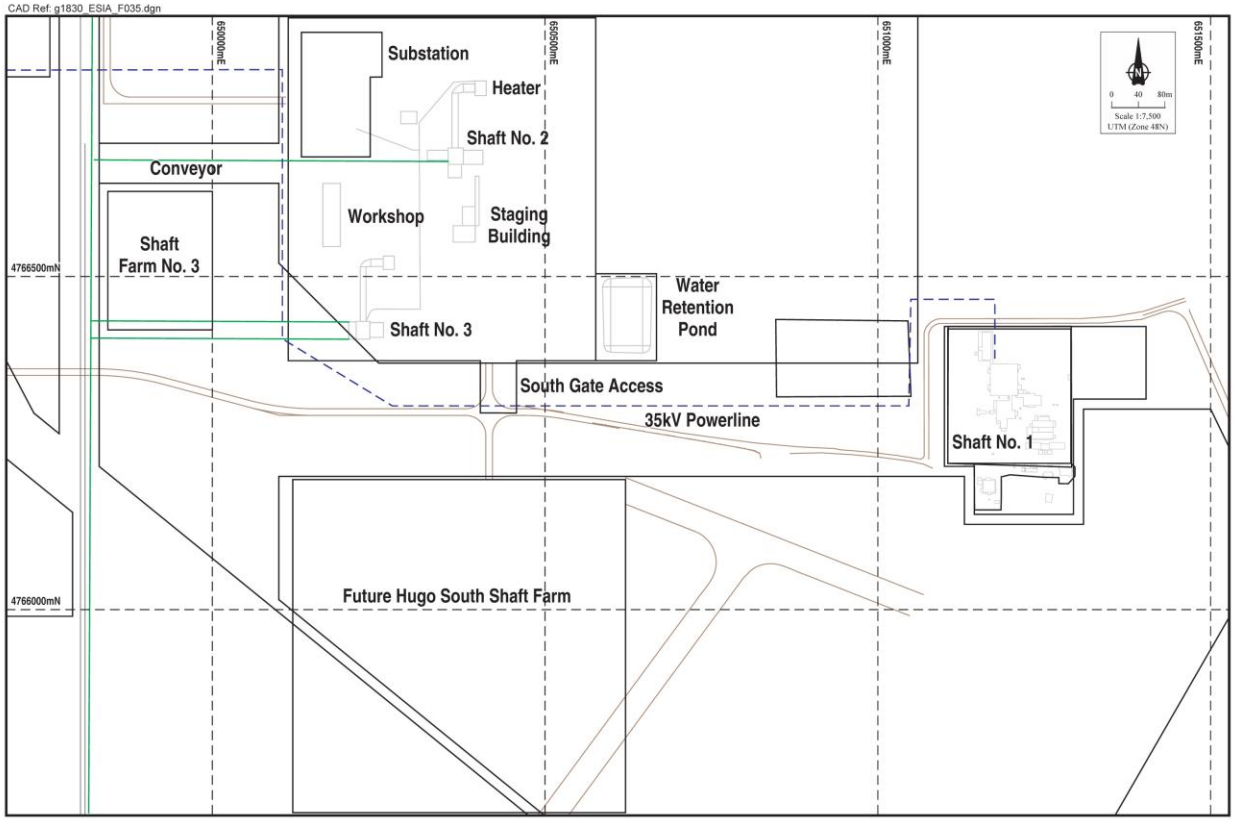
4.7.2 Surface Facilities and Shafts

Surface facilities will comprise a number of shafts used for personnel access, ore extraction, ventilation and emergency access. Shafts will be supplemented by a range of ancillary buildings and facilities, including power supply, water supply, offices, heating plants and the conveyor system to the ore processing plant.

Surface Infrastructure

Figure 4.11 shows the Shaft Farm surface layout around Shaft Nos. 1, 2 and 3. Shaft No. 4 is located approximately 3 km to the northeast of Shaft No. 2 and will be used for ventilation only; therefore, there will be no major surface infrastructure located near Shaft No. 4 with the exception of power, water supply, and ventilation fans.

Figure 4.11: Shaft Farm Surface Layout



Shaft No. 1

Shaft No. 1, which has already been constructed, is required for exploration and geotechnical characterization and is also used for preproduction development. Exploration includes further definition of underground characteristics by underground bulk sampling and drilling from the planned characterization drift tunnel. Shaft No. 1 was excavated to approximately 7.5 m diameter and finished to 6.7 m. The shaft collar elevation is 1,165 above mean sea level (msl) and the depth of the shaft is 1,385 m.

Shaft No. 2

Shaft No. 2 will provide the bulk of all movement of personnel, materials, equipment and services for the mine. It will also provide approximately a third of the total hoisting capacity of the mine and serves as a primary ventilation intake.

Shaft No. 2 will be a 10 m diameter concrete-lined shaft fully equipped with steel sets on 6 m centres. The collar of Shaft No. 2 is at 1,174 above msl, and the shaft is to be sunk to a depth of 1,335 m.

Shaft No. 3

Shaft No. 3 will be similar in design to Shaft No. 2 insofar as it is 10 m diameter concrete lined equipped with steel sets on 6 m centres. Shaft No. 3 will serve as a dedicated production shaft and fresh air supply. The collar of Shaft No. 3 will be at 1,174 above msl, and the shaft is to be sunk to a depth of 1,273 m. The Shaft No. 3 hoisting system will have a total productive capacity of 55,606 tpd.

Shaft No. 4 (in Shaft Farm No. 3 location)

Shaft No. 4 will provide additional exhaust ventilation required after production exceeds 28,000 tpd and will comprise a dedicated primary exhaust ventilation and secondary escape. Shaft No. 4 will be concrete-lined to a 10 m diameter and sunk to a total depth of 1,153 m. There will be no conveyances in the shaft except for an emergency auxiliary cage.

4.7.3 Underground Rock Handling

Ore Handling

The ore handling system transports ore from the drawpoint on the extraction level to the concentrator plant on surface. The system is based on a series of dump trucks, crushers, conveyors and shaft hoisting to the surface.

Development Rock (Waste) Handling

Waste and low-grade ore will be produced primarily from pre-production development activities. Prior to commissioning Shaft No. 2 all development waste will be transported to Shaft No. 1 for hoisting to the surface. At the surface, the waste is dumped on a dedicated stockpile near Shaft No. 1, and this material will ultimately be used as feed for the processing plant. This stockpile is located on the Cretaceous clays that overlay the area and has perimeter drains which capture any run-off and pass it to an engineered evaporation pond located within the clay.

Shaft No. 1 continues to be used for muck (waste) hoisting until such time as the ventilation requirement increases during production build-up at which point Shaft No. 1 will be stripped and used primarily for exhaust ventilation.

All trucks used during the development phase will be used to dump the ore into in-situ crushers for transfer into the ore handling system which leads to the production shafts for removal to the surface.

4.7.4 Mine Ventilation

Air quantity requirements are determined from airflow requirements specified for the production and development areas, transportation and haulage levels and fixed facilities. Ventilation in each area must be sufficient to dilute air contaminants to acceptable limits.

Air quantities are based on diesel emission dilution of 0.06 m^3/s/kW of diesel engine rating. The diesel engine ratings are based on technical specifications for major equipment. The ventilation criteria determine the total ventilation requirement for the underground mine. A total airflow volume of 1,850 m^3/s (0.022 m^3/s per tpd) is required at full production to provide adequate ventilation for mobile equipment, fixed facilities and personnel in the mine. The proposed final ventilation system consists of a “pull” network with all primary ventilation fans located on the exhaust side of the mine.

Dust control is expected to be a major concern underground because of both dry conditions predicted from the hydrology modelling and lack of any groundwater encountered during the driving of the exploration levels. If the silica content in the ore is higher than normal levels, the severity of the dust problem may be increased. It is impossible to predict where or when dust-generating drawpoints will be encountered. Therefore, a comprehensive dust control program is incorporated into the design to mitigate the dust problem. Water sprays are installed at all key points throughout the ore handling process where ore is disturbed and may generate dust. Further information on underground occupational safety management is set out in *Chapter D19: Worker Health & Safety Management Plan*.

Maintenance shops, fuel and lube storage areas, explosives magazines, and conveyor beltways are designed with direct connections to exhaust airways in order to prevent working areas from becoming contaminated by gases from potential fires caused by chemical, physical or electrical accidents.

4.7.5 Mine Air Heating and Refrigeration

Mine air heating will be required for fresh air through both Shaft No. 2 and 3 during the winter.

The mine air heating system at Shaft No. 2 will be composed of several finned heat exchanger coils supplied by a district heating hot water circulation loop. The coils are arranged in parallel within an insulated building. A set of two booster fans are installed on the rear of the mine air heater to draw air into the building, and through the coils; the heated air is then drawn underground by the primary ventilation fans. This heating system is duplicated at Shaft No. 3.

The data collected at site suggests there is an average requirement of 1,485 degree-days of heating each year. Coupling these degree-days with the heat required per hour and degrees of heating, the total annual heating requirement is 74 GWh per year.

Recent experience on site has shown that heat mitigation measures are required periodically during the summer months. The most practical solution to this problem is to reduce the temperature of the air being supplied to the work face.

Cooling of mine development headings is accomplished using packaged in-line refrigeration units. One of these units is provided for each development crew. The units are installed in abandoned muck bays and cooled air passing through the units is mixed with other intake air and ducted to the working faces. The cooling units are located 300-500 m from the working faces and are advanced periodically as development progresses. Refrigeration units are only required for a few months each summer.

4.7.6 Mine Access and Logistics

Personnel, equipment and materials will be transported into and out of the mine via the service cage at Shaft No. 2. The cage will have a payload capacity of 38 t with dimensions of 3.0 m wide by 8.75 m long. The cage is sized to allow hoisting of fixed and mobile equipment with minimal disassembly.

The main focus of the Shaft No. 2 main station will be the efficient and safe flow of unloading and loading personnel and materials. Personnel are separated from the material handling and are in safe designated areas during loading or unloading of the personnel transports (buses). A designated supply lay-down area with a 10 t cargo monorail will be provided on both the east and west sides of the cage.

Emergency response plans for underground activities has been prepared by the principal underground mining contractor, Redpath Mongolia LLC and are included in *Chapter D20: Emergency Response Plan*. Multiple shafts will provide for maximum flexibility if underground accidents or incidents do occur.

4.7.7 Fixed Underground Facilities

Underground Warehouse

The Hugo North operations will not utilise an underground warehouse. The central surface warehouse will store all underground material prior to transit underground. The underground storage areas are the shops, fuel station, explosives magazine, etc. that are designed to store a 3-day supply of materials.

Maintenance Shops

Service bays located at either end of each underground working cater to vehicles on a breakdown basis. Service trucks will repair the majority of these breakdowns; those that require additional work will be transported to one of the maintenance shops. Field service and repair trucks will also be employed to provide minor repair and lubrication services at the working face.

The main maintenance shop will be located along the service drifts from Shaft No. 2 on the west side of the extraction level to give access to the service shaft and ventilation airways. The main shop will be equipped to service all underground mobile equipment and support equipment, and will have welding facilities and an electrical shop.

Two “satellite” maintenance shops will be located along the east side of the extraction level servicing the northern and southern portions of the mine, with an additional satellite shop located near Shaft No. 1 for preproduction development. The satellite shops are set up to handle minor repairs, tire and bucket changes, and required equipment planned maintenance. The lunchroom in each satellite shop will serve as a mine refuge chamber.

Fuel and Lube Stations

Diesel fuel will be transferred underground daily in fuel-truck-sized batches of 7,500 L using a fuel drop system located in the utilities compartment of Shaft No. 2. The fuel drop pipe is installed in a dedicated borehole, which is located between the extraction level fuel station and the haulage level storage station.

Underground, fuel tanker trucks will supply fuel to four 10,000 L underground storage tanks. These storage tanks will be enclosed within a concrete containment area with fire suppression systems. The storage area will be adequately ventilated, with the exhaust air flowing to a dedicated exhaust air stream. Fuel will be transported to Shaft 2 by fuel tanker from the main fuel storage area on an as-needed basis.

Explosives Magazine

Development and operation requires bulk emulsion as the primary blasting agent for both production and development blasting. The emulsion storage and the blasting cap magazine will be physically separated to reduce accident risks.

Underground Office and Lunchroom

Mine rescue, first aid facilities, employee lunchrooms and lockers for all underground workers are provided as part of the office and lunchroom facility.

Refuge Stations

The mine will have several refuge stations for use in case of emergency. These are designed to be sealed and pressurized from the compressed air line in Shaft No. 2. Emergency drinking water and oxygen supplies will be maintained in each station. The refuge stations are located in areas from which escape routes may be blocked, and in locations further removed from the mine's exit areas. The lunchrooms will be fitted with doors and emergency oxygen supply cylinders for use as a refuge chamber, and refuge stations will also be provided at each of the satellite maintenance shops.

Compressed Air

A surface compressed air facility will be installed for the sinking of Shaft No. 2 and a compressed air line (250 mm diameter) will be permanently installed in the shaft being retained after the shaft sinking is complete. The air will be supplied at the shaft station, but no reticulation is planned throughout the mine, except for the health and safety requirement of a compressed air supply to the refuge chambers from compressors located on surface. A surface compressor plant is currently in operation at Shaft No. 1 to meet the compressed air requirements for exploration development and preproduction development undertaken from this shaft.

A combination of portable, fixed, and mobile equipment onboard compressors provides the principal compressed air requirements. Electric and electro-hydraulic systems are also used for some specific applications.

Water Management

Face pumps can be used to handle water encountered during lateral tunnel development. Any face pump discharge will be routed to intermediate sumps and a temporary stationary pumping system to lift any excess water out of the heading. The aim however is to treat water underground and re-use it underground The ground water inflow rates are expected to be negligible. No water has been intercepted during shaft sinking or development. The mine pumping system has been designed with a designed flow rate of 10 L/s. The mine emergency electrical generation plant will supply sufficient power to operate one set of main pumps in Shaft No. 2. This mine water discharge pumping system will feature high-head pumps capable of pumping from the main pump station to surface in a single lift.

Service water required for mine operations will be provided from raw water sources in the Gunii Hooloi surface well field. Raw water from these wells is routed to a 450,000 L service water tank at the shaft farm. The tank will supply service water to the surface facilities and down Shaft No. 2. A high-pressure water line feeds directly from surface to the underground main station providing shotcrete/concrete pipe clean-out water.

Shotcrete and Concrete Distribution

The existing surface batch plant is used for underground concrete and shotcrete requirements. The surface transmixer trucks will discharge into a hopper near and to the north of the Shaft No. 2 collar, which directly feeds the in-shaft slick lines. Shaft No. 2 will have three 152 mm slick lines, one in use and

two spares. The concrete and shotcrete slick line delivery point will be the main station, where the slick line discharges batched amounts of material to underground 4.6 m^3 transmixer trucks for delivery to the point of use. This design is similar to the system at the Henderson Mine, which has been successfully operated for over 30 years[17].

Power and Communication Systems

Electrical power will be fed to the Shaft Farm from the main substation at the concentrator at 220 kV. Three main 220/35 kV, 75 MVA transformers feed a gas insulated switchgear (GIS) distribution line-up, which in turn feeds the 35/10.5 kV transformers and distribution switchgear. The 35 kV distribution will include the Shaft No. 2 and 3 main hoists, underground feeds, surface conveyors, and an overhead line to Shaft No. 1 and 4. The 10.5 kV distribution feeds surface ancillary loads, headframe loads, ventilation fans and heaters, compressors, office facilities, and underground feeds for shaft pumping.

Development from Shaft No. 1 is powered by rented diesel generators until the Project diesel power station (DPS) is available. After the 220 kV power line is available in 2012, it will supply No. 1 shaft requirements. Shaft No. 2 sinking will be started using power generated at the DPS until the 220 kV line is available. At Shaft No. 2, a 1,250 kVA emergency diesel generator is also available during sinking. Upon its completion, the proposed 200 kV line from the Inner Mongolian Autonomous Region, in northern China will supply all power to the site.

There will be an emergency generator within the Shaft Farm to facilitate orderly evacuation of the mine. The emergency loads include underground Shaft No. 1 main exhaust ventilation fans, Shaft No. 2 auxiliary hoist, Shaft No. 2 service hoist clamp lift device and critical communications and feeds to Shaft No. 3. Shaft No. 1 has an additional emergency generator for the auxiliary hoist installed during sinking and development.

The underground production substation will have feeds to the individual crusher substations and sacrificial conveyors. The main conveyor drives are close to Shaft No. 2 and have their own substation that is fed from the Shaft No. 2 main station. The Shaft No. 2 substations will also feed the skip loading conveyors and main pump station.

Communication throughout the mine is provided by leaky feeder radio and a VoIP telephone secondary system. A personal emergency device system (PEDS) is provided to allow one-way, mine-wide emergency communication from surface to all cap lamps equipped with the PEDS pager. The telephone system, internet access, computer networks, security network, electrical monitoring system, distributed control system, and power monitoring system are extensions of the site-wide infrastructure systems to ensure compatibility. The Shaft No. 2 Shaft Farm substation, as well as the Shaft Nos. 1 and 4 sites, will have a communications drop provided as an interface to these site-wide systems.

Underground Mobile Mining Equipment

The mobile equipment required for lateral development includes drill jumbos, loaders, haul trucks, and ground support equipment. All tunnel development will utilise jumbo drilling machines, rock bolters, shotcrete mixers and trucks, and emulsion (explosives) trucks. Fixed equipment is purchased as dictated by the mine development and construction schedule. Underground mobile equipment will include:

- Loaders (up to 7m3 scoop capacity);
- Haulage trucks (up to 50 tonnes capacity);
- Drilling equipment;
- Concrete and shotcrete mixer and application vehicles;
- Explosives trucks;
- Underground buses; and
- Service vehicles and other specialist equipment.

[17] http://www.climaxmolybdenum.com/worldwidelocations/usa_colorado_henderson.htm

4.7.8 Personnel

Personnel requirements are developed to support planned development, construction and operations requirements for the mine. Personnel staffing is developed based on production phases in the life of the operation (preproduction, production build-up and sustaining production). The underground personnel requirements for Lift 1 will peak at over 1,400 in 2014 and will then level out to between 1,000 and 1,200 during main operations.

4.8 ORE PROCESSING OPERATIONS

The initial concentrator design is based on processing 35 mtpa of ore from the Southwest open pit and Hugo North block cave underground deposits followed by an expansion to bring capacity to 58 mtpa.

For the first 3 years, Hugo North development ore will be added to enrich the feed to the concentrator as it is produced. The following 2 years, development will advance and as production from the Hugo North block cave increases, ore from the Southwest open pit will be displaced. This progressive replacement of the Southwest ore with Hugo North Ore will significantly increase the copper head grade. This change in head grade requires an increment of additional flotation and concentrate handling equipment in Years 3 and 4.

By Year 6, a third grinding line will be added together with additional flotation and concentrate handling equipment to match continued mine production from the Southern Oyu and Hugo North deposits. For the next 13 years, ores from the Southern Oyu open pits and the Hugo North block caving operation are processed at rates between 55-58 mtpa. Approximately 50% of the ore will be provided by Hugo North. Open pit ore will feed the plant until the end of life in Year 27.

4.8.1 Design Factors

The primary crushing and overland conveyor facilities from the open pit mine to the coarse ore stockpile will be scheduled to operate on a continuous basis, 365 days per year, with an instantaneous capacity of 7,000 t/h of ore and utilisation factor of 69%, or an average of 16.5 hours per day. The conveying facilities from the underground mine have been designed to operate on a continuous basis, 365 days per year, with an instantaneous capacity of 7,000 t/h of ore and utilisation factor of 75%, or an average of 18 hours per day. The greater utilisation of the underground crushing and ore handling system is achievable due to the replicated crushing and multiple hoisting shafts.

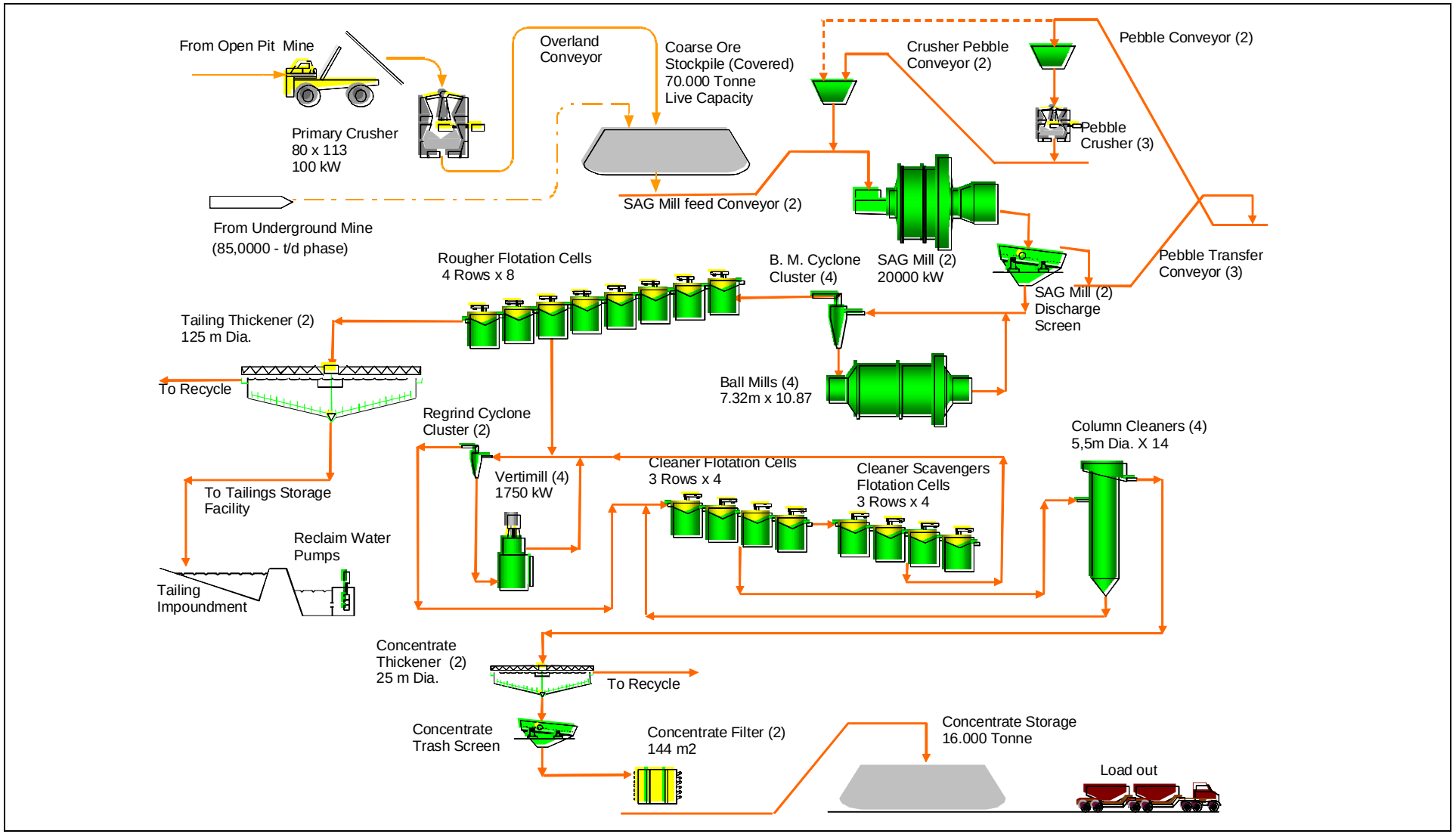
Grinding, flotation, thickening, and tailings disposal facilities are scheduled to operate on a continuous basis, 365 days per year, with a utilisation factor of 92%.

4.8.2 Process Description

The process is based on conventional technology and proven equipment, where possible single equipment streams have been chosen to minimise the number of equipment units and reduce footprint and complexity. A simplified process flow sheet is shown in *Figure 4.12.*

In simple terms, the flow sheet consists of primary crushing and coarse ore stockpiling followed by semi-autonomous grinding (SAG) and ball milling with pebble crushing. Rougher flotation is followed by concentrate regrinding and two stages of cleaning, the second stage being column flotation. Final concentrate is thickened and filtered before being transported by truck. Rougher and cleaner scavenger tails are thickened and disposed of in a tailings impoundment.

Figure 4.12: Oyu Tolgoi - Simplified Ore Process Flow Sheet



The stages in the process can be summarised as follows:

Crushing

During the initial Project start up the concentrator will process an average 100,000 tpd of ore, with the primary source of ore being the Southwest open pit. Ore will be hauled to a gyratory primary crusher. A run-of-mine (ROM) ore stockpile near the crusher will absorb fluctuations in mine production and facilitate the blending of different ore types. Crushed ore from the primary crusher will be conveyed to a stockpile near the concentrator. The stockpile will have a maximum capacity of three days' supply of ore for the mill; the maximum live load capacity will be one day.

Ore released during development of the underground mine and initial underground production will be trucked to the open-pit primary crusher and blended with open-pit ore. Underground ore will be delivered to a half-day surge pile near the mine shaft farm and conveyed overland to the coarse ore stockpile.

Grinding

The two SAG mills will be used, each of 38 ft diameter and powered by 20 MW motors. The grinding circuit will include four ball mills each of 24ft diameter with 11.4 MW motors.

Fines from the SAG mill will pass through cyclones for size separation, where fines of 150 microns will pass through to the flotation circuit.

Flotation

The plant will comprise a typical porphyry copper flotation circuit with no unusual features or equipment. The ball mill cyclone overflow will gravitate to four rows of eight tank-type rougher flotation cells. Rougher concentrate will be combined with cleaner-scavenger concentrate, classified, and reground by four vertical stirred mills in closed circuit with a cluster of twelve cyclones. Regrind cyclone overflow, at a particle size of 80% passing 25 micron, will be cleaned in three parallel rows of four cleaner cells followed by four scavenger tank-type flotation cells.

Cleaner-scavenger tailings will be combined with rougher tailings and pumped to the tailings thickeners. The first cleaner concentrate will be pumped to a distributor feeding four recleaner column cells. Recleaner column tailings will be combined with primary regrind cyclone overflow and routed to the cleaner/scavengers.

Concentrate Dewatering & Storage

Final concentrate will be thickened to 65% solids in two high-rate concentrate thickeners and stored in an agitated surge tank prior to filtration. Automatic pressure filters will reduce the concentrate moisture to less than 9%. Because of the cold winters, the concentrate thickeners and the stock tanks will be enclosed in a building.

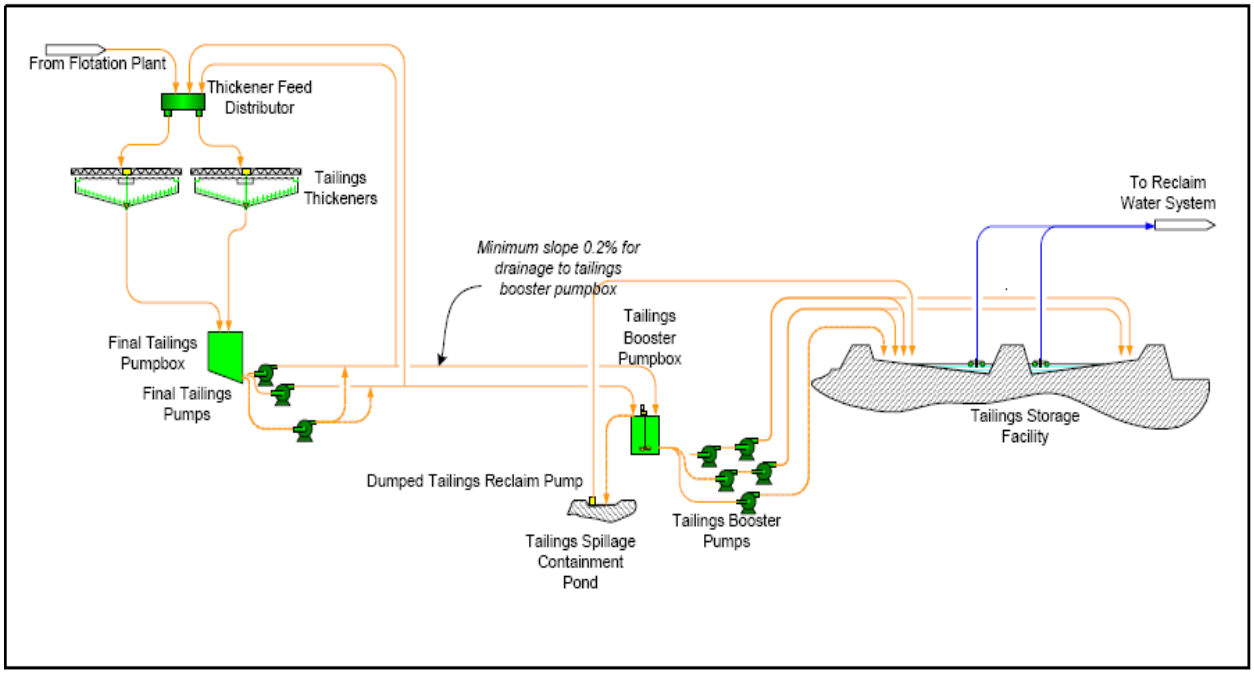
Concentrate Load-Out

During the initial operations phase, a wheel loader will load the concentrate into road trucks for transport to the point of sale at the Mongolian/Chinese border.

Tailings Disposal

Flotation tailings will be thickened to between 60% and 65% solids in two 80 m diameter tailings thickeners. The thickener rakes, which are designed for winter operation, will be traction driven. Thickened tailings will be pumped through two tailings lines to a booster pump station near the tailings storage facility (TSF). The tailings lines will follow a graded corridor to allow the tailings lines to drain into the booster pump box if operations are interrupted. Two two-stage booster pump lines will distribute tailings around the TSF. Excess water ponding on the surface of the TSF will be collected and pumped to the processing plant for reuse.

Figure 4.13: Tailings Disposal Flowchart



Grinding Media & Reagents

Grinding balls will be delivered from China and dumped into storage bins at site. Ball feeders will meter the balls from holding bins onto the SAG mill feed belt, and onto conveyors delivering balls to the feed chutes of the ball mills.

Flotation reagents will be obtained from international suppliers, generally through Chinese-based affiliates. Storage will be provided for a six-week supply of unmixed reagents and for a one-day supply of diluted, mixed reagent. Quicklime will be received in bulk from China and stored in a silo capable of holding a two-week supply. Quicklime will be slaked as required to maintain a one-day supply of slurry in holding tanks.

Table 4.5: Process Reagents (Flocculants) and Proposed Volumes to be Stored On-site

Process Reagent	Estimated Volume Stored On-Site
Aerofine 3418A	72,000 kg
Potassium Amyl Xanthate	358,000 kg
Methyl Isobutyl Carbinol	72,000 kg
IF56 or Dowfroth 250	36,000 kg
Magnafloc 351	1,000 kg
Magnafloc 800HP	76,000 kg
Magnafloc LT510	15,000 kg

4.8.3 Concentrate Handling & Shipping

There are no facilities for the processing of copper in Mongolia. The world's largest market for copper is in China, the border of which is 80 km from the Project. It is anticipated that all copper concentrate will therefore be sent to China for processing. The point of sale will be the Mongolian/Chinese border.

For the first five years of operations, concentrate will be loaded into 20 foot containers and carried by truck to the border from where it they will loaded on to customers trucks and transported directly to the smelter or a rail head. Depending on the border opening times the operation will be conducted on a 24 hours per day basis, and will require more than 60 trailer loads per day in Year 3, increasing to 80 trailer loads per day in Year 5.

In 2009 Energy Resources, as part of the development of the Ukhaa Khudag coal deposit in the South Gobi Region, proposed to route the rail line from the mine site to Oyu Tolgoi and then to Gashuun Sukhait. This proposal has been postponed while the Government of Mongolia considers other options using the existing trans-Mongolian railway line. If a rail line is constructed in the future, the construction of any spur line to Oyu Tolgoi would be subject to an appropriate level of environmental and social assessment.

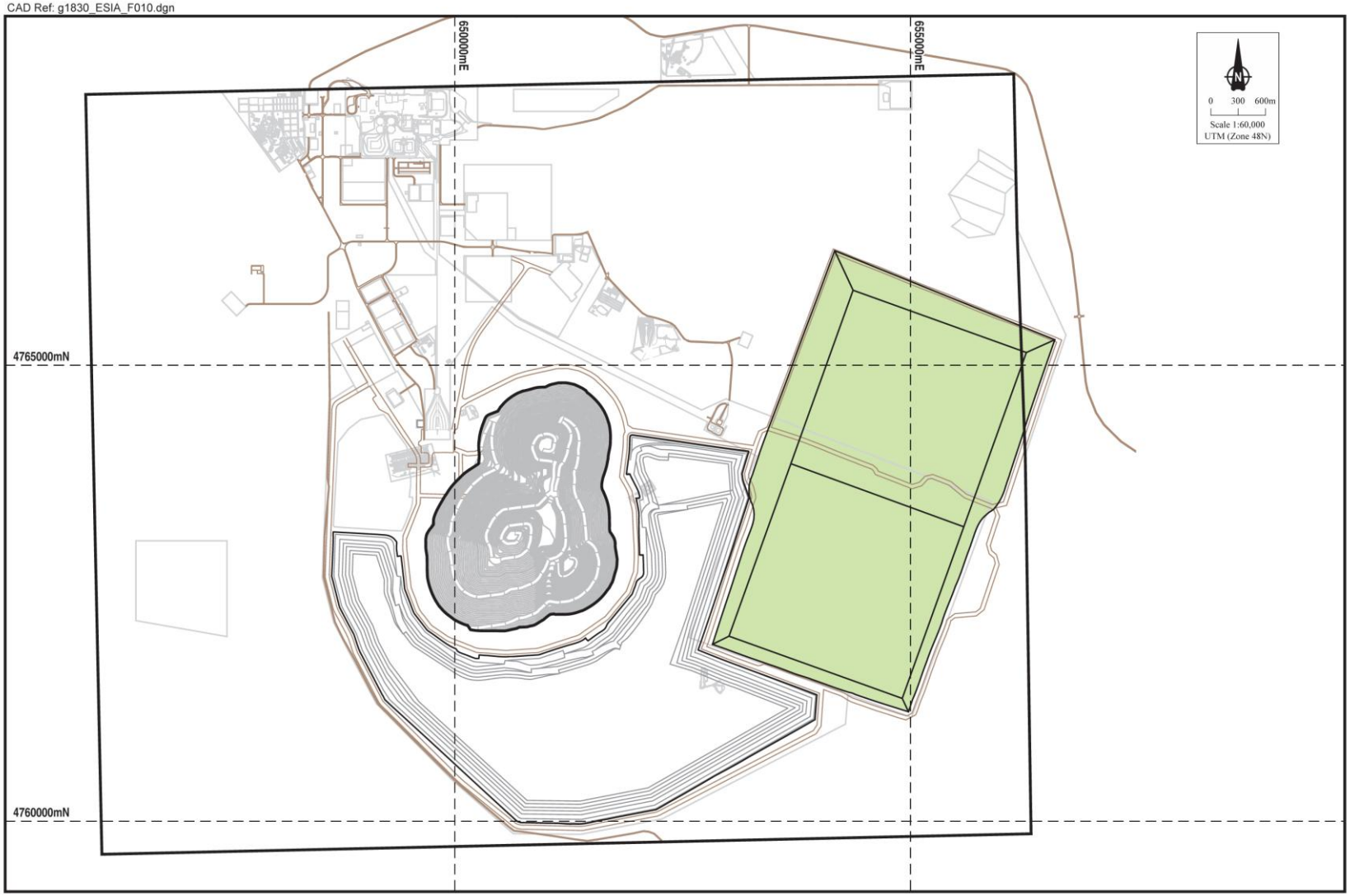
4.8.4 Tailings Storage Facility

The current design for the TSF[18] comprises two cells, each approximately 2 km^2. The facility will be built in two stages, with Cell 1 (the southern cell) constructed initially. The general arrangement of Cell 1 and typical embankment sections are shown in *Figure 4.15*.

The cell is divided into four 500 ha sub-cells by berms running the length of the facility. The tailings will be deposited at a slurry solids content of 64% by weight from the western embankment into each sub-cell for approximately 1.5 months in turn. The berms will contain the active tailings beach to one sub-cell. Deposition in each sub-cell will occur approximately twice per year. The purpose of this arrangement is to minimise the area of fresh tailings beach, thereby limiting the water losses to evaporation. Supernatant water will run off the active beach to the eastern embankment where it will flow along the embankment to a reclaim water pond in the northeast corner of Cell 1 (southeast corner of Cell 2) which will have a barge mounted decant-pumping systems to return water to the process.

[18] Klohn Crippen Berger (2008), Oyu Tolgoi Tailings Storage Facility Interim Design (Summary) Report, 11th April 2008

Figure 4.14: Tailings Storage Facility Location



The design is based on a number of assumptions as follows:

- The tailings beach will slope from the deposition point to the reclaim pond at an average slope of 1%;
- The tailings will achieve an initial deposit dry density of 1.4 t/m3 and a final average dry density of 1.5 t/m3; and
- The design is for a nominal 720 Mt of tailings. Cell 1 will be constructed and operated first, until Year 13-14 when Cell 2 will be used until year 27.

Allowances have been made in the design to accommodate variations in these assumptions. The design allows for variation in beach slopes ranging from 0.7-1.5%. The design also allows for the expansion of the facility to store 1,500 Mt of tailings which will be sufficient for the current reserve of 1,393 Mt. Testing of a limited sample of tailings has indicated that higher tailings densities may be achieved which would improve the storage capacity of the facility.

A detailed design criteria report has been prepared for the current design by KCB[19]. The design criteria include climatic and site conditions, design throughputs and total storage requirements, operating requirements and environmental considerations. Minimum standards for geotechnical and hydrotechnical design include return periods for design storms, precipitation, seismic events, required factors of safety, allowable deformations, etc. The design criteria are considered adequate for the current level of design. A key objective of the process plant and tailings storage facility design is to maximise water recycling and minimise evaporative water losses.

Design work on the TSF is ongoing and further information on how the Project will ensure that the design, construction, operation and closure of the TSF incorporates good international practice and meets applicable Mongolian standards and IFC and EBRD requirements to mitigate potential impacts will be set out in *Chapter D10: Tailings Management Plan* which will be prepared as part of the Operations-Phase Management Plans.

4.8.5 TSF Embankment Design

The starter dams will be constructed with locally borrowed clay and toed into the underlying clay ,or where natural clay is absent, the starter dam will be toed into the underlying engineered clay liner underlying the TSF. Dam walls will be raised annually by using waste rock from mining operations. The west, south, centre and north dam walls will use the modified upstream method of dam construction, where each successive dam raise is constructed inwards on the previous (lower) dam raise to give a stable slope to the embankment. The east dam, including the area of the free water pond, will be raised using the centreline method, where successive dam raises are built vertically on top of one another. All dam walls will be zoned to provide containment of tailings and drainage of water and the required flood freeboard to cope with extreme rainfall events.

Embankment slopes will be designed to provide static (minimum of 1.3 for construction and 1.5 for long term steady state) and dynamic (minimum of 1.1) factors of safety throughout the operation concomitant with International Commission on Large Dams (ICOLD) engineering recommendations. The embankments will be constructed to a maximum height of approximately 60 m on the western embankment and 40 m on the downstream or eastern embankment. All external embankments will be designed to a static factor of safety of 1.5 for closure.

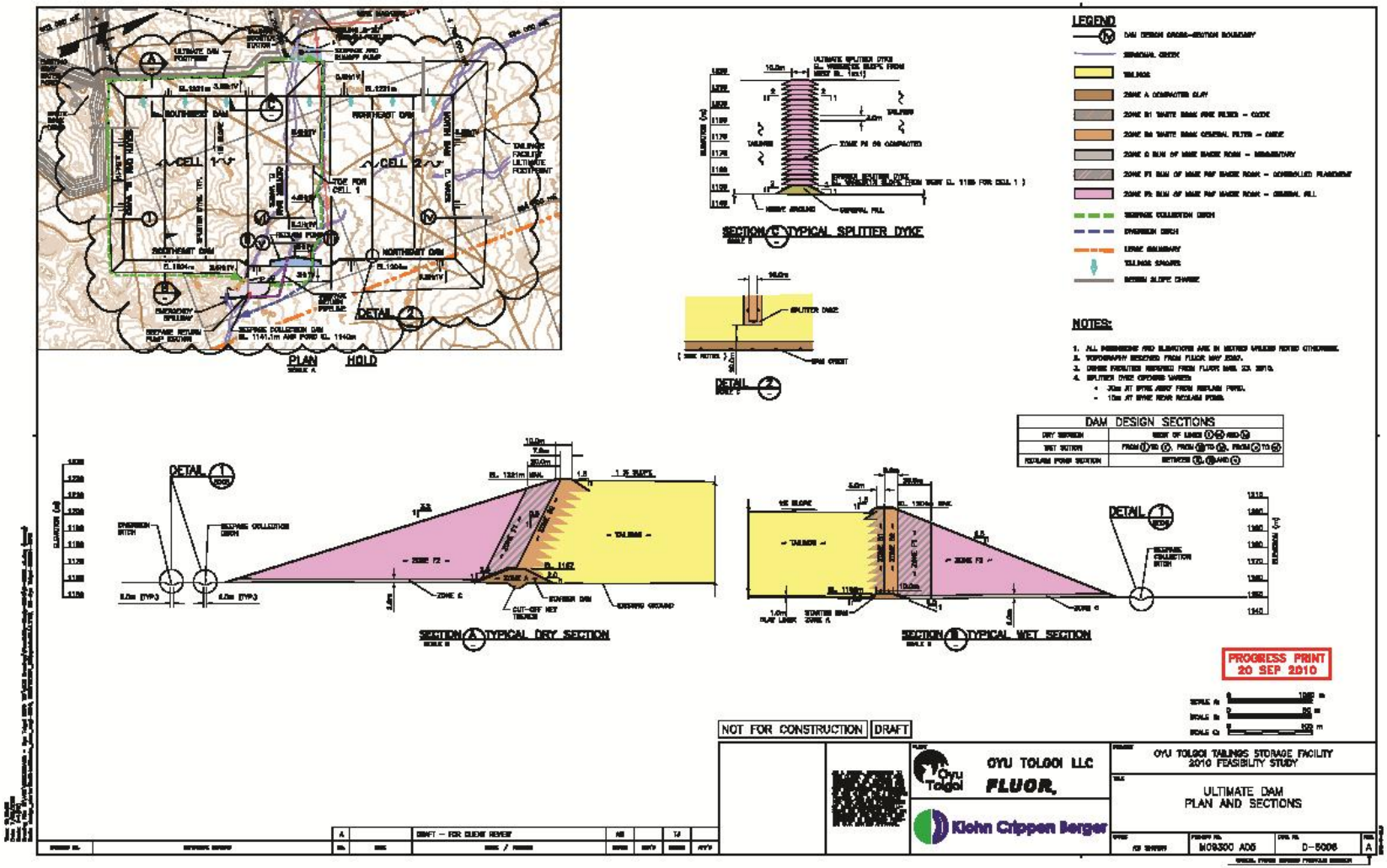
Embankment displacement was calculated using a probabilistic assessment based on a 1,000 year seismic event of magnitude 6.5 earthquake with a peak ground acceleration of 0.08 g. These results indicate that while the embankment will move during large seismic events, estimated displacements are negligible and the TSF will remain serviceable without release of tailings or water. This is dependent on the tailings being sufficiently dry and dense near the embankments so that liquefaction does not occur in the zones affecting upstream raises. For such large facilities in a dry climate such as at Oyu Tolgoi, this will be ensured during operation by proper monitoring and revising the construction and/or deposition methods as required. The design is flexible and can be modified at each raise to suit the tailings deposit conditions assessed through operational optimization.

[19] Klohn Crippen Berger (2008), Oyu Tolgoi Tailings Storage Facility Interim Design (Summary) Report, 11th April 2008

An Independent Tailings Review Board (ITRB) has been established in accordance with IFC Performance Standard 4 to provide independent review and oversight of TSF design and operational management. The ITRB will:

- Review TSF design and operational monitoring during construction and the initial phase of construction;
- Ensure that TSF design, construction and operation is undertaken in accordance with good international industry practice;
- Review the final TSF designs prior to financial close of project financing; and
- Review the final TSF construction as part of the Physical Facilities Completion Certificate for project financing.

Figure 4.15: Cell General Arrangement and Typical Sections



4.8.6 Tailings Water Management

Water management and conservation is one of the major drivers of the design and operational planning for the TSF. KCB has carried out water balances for start-up and steady state conditions for a base case, a wet case and a dry case. The estimate of water available for recycle for the base case is an average annual rate of 650 L/s, peaking at 1,450 L/s during the spring melt. When the plant is operating at the start up condition of 85,000 tpd at 50% solids by weight, the maximum plant top-up water usage is 85,000 m^3/d or 980 L/s. For steady state operations, at 64% solids by weight, the average plant top-up water usage is 700 L/s.

Seepage

Seepage through the tailings mass will be minimised and controlled through a series of design and environmental considerations including:

- The use of thickened tailing slurry at discharge significantly reducing available water in the facility;
- Reduction of the drainage area through deposition channel and pond control;
- The low permeability of the in-situ clay underlying a significant portion of the facility, and the placement of an engineered layer of clay beneath the TSF where there is no in-situ clay material; and
- The arid and evaporative nature of the climate due to very low humidity.

From the current assessment of the tailings properties, cyclic nature of the deposition plan, and drying effect on surface, it was determined that an under-drainage system would likely not be effective after the first deposition cycle. It is expected that with the need to re-saturate the tailing after desiccation between deposition cycles, large portions of the tailing will remain unsaturated during operations. For this reason, it is concluded that an under-drainage system will not be needed.

The proposed site for the TSF is partially underlain by low permeability Cretaceous clay and partially by more permeable residual soils and weathered bedrock. To reduce the risk of seepage contaminating soil and groundwater resources, a clay liner will be installed under the TSF, comprising natural in situ clays and a clay layer where natural clays are not present (see *Section C5.4.9*). The clay fill will be placed in loose thickness lifts of 300 mm and then compacted to 95% of Standard Proctor maximum density and between -3% and +2% of optimum moisture content In addition engineered clay cores will be constructed as part of the impoundment walls to minimise flows through the dam walls[20]. The starter dam walls will be constructed from locally-borrowed clay and toed into the underlying Cretaceous clay, or, where this is absent, tied into the natural/engineered clay liner underlying the TSF. Dam walls will be raised annually by using waste rock from mining operations.

Groundwater flow in the area of the TSF site is likely to be very low due to the low permeability foundation soils and low groundwater recharge associated with the arid climate. The groundwater quality in the low permeability Cretaceous sediments beneath the site of the TSF has variable quality and generally the deeper groundwater within discontinuous coarser horizons has high concentrations of total suspended solids, indicating that the groundwater is ancient, with little “fresh” recharge from surface water.

Existing test pits near the south-eastern corner of the TSF indicate that the fluvial soils are less than 5 m deep, and are very limited in lateral extent. Aerial photos show that a seasonal fluvial channel passes through the southern portion of the site. A diversion channel will be constructed around the TSF to capture any surface water flows in the ephemeral channels and also any groundwater present in the shallow discontinuous alluvial aquifers associated with some of these channels. The diversion channel will route any flows into the Budaa downstream of the TSF. A 4 m deep ditch will be excavated at the toe of the tailings embankments to collect seepage and precipitation falling on the downstream slopes of the embankments. Two seepage collection ponds (East and West) will be constructed on the east and west sides of the TSF to contain the seepage flows and runoff from a 100-year 24-hour storm. The base of the ditches will be founded in low permeability Cretaceous clay or intact bedrock. Where the depth of these

[20] Klohn Crippen Berger, 27 April 2010. Oyu Tolgoi Tailings Site Reassessment – Draft. Contact No. A2MW-90-KO55A.

units exceeds 4 m, seepage cut-offs will be constructed to reach low permeability stratum. Any seepage from the TSF collecting in the seepage collection ponds will be directed back to the supernatant pond within the TSF and returned to the processing facility for re-use. Groundwater monitoring wells will be installed around the perimeter of the TSF enabling Oyu Tolgoi to monitor seepage potential over the life of the Project. Further details on groundwater management practices can be found in *Chapter D7: Water Resources Management Plan*.

Chapter B6: Water Resources provides information on groundwater conditions within the Mine Licence Area. The underlying bedrock lithologies within the Mine Licence Area typically have very low permeability; however shallow secondary permeability resulting from fracturing and weathering are relatively common in the area around the proposed Southwest and Central pits. Exploration (reverse circulation or 'RC') drilling in these two areas has intersected a few water strikes, the highest resulting in an airlift yield of 8 L/s, predominantly from the transition zone of weathered to fresh bedrock at depths between 20 and 100 m. Other than some isolated occurrences, this drilling has encountered very few water-bearing fractures below 120 m depth, indicating very low bedrock permeability. This assessment has been reinforced by the almost total lack of water encountered during the sinking of Shaft No.1 and the driving of the underground development levels.

Facility Operation

Sub-aerial (hydrocyclone) deposition methods will be used for the following reasons:

- The supernatant pond can be as small as practicable to reduce water losses due to evaporation and seepage;
- It allows operating flexibility to mitigate dust generation on the tailings surface;
- It allows full drying of the tailings adjacent to the embankments to prevent liquefaction and facilitate lift construction; and
- It reduces the extent of saturated beach area and consequently will reduce the potential for water losses through seepage.

Water from the tailings pond will be reclaimed to the process water ponds. This recovery will be maximised by using two pumping systems to minimise evaporative losses and reduce the amount of raw water required from external sources.

Three independent tailings pipelines will be installed to ensure that tailings can be discharged from anywhere around the cell periphery or the central divider embankment and that operations are not limited by embankment construction.

During winter, tailings will be discharged from a single, large-diameter line. A thin sheet of ice and glaciated tailings will be allowed to develop over otherwise inactive beach areas in each of the two sub-cells. The sub-cell used for winter deposition will be taken out of service during spring and allowed to thaw. As much stored water and thawed ice as possible will be pumped back from the TSF, and the supernatant pond will be drawn down to reduce evaporative losses.

4.9 WASTE ROCK MANAGEMENT

The open pit waste rock dump (WRD) will be located within the Oyu Tolgoi Mine Licence Area and adjacent to the open pit area (see *Figure 4.14*) to reduce haulage distances. The WRD forms a semi-circular structure around the southern part of the open pit. There will be a peripheral 45 m wide haul road around the base of the WRD, which along the Undai diversion will be on a road base above the 1 in 1,000 year flood level. The WRD will be constructed in a series of 10 m lifts with three lifts to a bench, and reach an ultimate height of 90 m above the surrounding land surface. The initial slope angle will be 37^{o} and on closure will be battered back to 18^{o} at the base increasing to approximately 31^{o} at the upper levels and retaining 7 m wide benches. The current conceptual design is for the WRD to be armoured with rock to prevent wind erosion.

Preliminary environmental test work[21] has shown that some open pit waste, mainly in the central pit, is potentially acid forming (PAF), but that a significant proportion of waste also has an acid neutralizing

[21] Environment Geochemistry International Pty Ltd (2008), Oyu Tolgoi Project Acid Rock Drainage Review and Recommended Investigation Programme, May 2008

component (ANC). Even waste with PAF and also some ANC will have a long lag before the onset of acid formation as the climatic environment at the Project has a substantial excess of evaporation over precipitation and the process of potential acid leachate formation will not even commence until PAF material has been oxidised in the air and then becomes wet.

As the pit sizes change, the proportion of PAF and non-acid forming (NAF) rock will change. Column test work is continuing to verify the acid-forming potential and associated lag periods for selected representative waste rock samples. Based on the results of this the mine plan will be used to calculate the timing of the generation of PAF rock and enable the WRD design to be refined. The current WRD is being further developed to take account of both the PAF generation and the volumes of rock required for the dams of the TSF. At this stage it is assumed that no PAF will be used in the TSF dams; however this assumption is being assessed further as part of the detailed engineering design and necessary environmental considerations.

The base and cover of the WRD will comprise a 3 m layer of NAF, with the internal layout of NAF, PAF and ANC managed via a combination of mine scheduling of applicable waste types (based on ARD potential), and appropriate waste dump design and construction. The intention is that PAF will be located in the areas of the WRD which are away from underlying stream sediments (such as those associated with the Undai), and in the areas where there is a greater proportion of clay in the underlying sediments. This is discussed further in *Chapter C5: Water Resources* and in the *Chapter D9: Waste Rock Management Plan*. As a further mitigation measure the potential for acid leachate is also considered in the engineering works for the adjacent Undai diversion. The works on the Undai will also include a cut-off wall across the former ephemeral watercourse immediately downstream of the WRD. The objective of this will be to preventing the return of diverted water back to the open pit, and also serving to control any leachate that may arise from the WRD and avoid any potential for it to flow downstream into the Undai. Any seepage or run-off water collecting in the pond upstream of the cut-off wall will be either allowed to evaporate or, if compliant with applicable Mongolian standards be released into the Undai. In the long term if required to manage this water, Oyu Tolgoi will consider the use of directional drilling to create a drainage route from the seepage collection pond on the southern side of the WRD back to the open pit (see *Chapter C5: Water Resources*). Groundwater quality downstream of the cut-off wall and collection pond will be monitored through a series of monitoring wells.

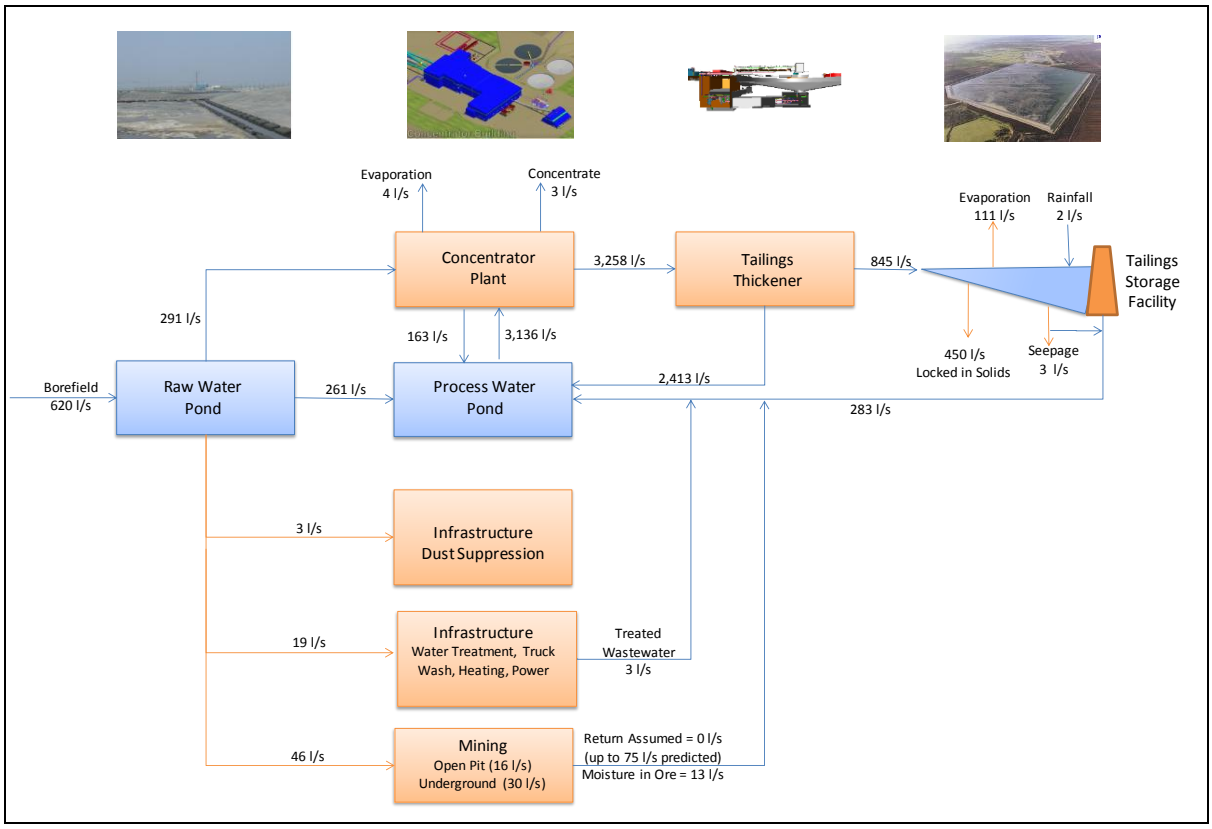
Design work on the waste rock dump is ongoing and further information on how the Project will ensure that the design, construction, operation and closure of the WRD incorporates good international practice and meets applicable Mongolian standards and IFC and EBRD requirements to mitigate potential impacts is set out in *Chapter D9: Waste Rock Management Plan*.

4.10 PROJECT WATER MANAGEMENT

Actively managing water use throughout all the operational aspects of the Project is a key focus of Oyu Tolgoi which aims to minimise its impacts on the water resources of the area. Oyu Tolgoi recognises that it has a responsibility to the local community and Mongolia to manage the water resources it uses carefully and efficiently.

The operational phase of the Project will utilise the water from the Gunii Hooloi borefield with the main water use being in the production plant (i.e. the concentrator). The water balance for the Project is presented in *Figure 4.16*. This water balance is being refined but the key features this illustrates are the volume of water that is recycled back to the Process Water Pond; primarily from the tailings thickener and pond, but also the significant recovery percentages from the wastewater and the grinder cooling.

Figure 4.16: Water Balance 100,000tpd case



Note: Values in litres per second

The key features of the water recycling based on the current plans are:

- 84% of production water will be recycled within the ore processing circuit with the 16% of additional water required being supplied from the ground water reserves in the Gunii Hooloi basin;
- 80% of drinking and public use water will be treated and recycled into the production water; and
- 50% of water used for cleaning machinery and equipment will be re-used.

These recycling figures will be further refined and improved wherever possible[22], and will form a key performance indicator for Oyu Tolgoi.

Oyu Tolgoi is a world-class Project and will measure itself against other world class mines; this will include assessing factors such as litres of water used per tonne (L/T) of concentrate produced. The current assessment is that the Project will use 487 L/T, this compares favourably with other comparable sized operations in similarly arid conditions such as Chuquicamata, operated by Codelco in Chile which achieves a water use of 570 L/T[23] and water recycling rate of 72% (compared to Oyu Tolgoi's better rate of 84%). Oyu Tolgoi will seek further comparable international operations with which to develop a benchmarking exercise with the aim of being a world leader in terms of its minimal water use and other environmental parameters.

[22] Currently the percentage of recycling is rounded to the nearest full number, Oyu Tolgoi recognise that fractional improvements will, particularly when considered over the life of the mine, result in a significant water saving leaving more water in the Gunii Hooloi aquifer for future users.

[23] Codelco Sustainability Report 2009

4.10.1 Mine and Process Water Demand

The average water demand during the initial years of 100,000 tpd mine production is predicted to be 696 L/s based on the conservative assumption of there being no water recovery from the underground or open pit mines. The borefield and supply pipeline have been designed with a capacity of 900 L/s to provide for seasonal peak demand and to provide a margin for refilling the emergency storage lagoons after its emergency use (see *Table 4.6* below).

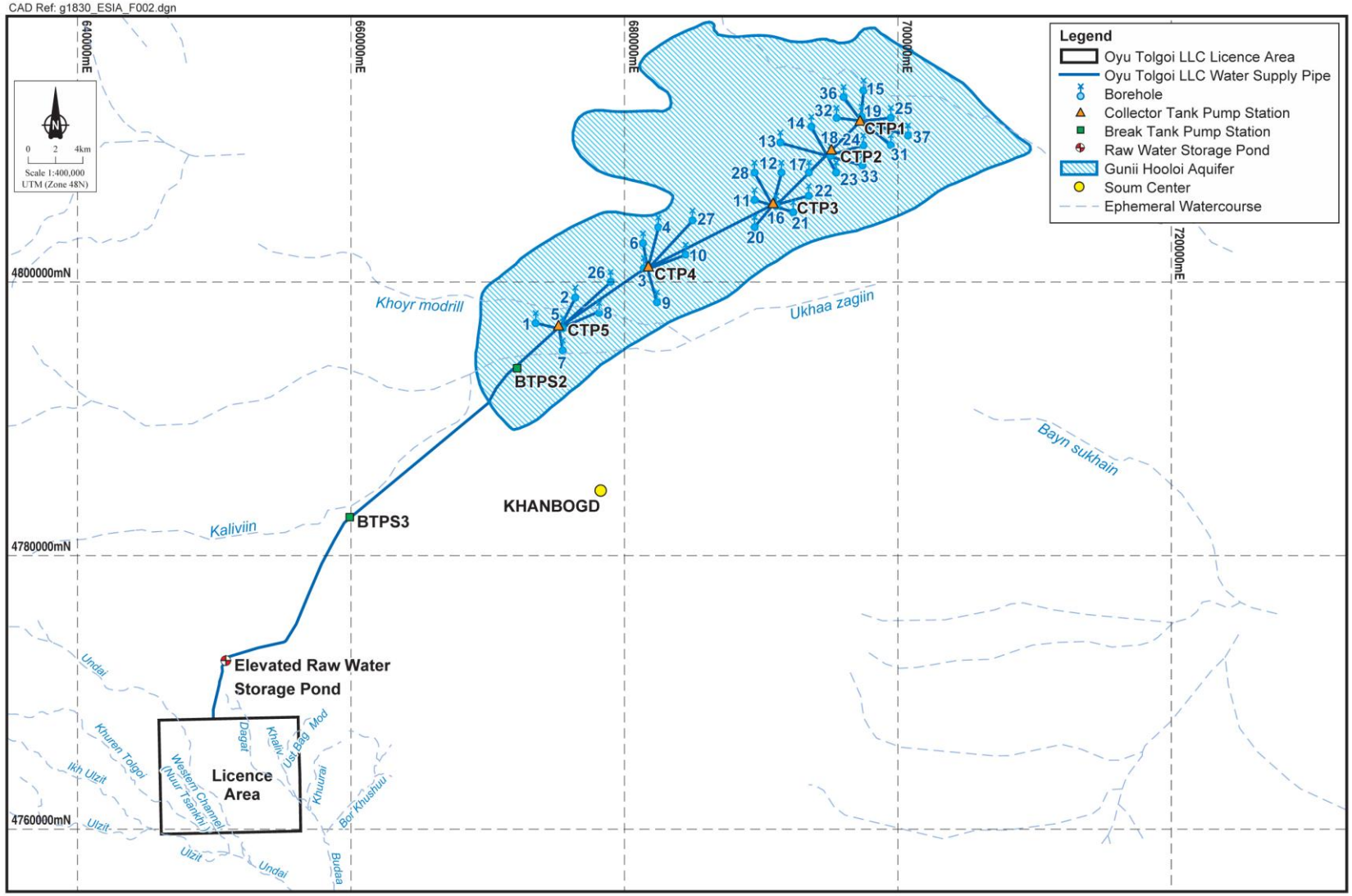
Table 4.6: Summary of Project Water Demand and Borefield/Pipeline Design Capacity

Project Water Demand	**100,000tpd Mine Production**	
	Average Demand (l/s)	**Peak Demand (l/s)**
Concentrator	628	671
Mines & Infrastructure	69	115
Design Development Contingency	0	0
Total Site Demand	**696**	**785**
Margin for Lagoon Refilling	-	100-150
Borefield/Pipeline Design	**-**	**900**

4.10.2 Borefield Water Supply System

The Gunii Hooloi borefield extends to the northeast of the Oyu Tolgoi mine as illustrated in *Figure 4.17.*

Figure 4.17: Oyu Tolgoi Borefield



Bores will be developed in two distinct areas, the southwest “low transmissivity” area and the northeast “high transmissivity” area. In total, ten water bores are located in the nearer southwest part of the borefield and are designed to provide approximately 30 L/s per bore (300 L/s in total) and fifteen water bores are located in the higher transmissivity northeast part of the borefield and are designed to provide approximately 40 L/s per bore (600 L/s in total). Three additional 40 L/s capacity bores are provided in the northeast area for standby capacity. The overall borefield and raw water supply pipeline has a design peak capacity of 900 L/s, providing for peak water demand and an additional 115 L/s margin which can be used to refill the Project emergency storage lagoons following its emergency use and without impacting site water needs.

Groups of individual bores will be accumulated into more centrally located collection tank pump stations, from which water will be pumped into the main water line leading to the Oyu Tolgoi site. A break-tank pump station divides the pressure in the overall pipeline and provides the additional pumping energy to bring the water to the site.

Water will be pumped into two 200,000 m^3 emergency storage lagoons located on elevated ground approximately 5 km to the north of the Oyu Tolgoi site. These lagoons provide approximately 1 week of emergency supply of water as a contingency in the event of a pipeline/borefield breakdown and maintenance. The lagoons will be covered with a floating cover to prevent evaporation. The water will be gravity-fed to the site through two pipelines from the lagoons.

All equipment in the Gunii Hooloi borefield and pipeline will be remotely controlled using the site distributed control system (DCS) linked by redundant telecommunications networks. All equipment in the Gunii Hooloi borefield will be provided with electricity through a high voltage transmission line routed adjacent to the pipeline. Power drops will be made to each pump station and to the borefield. A light duty access road will be provided along the pipeline to each pump station and bore.

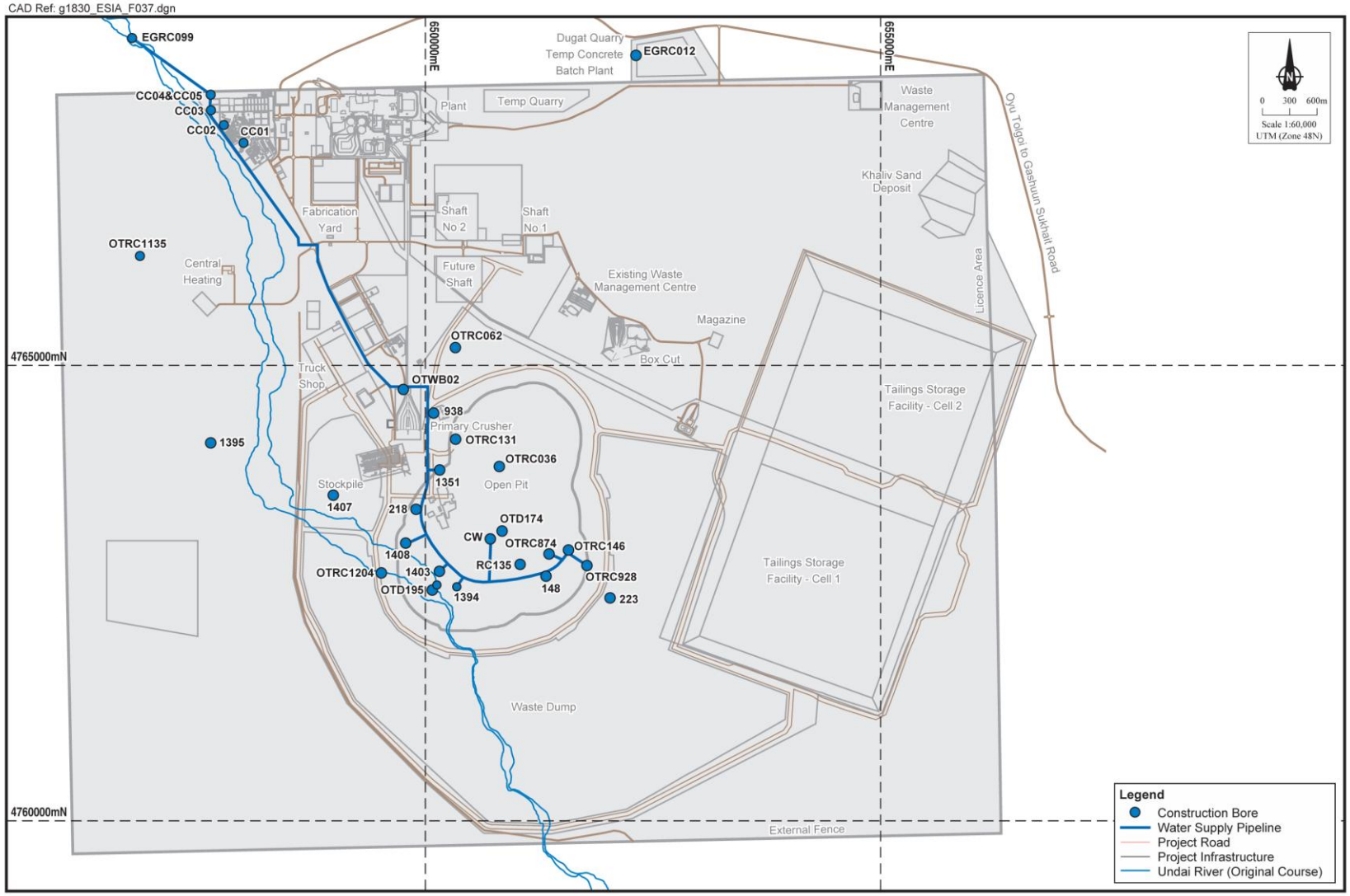
4.10.3 Camp & Construction Water Supply

The requirement for camp and construction water has evolved over the life of the Project. A number of construction water bores have therefore been identified over the long period of water exploration at Oyu Tolgoi. Twenty viable construction water bores have been identified across the central part of the Mine License Area, with an inferred combined water supply capability of 57.2 L/s, which has been adequate to meet the Project’s needs until water became available in Q4 2011 from the permanent Gunii Hooloi borefield and pipeline. Of the 20 viable construction water bores identified, 16 are connected to the main water supply pipeline and 4 are used as local water supplies. Pump testing has been undertaken on each viable water bore in order to confirm its viable supply capability and to provide supporting documentation for water use assessments by the Mongolian Water Agency.

Submersible pumps are used to extract water from each borehole. Bore headworks at the top of each water bore include various valves (control and pressure release), instruments (thermometer, flowmeter, etc) and fittings. Each water bore and associated equipment is protected and sheltered in an insulated bore shelter building. Water bores that are remote from the main established electrical power supplies are equipped with their own diesel generators with a small associated tank fitted with a drip tray that holds 1 week’s fuel supply. The diesel generator and tank are located outside the bore shelter building and are provided with secondary containment to prevent water contamination in the event of a spill.

The main construction water supply pipeline extends from a number of dewatering bores located around the south and west sides of the open pit mine and then leads north-north-west to the mine crusher, customs yard, lay-down area, warehouses and a number of water bores and facilities located at the Oyu Tolgoi construction camp. A secondary water supply pipeline connects the main supply pipeline with the Concentrator facility and associated contractor camps and concrete batch plant. The pipeline is constructed of high density polyethylene pipe buried below the ground freezing layer and equipped with insulated air release valve at high points and periodic isolation valves.

Figure 4.18: Mine Licence Area Construction Water Supply



Construction water off-take points are provided at all viable water user locations located along the alignment of the pipeline. Each off-take point is located at a manhole and has buried connections for medium term use and exposed connections for short term use plus associated control valves. The construction water supply pipeline will additionally connect with the raw / fire water tanks in the site Water Treatment and Bottling Plant building, which will supply the entire construction camp with all fire water, domestic water, bottled water, hot and heating water (via the construction camp boiler facility) needs during the construction period. Isolated water bores that are not connected to the main pipeline are equipped with off-take points and/or truck filling points, as considered most suitable.

4.10.4 Mine Dewatering

Oyu Tolgoi commissioned a study of the dewatering requirements and impacts associated with the mining developments[24]. A numerical flow model was used to predict inflow into the open pits and the underground mine workings and was also used in conjunction with an analytical model to assess the post-mining pit water balance and water recovery levels. The combined mine dewatering rates from the open pits and Hugo North are predicted to rise to a peak of approximately 125 L/s after four years, remain above 100 L/s until year 11, and then gradually drop to approximately 60 L/s at the end of the 27-year mining timeline. This was based on limited data available on the local hydrogeology; subsequent work including the sinking of Shaft No.1 (where no groundwater was encountered in the bedrock) has revealed that this model most likely represents an over estimate of the likely inflows to the open pit. A revised model has been developed to reflect more recent hydrological data and potential future mining activities, such as those associated with the Heruga deposit. Further details are provided in the relevant water resources chapters of this ESIA.

During the period of underground mining, once the fracture system generated by the subsidence above the block caving intersects the surface water bearing formations, the drawdown point for groundwater is expected to drop below the base of open pits. As an interim measure, before the revised model is available, the current model has been rerun with more appropriate hydraulic conductivities. This model rerun indicates that the drawdown (>1m) around the underground mining and the open pit will extend out to a maximum of 5 km from the pit and the subsidence zone.

After mining, the underground mines will flood, but evaporative losses from the open pits will cause a long-term zone of drawdown approximately 300 m deep at the Southwest pit, with the 1 m drawdown level extending up to 5 km. The likely cone of depression will be better understood once the new model is developed; as this will take account of the variable hydraulic conductivities in the different sedimentary and bedrock lithologies, as well as barrier effects (such as the dykes and faults). The actual cone of depression is expected to be less than the predicted 5 km (for the 1 m contour). Given the low groundwater recharge in the region, it is likely to take at least 300 years before steady-state conditions to develop.

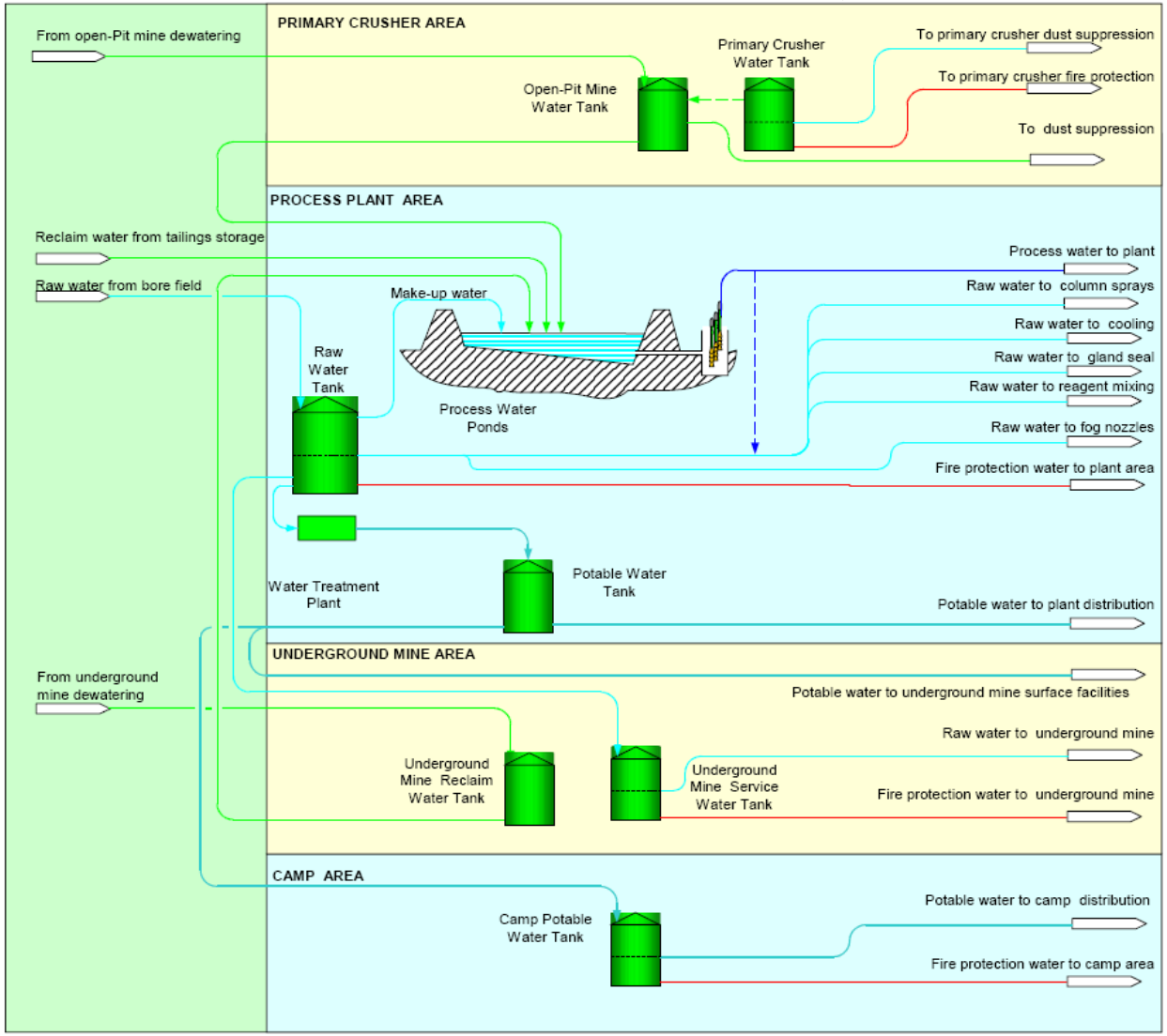
4.10.5 Process Water

Process water will be supplied from two ponds at the concentrator, each capable of meeting 24 hours of demand. Make-up water will be added to the pond from the raw water supply system to maintain the inventory. The ponds will collect reclaim water from the TSF, surplus water from mine dewatering, and runoff from the site drainage containment system.

Raw water from the borefield will be pumped to a tank close to the process plant for use in fire fighting, cooling, gland seal, column sprays, and other applications where clean water is required.

[24] Aquaterra (2004), Feasibility Study, Oyu Tolgoi Dewatering Investigation Open Pit and Block Cave Mining, 18th October 2004

Figure 4.19: Process Water System



4.10.6 Water Treatment & Bottling Plant

The water treatment and bottling plant will be constructed within the confines of the construction camp and will treat raw water from the Gunii Hooloi borefield to drinking and domestic water standards, as follows:

- **Potable Water:** Potable water is intended for routine drinking and will be provided in 20 L bottles for distribution through the mine. Potable water will meet applicable Mongolian Standards and World Health Organisation (WHO) guidelines for drinking water quality. Treatment includes dosing, multi-media and granular activated carbon filtration, micro filtration, reverse osmosis treatment, ultra violet sterilisation and ozone disinfection prior to bottling within a microbiologically filtered "clean room" and onward distribution.

  Treated potable water is passed to the water bottling line. This line is comprised of an automatic washing, filling, capping skid machine, with a capacity of 200 bottles/hour. The filled water bottles will be stored in the water treatment plant for distribution. Empty bottles will be collected and stored in the water treatment plant for sterilization and reuse.

- **Domestic Water:** Domestic water is not intended for routine drinking (used for washing, cleaning, flushing toilets, etc) but will be safe to drink. Domestic water is to be produced at an average flow rate of 70 m3/h with a peak flow rate of 125-150 m3/h. Domestic water will meet applicable Mongolian Standards and WHO guidelines for physical and microbial drinking water quality. Treatment includes dosing, multi-media and granular activated carbon filtration and chlorine disinfection prior to onward pipe distribution to the construction camp and remainder of Oyu Tolgoi site.

There are two rooms in the water treatment plant, one room includes raw and fire water storage tank, domestic water tanks, camp fire water pump station, and domestic water pump station; the other room includes the domestic water and bottling water treatment plant, bottled water storage, laboratory/office, equipment storage, and chemical storage rooms. Waste water is to be automatically and regularly discharged into the sewerage system by the waste water pumps stationed in this room.

The capacity of each of the raw water tanks (including fire water capacity), is 400 m^3, for a total volume of 800 m^3. In these two raw tanks, the independent fire water capacity is designed at 324 m^3. The remaining raw water capacity of 476 m^3 can provide water to the treatment plant for up to 10 hours at full demand rate in the event of a loss of raw water supply.

The two domestic water tanks each have a 400 m^3 capacity. The stored domestic water has sufficient capacity to supply water at full demand for 16 hours in the event of a loss of raw water supply.

Fire Water

A fire water storage tank (to be located in the Concentrator) and pump stations will be established in the main functional areas of the site.

Dedicated fire mains complete with hydrants will be provided at the above main functional areas. The fire mains also serve sprinkler systems and fire hose reels which will be installed at key facilities, including the Warehouse, Operations Camp, North Gatehouse, Concentrator office, etc. Fire extinguishers will also be provided at all facilities as a first line of defence.

Fire detection and alarm systems will be provided at key facilities and will report to the mill area control room in the process plant or to the main gatehouse, which will be manned 24 hours a day.

4.10.7 Wastewater

An existing waste water treatment plant, located within the construction camp, has been expanded from the capacity of 800 equivalent personnel up to a capacity of 4,000 person equivalent (PE) and accommodates the sewage production for the construction and operations labour force. In addition, there will be additional temporary wastewater treatment facilities at the temporary construction camps to treat peak wastewater for 14,800 PE. Treated effluent is being used in the concrete batch plant to reduce the volume of raw water required for concrete production.

All wastewater streams from the different camps on the site report to this facility. As part of the expansion, the previous waste water treatment plant has been integrated into the expanded plant (*Figure 4.20*).

Figure 4.20: Completed Wastewater Treatment Plant (including expansion)

This will be the permanent wastewater treatment plant for the construction and operational phase and all sewage generated on site will either be pumped directly to the plant or transported by truck to an unloading bay. This tankered wastewater will include wastewater generated at the airport and remote construction camps associated with the construction of the borefield and the concentrate haulage road.

Sewage treatment comprises screening followed by treatment in a pair of Sequencing Batch Reactors (SBR) undertaking sequenced steps of filling, aeration, de-nitrification, stabilization and removal of treated water / sludge. All treated water is filtered and ultraviolet sterilized prior to removal to an adjacent treated effluent holding tank. Treated wastewater will be recycled to the mine ore processing plant to minimise raw water consumption; sludge will be disposed of to the site's landfill or may in the future be composted.

The treated effluent is suitable for direct discharge to land but will be recycled for road dust suppression and/or concrete production during the construction period and will be used as supplemental water to the Concentrator process during the operational period in order to minimise usage from natural resources. Dust suppression during the operations phase will be by a combination of treated effluent and chemical dust suppressants. Operating in an arid environment such as the south Gobi requires a trade-off to be made between dust suppression and water consumption and this will be the subject of ongoing review and optimisation.

4.11 ON-SITE PROJECT INFRASTRUCTURE

4.11.1 Plant Site

The selected plant site is close to the open pit and underground mines and provides a compact layout. The site is generally flat, with some relief to about 6 m height, and includes a bedrock plateau where the SAG and ball mills will be founded. All facilities are located beyond the estimated underground mine subsidence zone outline, as defined in IDP10.

To prepare the building site foundations, topsoil is removed and stockpiled, followed by cut-and-fill levelling as required. Approximately 1.0 Mm^3 of material will be excavated for the cut and fill for the concentrator site. Additional fill from selected borrow pits is required to form elevated pads for the thickener, process water ponds, and the coarse ore stockpile.

4.11.2 River Diversion

The Undai is an ephemeral water course that runs in a southeast direction to the south of the proposed open pits. Subsurface flow in the sediments of the channel is constant, but surface flows also occasionally occur, though usually only after heavy rainfall. These can be large floods in the Undai channel and because the open mine pits encroach into the existing channel, the Undai must be diverted.

The Undai diversion system consists of a dam, diversion channel and sub-surface diversion arrangement[25]. The diversion system was based on a data set extending over forty years and is considered therefore to be robust and representative. A hazard assessment of the facility undertaken as part of the preliminary engineering study resulted in a classification of "Low". On this basis, the following design criteria were adopted:

- Design flood: 1,000 year Average Return Interval (ARI);[26]
- Earthquake design: Maximum Design Earthquake (MDE) with a 1,000 year ARI; and
- Dams and associated hydraulic structures designed to ICOLD[27] standards.

The potential impact of possible future mining activities on the proposed diversion, such as the development of the Heruga deposit, will be assessed as future developments are planned.

The location of the current course of the Undai in relation to the mine and the proposed diversion is illustrated in *Figure 4.21*.

The diversion system to divert all subsurface and surface flows around the pit has three main components: main dam, diversion channels, and subsurface diversion. The main dam wall will be an earth embankment with an effective crest of up to 2.5 m above the diversion channel bed and which will be keyed into the rock which is approximately 5 m below the riverbed (see *Chapter C5: Water Resources*). The embankment will have an upstream, low-permeability zone, a key trench, and a downstream fill zone. The dam will be used to divert groundwater through a buried pipe back to the river downstream of the Project site and surface flood water via a diversion channel to a parallel tributary. Both flows will return to the Undai downstream of the Project, with the flow through the alluvial sustaining the downstream springs on which herders and wild animals rely.

The main diversion channel is 800 m in length and has been designed with the low flow channel contained within it. The main channel is 200 m wide, while the low-flow channel is 20 m wide and is 1 m below the level of the main channel. This main channel width was selected as it is comparable to the width of the western channel into which it discharges.

The subsurface flow will be diverted through a HDPE diversion pipe which is 6 km long, the gradient increases downstream from 1 in 300 for the first 1.5 km and 1 in 225 for the latter part. A 200 mm pipe is proposed, rather 100 mm which is adequate for the modelled flow of 2.3 m^3/hr, so as to avoid any potential issues with sedimentation in the pipe. The average burial depth of the pipe will be between 3-4 m and below the freezing zone. The inflows and outflows will be through a perforated pipe extending across the width of the river with 50 mm diameter inlets. This will have a gravel packer with a higher hydraulic conductivity than the alluvial sediments and the inlet will be set into the base of the sediments to ensure it captures all flow in the sediment. The gravel pack will be encased in a filter to minimise sediment load in the pipe. A series of inspection hatches will be placed along the route to enable the performance of the pipe to be monitored and any remedial actions with regard sediment implemented. Valves at each inspection point will enable sections of the pipe to be isolated if required.

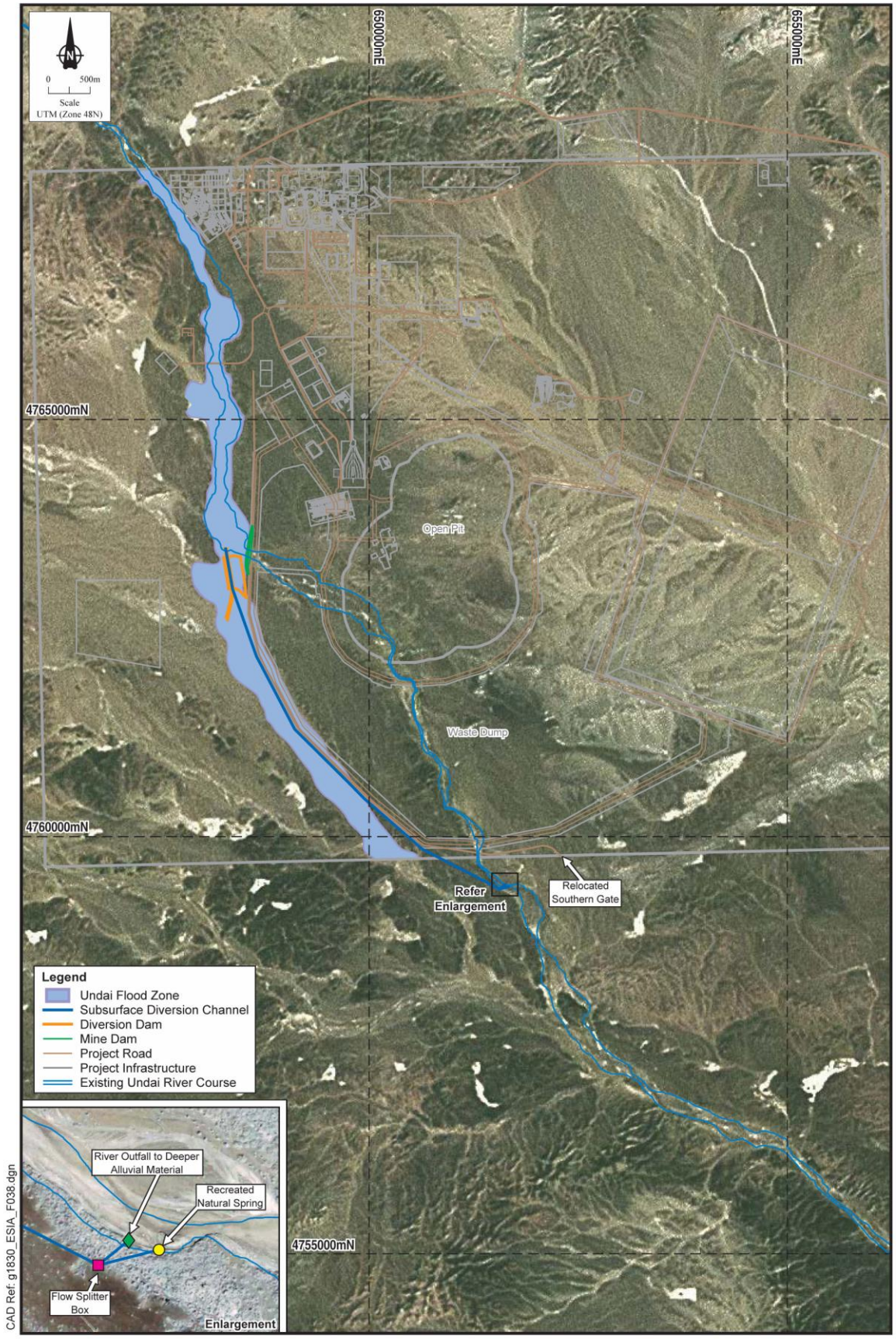
Following a 1,000 year ARI rainfall event, the estimated maximum surface flow within the Undai channel would be 245 m^3/s. The excavated low-flow diversion channel will have a capacity of 235 m^3/s and in this case will overflow into the larger stormwater diversion channel in which the low-flow channel is located and which has the additional capacity to receive a 1,000 year flood event with 0.5 m of freeboard from the channel crest.

[25] SMEC (2007), Undai River Diversion, Basic Engineering, Final Report, February 2007

[26] See *Chapter B2: Climate* for details on flood modeling.

[27] International Commission on Large Dams (www.icold-cigb.net)

Figure 4.21: Undai River Diversion



The diversion will be separated from the base of the WRD which is located to the east of the diversion by an access road which will be above the level of the one in 1,000 flood event. Access across the diversion will be via a ford crossing with a culvert for the low-flow channel.

Design work on the Undai diversion and further information on how the Project will ensure that the design, construction, operation of the Undai diversion incorporates applicable good international practice and meets applicable Mongolian standards and IFC and EBRD requirements to mitigate potential impacts is set out in *Chapter C5: Water Resources Impact Assessment* and *Chapter D7: Water Resources Management Plan*. Oyu Tolgoi has recently commissioned a review of the engineering design of the diversion[28] (the original design dated from 2006). This review identified no requirement for significant design changes based on the current mine plan; it did however identify the requirement for some add-on features as follows:

- **Up-stream groundwater capture**. Due to the potential risk that drawdown from the open pit could result in drawdown of groundwater in the alluvials of the Undai upstream of the diversion, and therefore reduced base flow in the diversion pipe, an additional collector system is proposed to be placed up-stream of this area. This would be based on a herringbone pattern of drains which collect the groundwater flow in the sediment and convey it southwards into the planned diversion pipe.
- **Installation of a cut-off wall in the abandoned section of the Undai south of the WRD**. This cut off wall would serve two purposes:(i) preventing return of diverted water back to the open pit and (ii) controlling any leachate that may arise from the WRD, preventing it from flowing downstream into the Undai. This latter objective could be enhanced through the installation of a drainage pipe back to the open pit.
- **Creation of an 'artificial' spring south of the Mine Licence Area**. This would incorporate appropriate engineering of the Undai where the subsurface flow is returned to create a spring that replaces the Bor Ovoo spring which will be lost due to the construction of the WRD. This would be designed to include natural scouring to ensure that it was not filled-in following a flood event.

These mitigation features are discussed further in *Chapter C5: Water Resources Impact Assessment*.

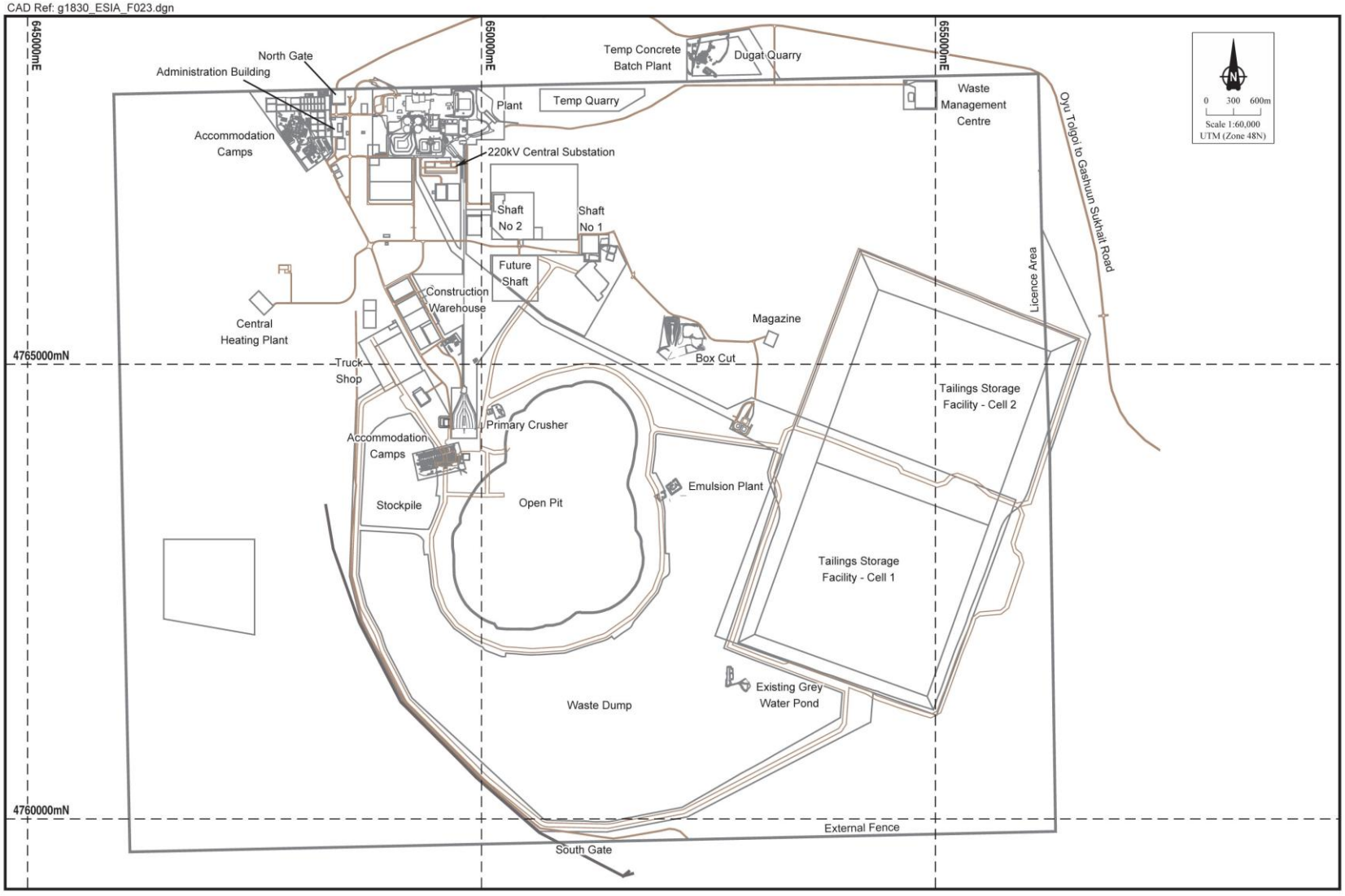
The Budaa watercourse, which is a tributary of the Undai, passes across the eastern part of the Mine License Area and crosses the footprint of the TSF. The Budaa and its tributaries will be diverted around Cell 1 of the TSF when it is constructed and will ultimately be diverted around Cell 2. Alluvial sediments associated with the watercourses, where present, are thin (reaching a maximum of around 4m) and discontinuous and do not sustain any springs. The diversion channel, which will be cut into the Cretaceous clays, will intersect any alluvial sediments and capture any seepage along with surface flows and return any flows into the Budaa downstream of the TSF.

4.11.3 On Site Support Buildings & Structures

The layout of the buildings and structures on the site is illustrated in *Figure 4.22* and the key elements are described below.

[28] SMEC (2010), Review of Undai River Diversion Project Basic Engineering, 5th November 2010

Figure 4.22: Site Layout



Warehouse

The main site warehouse will provide heated, covered storage for equipment spares and weather-sensitive materials, as well as office space for warehouse personnel. Adjacent external storage areas will include a concrete-surfaced pad and include a separately fenced hazardous chemicals (HAZCHEM) storage yard. All external yards will be surrounded by security fencing.

Medical Centre

The medical centre will have three points of entry (main, emergency and the safety office entrance) and two main treatment rooms. Two ambulance vehicles fully equipped with emergency beacons / sirens will be available.

Fire Station

The fire station will be located in the warehouse compound, and will be equipped with fire fighting equipment heated vehicle parking and full fire-fighting suits with breathing apparatus. The primary response vehicle will be a fire truck with pumping capability of 40 L/s fitted with 7,000 L water tank, 800 L foam tank and roof-mounted foam monitor.

Truckshop Complex

The truck shop complex will be located approximately 1 km north-west of the primary crusher and cover a land area of approximately 225 m by 175 m or 4.5 ha. The area will incorporate outdoor facilities and three self-contained structural steel, pre-engineered buildings designed to accommodate the required facilities for repair, maintenance, and rebuild of the open pit mining equipment, storage space for spare parts and consumables, and administration offices.

The entire area will be fenced for security and safety reasons. Open pit trucks will enter via the entry gate at the south west corner of the facility and be placed on the dead line awaiting maintenance. Trucks already repaired will be held on the go line which is adjacent to the dead line. Repaired vehicles exit back to the open pit via the south east gate.

Maintenance Complex

The maintenance complex will comprise offices, service bays, meeting rooms, utility rooms, storage rooms and workshops. The complex includes buildings for lube storage, vehicle wash and a welding and machine shop

The Heavy Vehicle Repair Bay will be used for the repair of major mining equipment and comprise ten bays with automatic hose reels for dispensing engine oil, transmission fluid, hydraulic oil, air, solvent, diluted coolant and grease. Recovery systems and holding tanks will be provided to store waste oil and coolant products for recycling or disposal.

The Vehicle Wash Bay will be a stand-alone building northeast of the workshop and will accommodate a haul truck with the truck box in the dump position. Floor-and catwalk-mounted monitors will provide high-pressure water streams to wash the haulage trucks and loaders. Wash water will be recirculated through a large sump outside the building, where solids will settle out before the water is recirculated to the wash bay. Any oil in the recycled water will circulate through an oil skimmer to remove hydrocarbons prior to re-use.

Additional facilities housed within the maintenance complex at ground level include a fabrication workshop, tool crib, tool box storage battery storage, compressor room and mechanical room.

Lubricant Storage Area

The lubricant storage area will be located adjacent to the truckshop and house tanks for an approximately two-month supply of lubricants, coolants and waste oil for the mining and plant support equipment fleet. A separate exterior storage facility, with spill containment features, will be provided for waste oil and spent coolants.

Welding / Machine / Tire Shop

The welding / machine / tire shop will incorporate a tire repair shop, tire change shop, two welding bays, a machine shop, a rebuild shop and a compressor room.

Explosives Magazine & Emulsion Mixing Plant

The magazine and emulsion mixing facilities will be constructed and operated by a contractor. Facilities will consist of fuel oil storage tanks, an ammonium nitrate storage area, a detonator storage area, and an emulsion mixing plant.

Accommodation Camp

The permanent accommodation facilities designed for the first 10-15 years of operations are located in the north-western part of the Mine Licence Area, which is in a location upwind of the main facilities. This has been constructed in dormitory format using prefabricated buildings as well as communal and individual *ger* style accommodation. The final camp will be constructed on an area of 150 m by 270 m with a total area of approximately 43 700 m^2. Two levels of permanent accommodation are being provided including senior staff and junior staff and there will be a total of seven, single-level senior staff buildings and seven, two-level junior staff buildings. All buildings will be equipped with sprinkler systems and fire detection systems. Exterior access doors will be protected from prevailing winds. Built-in closets in all rooms will be large enough to hold cold-weather clothing. The accommodation camp has been designed to take account of the IFC/EBRD guidance on worker's accommodation[29].

Facilities will include the following:

- Dormitories and ger style accommodation with associated sanitary facilities;
- Mine administration building;
- Kitchen and associated food storage and preparation facilities;
- Local style and Western style mess;
- Wet mess;
- Laundry and associated room-cleaning facilities;
- Village administration and recreation facilities (including basketball courts and indoor gyms);
- Shop, including post office and public phones;
- Cultural centre;
- First aid facility; and
- Occupational health testing facility.

The camp will be constructed to meet the requirements of the operational workforce during their working rotations. It is envisaged that the majority of workers will live on a permanent basis within the South Gobi region in a variety of settlements as part of the Project's approach to support the development of the region as a whole.

A series of three temporary camps for construction employees and contractors accommodates approximately 14,800 people. The temporary construction camps consist of pre-fabricated buildings that will be removed after construction.

A construction camp for the Chinese contracting companies, sized for 4,000 workers is located to the south of the concentrator area and is designed to the same standards as the permanent camp, with workers housed in communal dormitories with central communal facilities. The camp is managed by Oyu Tolgoi's services contractor (Catering International Services) who provide the food and laundry services. All water and wastewater for this camp utilises the main supply and wastewater treatment facilities. Solid waste is sent for recycling and disposal to an on-site waste management centre.

All accommodation has been designed, and will be managed, to meet international camp management guidelines[30].

[29] Worker's Accommodation: Processes and Standards, A Guidance Note by the IFC and the EBRD, August 2009

[30] Including EBRD Performance Requirement 2, para.16 on worker accommodation and IFC Performance Standard 2 on Labour and Working Conditions.

Administration Building

The administration building will serve as the primary office space for all operations staff on site. The intention is to have a centralised facility for mine site operations including executive, supervisory and support staff. Facilities will include necessary support and contain the site's main Data Centre. In addition, there will be an Emergency Response Area located in the main conference room that will serve as the command point in the case of an area-wide emergency. It will be established as a two-storey pre-engineered, steel framed building incorporating architectural finishes and aesthetically pleasing in appearance. The building will have a total floor area of 5,000 m^2 and contains 83 offices for Senior Staff and 91 workstations in an open plan area. The building will include a main and four smaller conference rooms. The Data Centre will house the majority of the site's ICT management and storage equipment. Support facilities will include a Medical Centre, Fire Station and Security office.

Mine Dry Facility

The Oyu Tolgoi Mine Dry Facility is a centralised permanent operations facility whose primary purpose is to provide all site staff with a place to shower and change into work clothes and back into clean street clothes. This includes and is not limited to: open pit and underground operations, concentrator staff and truck shop maintenance staff. There are also spaces for other various activities that are centralised for use by multiple mine operation groups.

Core Storage Facility

The site engineering department has completed the conceptual design of the core storage shed. Documents include a technical summary and structural drawings for the foundations of a pre-engineered building.

Toyota Workshop

Toyota has constructed a light-vehicle maintenance facility for its fleet of vehicles at the site. The facility is complete and fully functional.

Fencing

The entire site boundary will be surrounded by a mine lease perimeter fence with security gates at entrance/exit points. The fence will be a conventional post-and-chain mesh, wide-type, approximately 2 m high.

Supplementary security fencing may be required at individual infrastructure facilities. Temporary security fencing is already established at the Project, but it does not cover the entire site boundary, including some development facilities.

Security Facilities

The site has two manned guardhouse gates situated at the north and south entrances. The southern guardhouse is a temporary facility and will be moved when the operational fence line is constructed. The site currently has a temporary perimeter fence which encloses the construction activities and serves to increase the safety and security of personnel and property, to prevent animals from wandering onto the site.

Security services are provided by a licensed security contractor. Security personnel are unarmed. The only exception is those security personnel guarding the explosives magazine, who are armed.

Dugat Quarry Deposit

The Dugat quarry deposit, is located on the northern part of the Mine Licence Area, is a hard rock quarry and gravel deposit. The deposit resource was approved on 10th July 2007 by MNET (order No. 245) and has 1.13 million tons of measured resource (A) and 3.04 million tons of inferred resource (C).

The mining of the Dugat quarry deposit started in 2007 and covers an area of 4,26 hectares. The Mongolian feasibility study for the Dugat Quarry Deposit was approved on 31st March 2009 by the Director of Mineral Resources and Petroleum Authority of Mongolia (MRPAM) (Order number 51). This approval permits the Dugat Quarry to operate with an annual capacity of 100,000 m^3 for 40 years of duration with the rock and gravel used for construction and concrete production.

Khaliv Sand Deposit

Sand for the construction work at Oyu Tolgoi is mined from the Khaliv sand deposit located on the north eastern part of the Mine Licence Area. Approval to use this deposit was provided to Oyu Tolgoi on 13th May 2008 by the MRPAM (Order number 2007), with an approved indicated resource (B) of 1,089,500 m^3 on 96 hectares. The feasibility study for this deposit allows it to operate for 8 years with an annual capacity of 150,000 m^3 (approved on 21st July 2009 by the Director of MRPAM; Order number 285).

4.11.4 Utilities and Services

Power Distribution

For the construction phase of the Project the power is being provided by approximately 60 small-scale diesel generators. Each diesel generator consists of a protective fence, shelter, fuel tank, electrical supply, control panel, and a container to contain spilling is installed under the each tank. There are currently three electrical generators in operation providing the electrical needs of the construction camp. A temporary diesel power station of 20 megawatts capacity and associated overhead power lines has been installed to meet the electricity demand of the construction phase prior to a permanent power supply being installed.

Under the terms of the Investment Agreement permanent power supply is required to be sourced by the fourth year of Project operations from a Mongolian power plant; in the interim power is expected to be sourced via a transmission line from China. The on-site facilities will be supplied by a 35 kV distribution system through radial feeders originating at a 220 kV main substation and routed through underground cables or overhead power lines. The following voltages will be utilised for systems and equipment:

- 35 kV for the plant site power distribution system and the primary feeders to the converter transformers for the gearless mill drives;
- 3.3 kV for large motors above 200 kW rating;
- 10.5 kV and 3.3 kV for the underground mining power distribution systems;
- 690 V for process equipment rated less than 200 kW; and
- 380/220 V, three phase and single phase, for lighting and small power loads.

Heating

Except for remote and small buildings whose heating will be provided by electric heaters, the main areas of the facility will be heated through local coal fired boilers. The heat from the boilers will serve to maintain an acceptable working environment during the colder conditions. The major areas of the plant to which heating will be provided are as follows:

- The Concentrator;
- The Underground mine and shaft farm surface infrastructure facilities; and
- Infrastructure facilities.

Emergency Power

Emergency power will be provided by diesel-fuelled generating sets, installed in the following locations:

- Process plant (four 1.5 MW diesel generators for a total of 6 MW capacity);
- Tailings pump house (one 1.5 MW diesel generator);
- Truck shop facilities and boiler house (one 750 kW diesel generator); and
- Accommodation village (four 750 kW diesel generators for a total of 3 MW capacity).

In the event of a utility power failure, the emergency power generators will start automatically, providing power to the essential loads such as lighting, heating, and communication systems in buildings, and to emergency loads for selected process equipment in the process plant to ensure orderly shutdown and permit plant maintenance activities.

Communications

A communications network will be established based on satellite technology and wireless communication for voice, fax, Internet, and PC network traffic. The communications and IT infrastructure will consist of satellite link, PABX, Ethernet LAN, IT servers, desktop computers, UPS system, copper and fibre cabling, and site VHF radio system. VSAT (very small aperture terminal) satellite equipment on site will consist of satellite antenna, transceiver, modem, and bandwidth manager. Ethernet LAN points will be provided in all offices, stores, and workshops. A "trunked" repeater system will provide the infrastructure to enable VHF and mobile radio sets to communicate around the site.

System security will be achieved by a centralised access control server with a network intrusion detection system and VPN (virtual private network) concentrator. Voice communications will be based on an IP network using wide area network (WAN) links, which will result in lower operating costs.

Coal Supply

Coal is required for the boilers used to heat the process plant, accommodation area buildings, and underground mine. Coal is supplied by third party contractors and is delivered to site from the coal mines to the west of the site; these coal mines do not form part of the Project. The coal is stored on the side of the temporary waste management centre and then transfers to local stockpiles adjacent to the heating units. Coal consumption is estimated at 12,000 t/year initially, increasing to 20,000 t/year when Hugo North is in full production. Coal will be purchased from one of a number of large coal projects within Mongolia.

Bulk Fuel Store

During Construction, bulk fuel will be supplied and operated by Petrovis LLC, the leading fuel supplier in Mongolia. Following a study of site fuel consumption, Oyu Tolgoi has reduced site storage of bulk fuels to 3,800m^3.

Diesel fuel will be delivered by the supplier in a tank truck. The fuel will be unloaded and stored in storage tank farms. Three diesel fuel storage and dispensing facilities will be strategically placed close to users; the first for general vehicle fuel located in the northwest corner of the site with 2 x 50 kL gasoline tanks and 2 x 400 kL diesel tanks; the second for fuelling the mine fleet will be located south of the truckshop with 2 x 400 kL diesel tanks; and a third will be located at the diesel power station with 4 x 50 kL diesel tanks.

This central fuel store will be used to supply the power generator, drills, and mining heavy equipment and recharge remote fuel units (generators etc). All fuel tanks in the fuel store are bunded (and meet the MNS4628-98 standard). In line with good international practice the fuel storage bunds are designed to contain not less than 110% of the volume of the largest storage vessel or inter-connected system, and at least 25% of the total volume of substances stored in the compound. All tank loading/unloading points are located in bunded areas and all filling points are located on concrete aprons with a concrete-lined sump to capture any spillages.

During the initial years of open pit mining, annual diesel fuel consumption will reach approximately 50 ML/year decreasing once the planned electrical transmission line is installed.

Figure 4.23: Current Petrovis LLC Bulk Fuel Store

In addition to these liquid fuels, liquefied petroleum gas (LPG) is also stored on site for cooking and other uses.

4.11.5 Waste Management

Existing Waste Management Facilities

The site operates a temporary, construction phase waste management centre located to the southeast of Shaft 1. This site is located on the Cretaceous clay and currently comprises: Waste collection for recycling (metal, plastic and wood), a general waste (domestic/office) pit, a construction waste pit and food waste pit. Burning of general waste is prohibited.

Under current arrangements, wastes delivered to the Oyu Tolgoi landfill site are segregated prior to delivery, and on arrival are registered with the Landfill Attendant, and then classified and disposed of to the correct landfill location.

Local businessmen are permitted following a short induction to collect wood to sell in the local communities, these individuals are provided with applicable PPE whilst on site.

The existing waste management centre has been upgraded to ensure that it can manage the increased volumes of waste generated during the construction phase.

Permanent Waste Management Facility

The operational Waste Management Facility will be located in the northeast of the Mine Licence Area and will be the focal point of waste management practice at the Oyu Tolgoi Site. This will be a purpose-built engineered facility which will be operational in 2012. Principal features of the Waste Management Centre will include a non-hazardous waste landfill and leachate treatment, recycling centre and composting centre.

Within the operational Waste Management Facility, waste that is classified as being non-hazardous will be placed in a secure sanitary landfill (see *Figure 4.24*) that uses the U.S. EPA Subtitle D-Non hazardous Solid Waste (Liner System) in its design; this requires a single composite liner comprising a geomembrane with a clay liner. This will comprise:

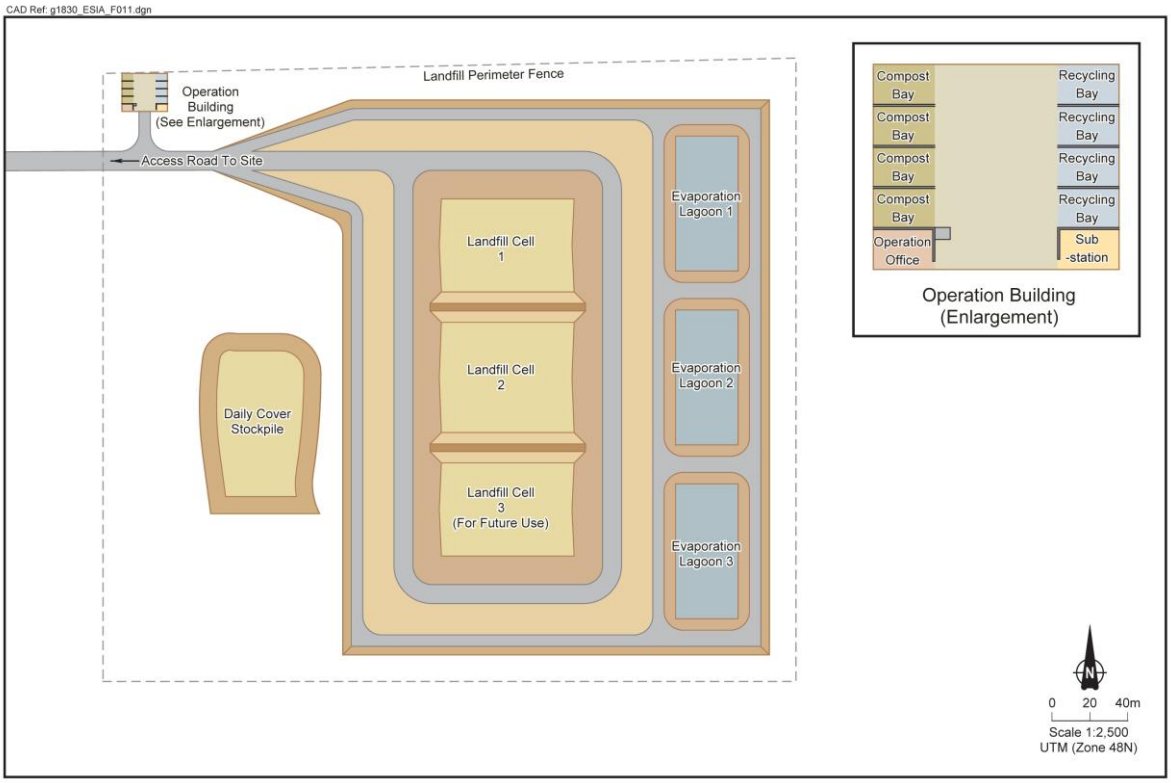
- Prepared ground foundation layer;
- Compacted clay liner with a minimum thickness of 600 mm and a maximum hydraulic conductivity of $1x10^{-7}$ cm/s;
- Geomembrane of 0.75 mm or thicker, with a minimum thickness of 1.5 mm for HDPE geomembranes;

- Leachate collection layer with minimum thickness of 300 mm and hydraulic conductivity of $1x10^{-2}$ cm/s;
- Leachate removal system in leachate collection layer with a minimum head of 300 mm; and
- Filter between the leachate collection and removal system and waste.

Leachate will be collected in a gravel-pipe leachate collection system and gravity fed through a discharge system and onto an adjacent leachate evaporation pond. The landfill will include a passive landfill gas collection system, environmental monitoring wells and secure perimeter fencing.

As the waste in the landfill reaches final elevations, the landfill will be covered with a protective clay-vegetative layer. Exposed waste will be routinely covered with soil to satisfy hygienic and visual needs.

Figure 4.24: Landfill and Leachate Pond Layout



Leachate Treatment

Due to the arid climate at the Oyu Tolgoi site, treatment of leachate (the waste liquid that collects at the base of a landfill) will not be required and effluent solutions will be contained and allowed to evaporate in leachate ponds. The leachate evaporation ponds will have engineered embankments and base grading and solute will be fully contained by a composite clay-geomembrane liner system on prepared ground, similar to the landfill.

Waste Incinerator

The construction phase truck shop houses a small incinerator which is used to burn certain hazardous materials (oily rags) and medical waste. This incinerator has a combustion room temperature of 1,200^{o}C with a burning capacity of 10-30 kg/hour. No sampling of incinerator emissions has been undertaken due to the difficulty of importing reference gases (used to calibrate testing equipment) into Mongolia. Given the very low volume of ash generated by the incinerator, no chemical testing of the ash has been undertaken; however no chlorinated waste products are disposed in the incinerator. Currently about 95% of all incinerated waste is composed of oil filters or oily rags.

Infectious wastes generated from the Oyu Tolgoi medical centre is being burned in the incinerator under the supervision of the clinic staff, whilst the non-combustible medical wastes (sharps etc) are sealed and sent to Ulaanbaatar for appropriate disposal.

For the operational phase of the Project a slightly larger incinerator with higher specification, which has been designed to meet European Union (EU) and IFC combustion efficiency, residence time and emission standards will be installed. This incinerator will be capable of burning selected hazardous wastes (e.g. oil filters, expired resins etc.). Given the low production volume of select hazardous wastes / waste oils at the Oyu Tolgoi Site, the incineration capacity is indicated to be 0.6 ton/day, equivalent to a small sized incinerator. The incinerator has been specified to meet Mongolian and international (including EU) standards for air emissions for hazardous waste incinerators.

Ash residue from the current incinerator is disposed of to the temporary non-hazardous landfill and the future incinerator ash will be disposed of to the new waste management facility in a specific hazardous waste disposal cell.

4.11.6 Access Roads

Internal Access Roads

Internal access roads are being established to service the construction phase and will ultimately include a total of approximately 26 km of construction within the Mine Licence Area. The full construction will include 35 culverts, one river crossing and three overpasses. All internal access roads will be of graded gravel construction with a chemical dust suppressant agent. Road bases will be built with scarified/compacted existing ground where suitable or will be replaced with well graded gravel and sandy fines where the existing soil is unsuitable. The top elevation of the shoulders of the gravel pavement surface will be approximately at the same level as the surrounding surface except at pipeline crossings. Side drain ditches will be provided where storm water drainage parallel to the road is necessary.

Internal access roads are classified according to their use. Two classifications will be adopted; Primary Roads and Secondary Roads. Primary roads will include the main routes to connect the mining facilities. Secondary roads will include minor routes used for small vehicles and normal road transport trucks. All roads will be constructed to the Mongolian National Standard, applicable international standards and AASHTO Standards[31].

4.12 OFF-SITE PROJECT INFRASTRUCTURE

4.12.1 Regional Roads

An existing road from the Chinese border at Gashuun Sukhait passes close to the Oyu Tolgoi site and is used by the Oyu Tolgoi for access to the border crossing and for access to Khanbogd *soum* centre and beyond. Details of the road from Oyu Tolgoi to the border can be found in *Section 4.14* of this Chapter. Oyu Tolgoi also undertakes regular maintenance of the existing earth road from the Mine Licence Area to Khanbogd.

Fuel and supplies will also be transported to the Project site by road from Ulaanbaatar during the construction and operational phases. Management of fuel transport including spill response capability are addressed in *Chapter D5: Petroleum and Fuels Management Plan* and *Chapter D11: Transport Management Plan*.

4.12.2 Water Borefield Access Track

Access to the water borefield will be via a gravel service track from the plant site, across the northern lease boundary and following the pipeline route to Gunii Hooloi (see *Figure 4.17* and refer to *Section 4.10.2* for information on the pipeline). Traffic loading for the borefield track will be limited to light vehicles and occasional heavy equipment and trucks for routine inspections and maintenance. The track will be constructed to Mongolian standards in accordance with a Resolution issued by the Mongolian Department of Roads in 2002. This standard requires that top soil be removed and the road surface be levelled and compacted. The track will be formed with a cross-fall and table drains and have a wear surface constructed of gravel. The running surface will be 3 m wide with shoulders 1 m wide. Signage will be added as required.

[31] The American Association of State Highway Transportation Officials (www.transportation.org)

4.12.3 Off-Site Administration

Oyu Tolgoi has established a regional office in Beijing for the following operations functions:

- Concentrate marketing and sales;
- Concentrate transport logistics; and
- Procurement and logistics.

The existing Oyu Tolgoi office in Ulaanbaatar includes offices for personnel involved in the following activities:

- Government relations;
- Legal support;
- Travel coordination;
- Human resources;
- Accounting; and
- Translation.

Oyu Tolgoi has representative offices in *soum* centres of Khanbogd, Bayan Ovoo, Manlai and Tsogttsetsii and in the *aimag* capital, Dalanzadgad. It is envisaged that Dalanzadgad, northwest of the Project site (see *Figure 1.6* in *Chapter A1: Introduction*), will be the main regional centre for recruitment of semi-skilled and unskilled personnel, as well as some skilled and professional employees, and that a recruitment centre will be established there in due course. Oyu Tolgoi has established a representative office in Dalanzadgad and is constructing a training centre for local businesses. Khanbogd is the community closest to the site and will be another source of personnel. Oyu Tolgoi will develop recruitment and training facilities (based on the existing representative office) in Khanbogd.

4.12.4 Housing for Workers

The Project anticipates that approximately 14,800 workers will be recruited from outside the immediate vicinity of the Project area during construction. Though the majority will be Mongolian, about 30% are foreigners undertaking specialist tasks for which the necessary workers are not available in Mongolia. During operations the Project anticipates a steady workforce of approximately 3,500 people, and at least 90% will be Mongolian by year 5 of production. During construction, all workers will be housed in purpose-built camps at the Oyu Tolgoi mine site, with the exception of a limited number of Mongolian workers who will either be residents of Khanbogd *soum* centre or who are located in a camp for CIS staff, located adjacent to Khanbogd *soum* centre.

Oyu Tolgoi is developing and implementing a long-term worker housing strategy that is integrated with *soum* and *aimag* regional development plans.

Further details on how this issue will be managed are included in *Chapter C8: Population and Influx* and *Chapter D16: Influx Management Plan*.

4.13 AIRPORT

The original exploration airport within the Mine Licence Area was relocated in 2010 as the original location was required for the open pit and crusher. Site studies suggested it was unsafe to locate the new airstrip on the mine lease due to possible conflicts with aircraft approaches and proposed mine infrastructure such as power lines and heavy surface mining equipment. The Temporary airport is located approximately 7 km north of the Oyu Tolgoi mine lease area. It is required to facilitate the transport of people and goods to the site from Ulaanbaatar and could serve other internal Mongolian airports.

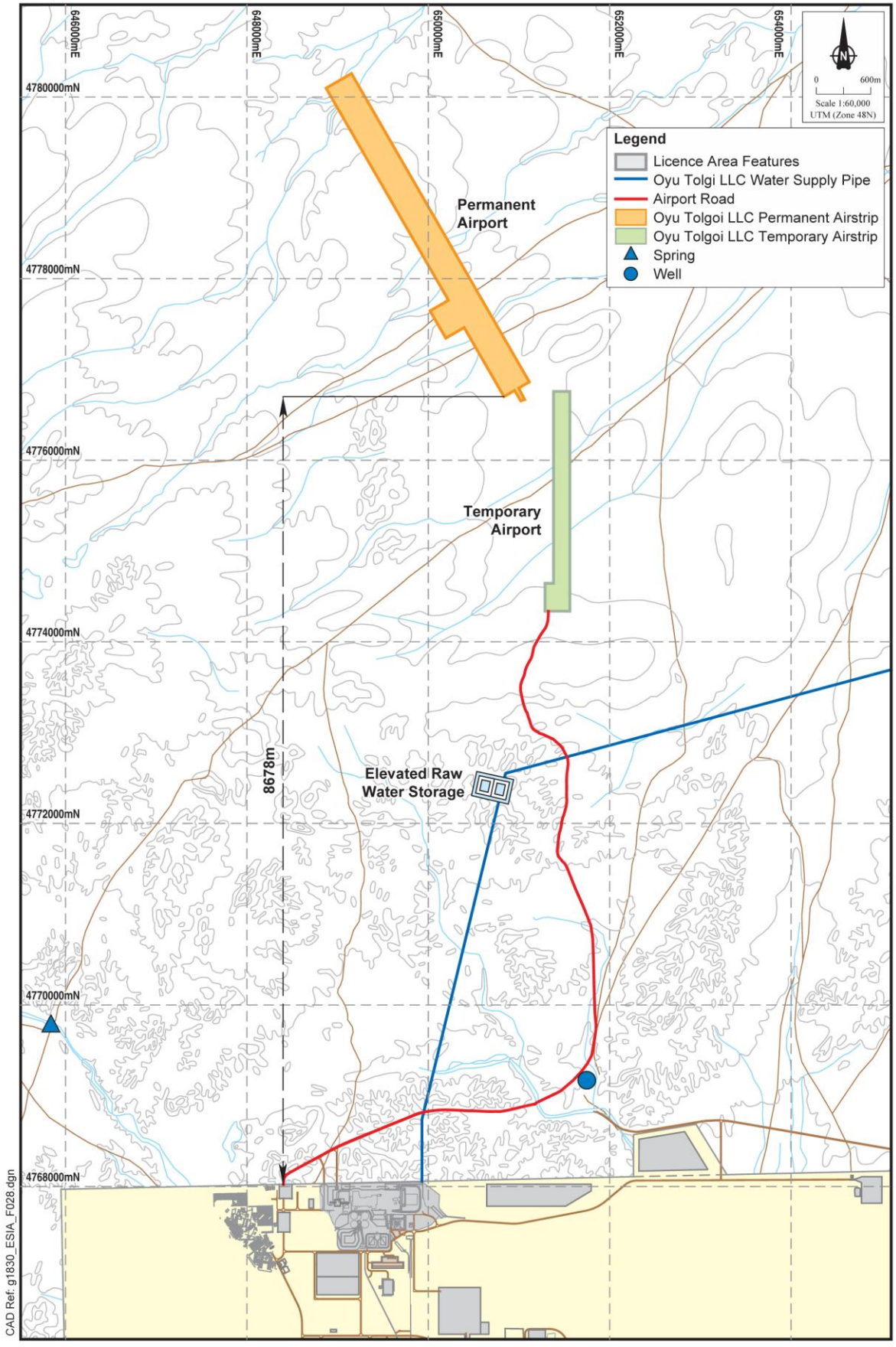
The runway has been aligned to the prevailing north-south wind direction to minimise cross-wind condition and facilitate optimal landing-takeoff conditions. The Temporary airport consists of basic infrastructure, such as runway (single gravel-surface strip), terminal building, control tower and other associated facilities.

The Temporary airport is an interim airstrip constructed to the south of the location for the final Permanent airport. The interim airstrip is expected to be used solely by Oyu Tolgoi for approximately 24 months. The Permanent airport is being constructed and will be commissioned prior to the commencement of operations in 2012, when the Temporary airport will be decommissioned and the land will be rehabilitated to its former state.

The Permanent airport (*Figure 4.25*) is based on specifications derived from the International Civil Aviation Organisations (ICAO) and will be suitable for Boeing 737-800 aircraft. This will require a 2,000 meter runway, taxiways, safety taxiway, safety end strips, parking apron, airstrip markings, runway lighting, power supply (to be provided by means of a 40 kVA generator), electrical design, fencing, surface drainage, control tower above the passenger terminal and a car park.

The passenger terminal will be approximately 15 m x 15 m in size. A water tank will be installed for water supply to the bathroom facilities and a septic tank system will collect waste water and sewage. A 40 kVa generator will provide power. The airstrip, terminal building, control tower and car park area will be enclosed by a chain link type security fence 2.5 meters high.

Figure 4.25: Airport Location



Construction

A geotechnical survey and investigation will be carried out to determine the nature and mechanical properties of the in-situ soil and construction fill material for the Permanent airport. In addition, local construction material resources will be identified that can be used for construction of the runway sub bases, sub grades and surface.

It is anticipated that a large proportion of the fill material will be provided in-situ. In the event that this material is found to be unsuitable for construction purposes, a contingency resource has been identified about 500 meters to the South West of the airport.

Flight Frequency

The frequency of flights to the airport comprises an average of 3 charter flights per week. As the Oyu Tolgoi Mine Construction Project progresses and more personnel are mobilized to site, it is anticipated that the flight frequency will increase to 7 flights per week.

Fuel Storage

Aircraft flying from Ulaanbaatar to Oyu Tolgoi will be fully-fuelled for a return trip prior to departure. A 40 kVa diesel generator will be refuelled by truck from the Oyu Tolgoi facilities, eliminating the need for fuel storage at the Permanent airport.

Operation and Management of the Airport

Once the principal construction activities have been completed on the permanent airport, it is anticipated that the airport will be handed over to the regional authorities to operate as a regional airport. In that case, other commercial flight operators will be able to use the airport, and Oyu Tolgoi will become one of a number of users of the airport.

4.14 CONCENTRATE TRANSPORTATION

4.14.1 Concentrate Transport Road Development

The route for the Concentrate Transport extends for approximately 105 km southeast from the north gate of the Mine Licence Area, following an existing earth road (a designated national road) to Gashuun Sukhait, the border post on the Mongolian side. The town of Ganqimaodu is located on the Chinese side of the border. The road design has been prepared by Oyu Tolgoi in accordance with a Memorandum of Understanding, signed with the Government of Mongolia in 2007. The existing road was used for local transportation and trade and was also used to access the border crossing at Gashuun Sukhait. The earth road has been used by Oyu Tolgoi during construction for the materials imported from China. The earth road has been improved during this time by grading and the road is currently being upgraded to a national specification sealed bitumen road that will be used by Oyu Tolgoi and general traffic (but not by coal trucks).

The *Oyu Tolgoi EIA Volume I - Transport and Infrastructure Corridor* and *Chapter A5: Analysis of Alternatives* examines the environmental issues associated with the development of various road alignments from the Mongolian-Chinese border at Gashuun Sukhait to Oyu Tolgoi. Since the assessment of the transport corridor, the existing road route from Gashuun Sukhait to a point 23 km from the border where the coal transportation route and the Oyu Tolgoi road merge, has been extensively used by coal trucks hauling from coal deposits west of Oyu Tolgoi to the Chinese border. Oyu Tolgoi will retain the use of this alignment and a new road alignment has been constructed by a consortium of coal companies so that coal trucks and Oyu Tolgoi traffic do not share the same road.

Figure 4.26: Oyu Tolgoi Road and Coal Transport Route

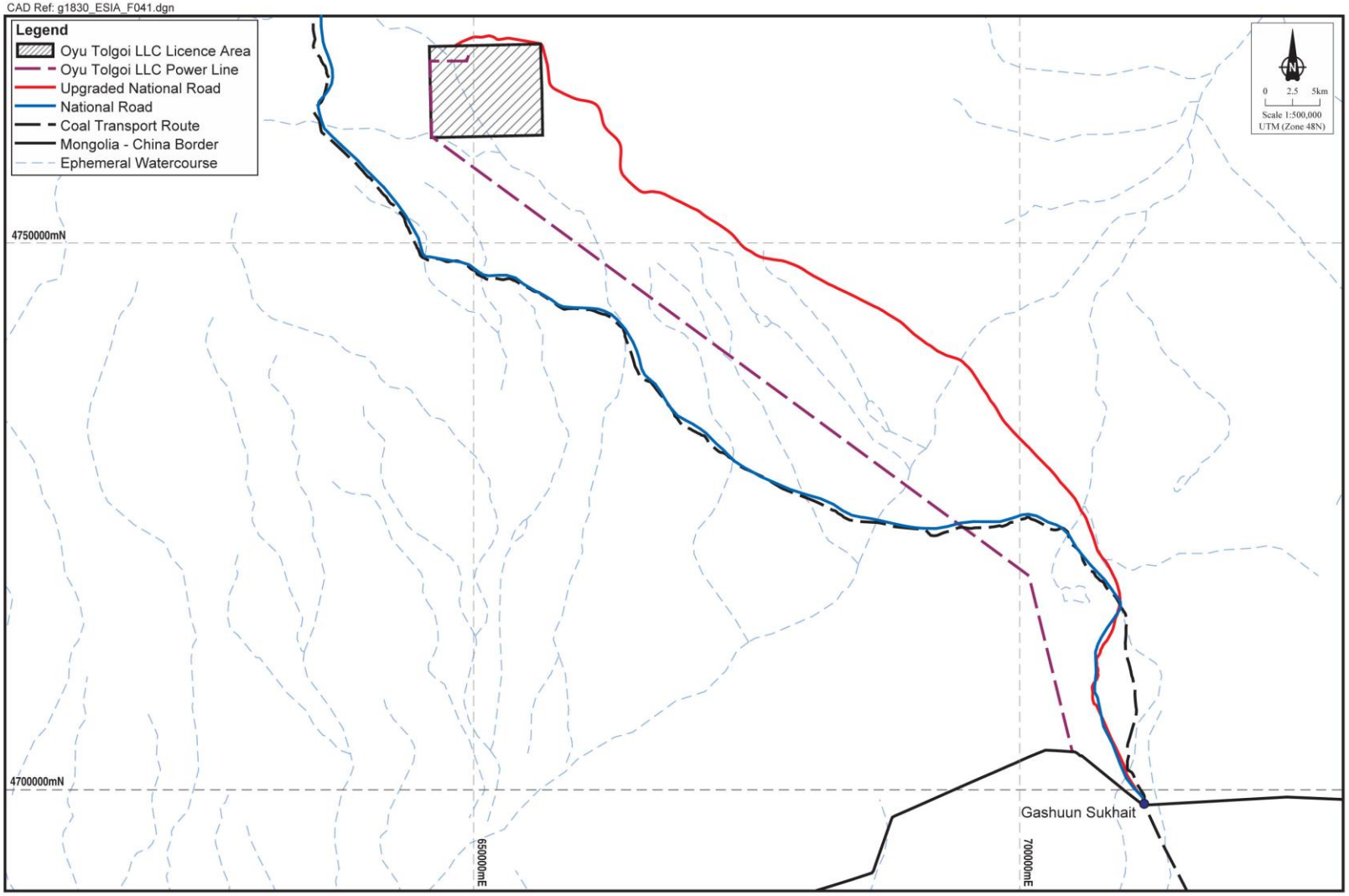
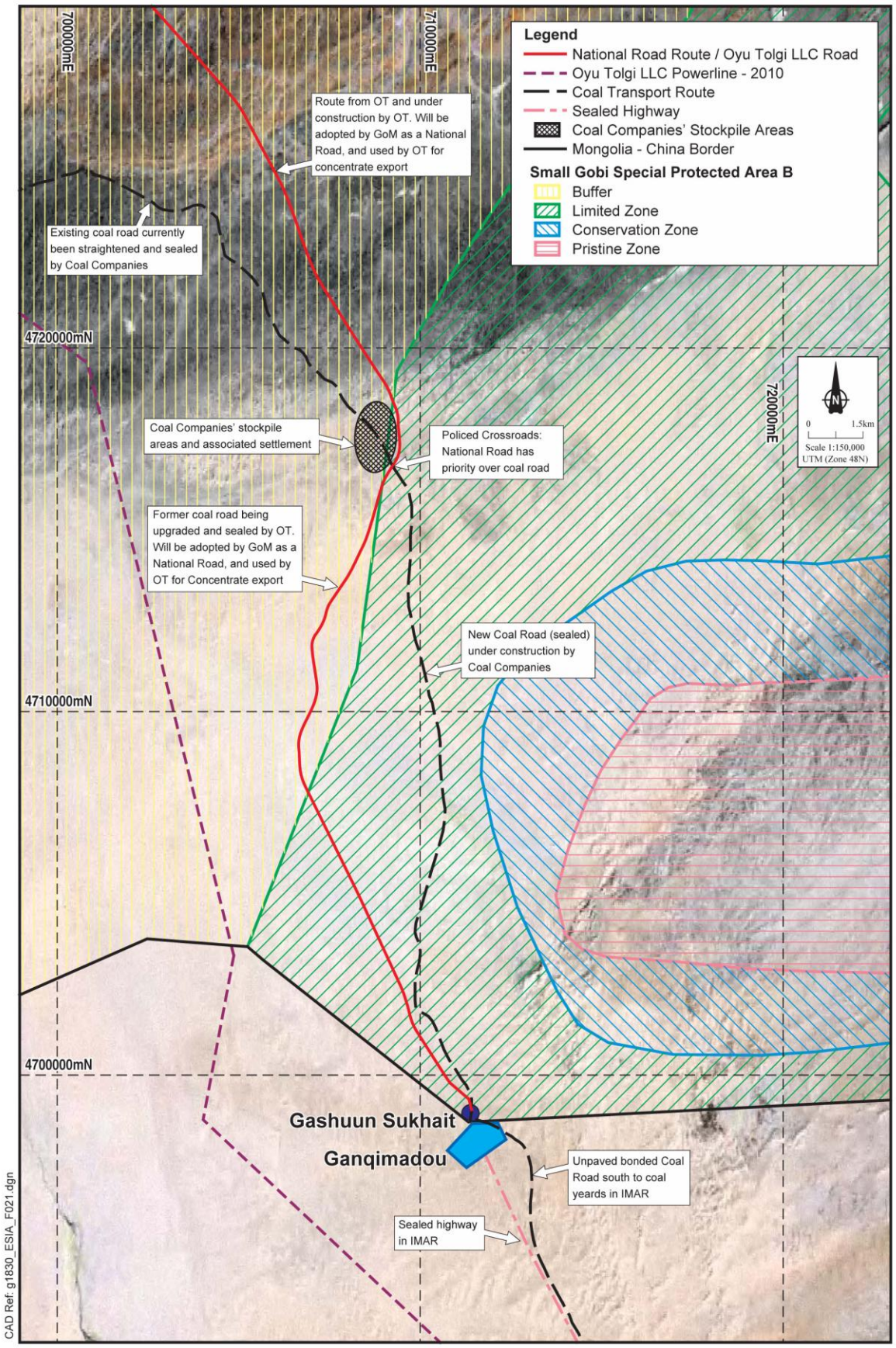


Figure 4.27: Road Approaches to the Border



The route passes through the Small Gobi "B" Strictly Protected Area (SGSPA) running to the west of and parallel to a new coal transportation road that is being constructed through the SGSPA. The route travels through 32 km of buffer zone surrounding the SGSPA and it passes through 17.6 km of the "limited use" zone of the SGSPA itself. The new coal transportation road is not being constructed by Oyu Tolgoi and Oyu Tolgoi has had no input into its design or location. To gain access to the Gashuun Sukhait border post there is no alternative to crossing the SGSPA as the Gashuun Sukhait border post is itself located in the SGSPA.

Oyu Tolgoi has started to improve the road base along the road section nearest the Mine Licence Area and has linked the road to the north gate as a temporary measure during the construction period. The operational road alignment runs to the north gate as illustrated in *Figure 4.26*.

The operational road will be constructed as a fully-sealed all weather road with a gravel sub-bed, using borrow materials from local sources adjacent to the road alignment, and will have an 8 m wide sealed running surface and 1 m wide shoulders. The design will be for maximum axle weight of 10 tonnes for six-axle 40 tonne payload truck-trailers or trucks (total maximum weight of 55 tonnes) to transport ore concentrate to China. This road is scheduled to be completed in 2012. Once completed the road will be handed to the Government of Mongolia and will become the National Road from the border. The coal transportation road, which is also currently being sealed, is a lower category of road and coal trucks will give way to the National Road with Oyu Tolgoi's trucks on it. The road junction will have two police posts to ensure that the coal trucks (which will be slowed with rumble strips) comply with the road rules and give way. The first five kilometres from the north gate to the new high way will remain Oyu Tolgoi's road and not form the National Road which links into the National road network. In the future the Government of Mongolia may choose to connect the National Road to the upper part of the coal haulage road, but this will not be the responsibility of Oyo Tolgoi. No part of the road under Oyu Tolgoi's control will be fenced.

All minor roads crossing the National Road will be provided with sealed ramps and appropriate road markings and safety signs. Identified animal crossing points will be marked with safety signs to warn drivers. These animal crossings are typically associated with herders' routes between winter camps and wells/springs.

Drainage and Flood Protection

The cross drainage is designed to bear the traffic load during the transport of mine construction vehicles and for the public transport. The cross drainage will comprise eight different sizes of 1,200 mm to 1,800 mm square and round pipe culverts at 129 locations. Locations and culvert sizing were based on drainage area and flow velocities.

Operational Loads & Parameters

The road has been designed to handle operational loads of 10 tonnes per axle, with a maximum vehicle weight for a 6-axle unit (3-axle truck and 3-axle trailer) of 55,000kg.

Animal and Herder Crossings

Animal and herder crossing points have been identified in conjunction with herders and crossing points have been built into the road layout. Further animal crossing points are planned to minimise disruption to wildlife movements. Further details are provided in *Chapter C6: Biological Resources*.

4.14.2 Cross-Border Access Road to China

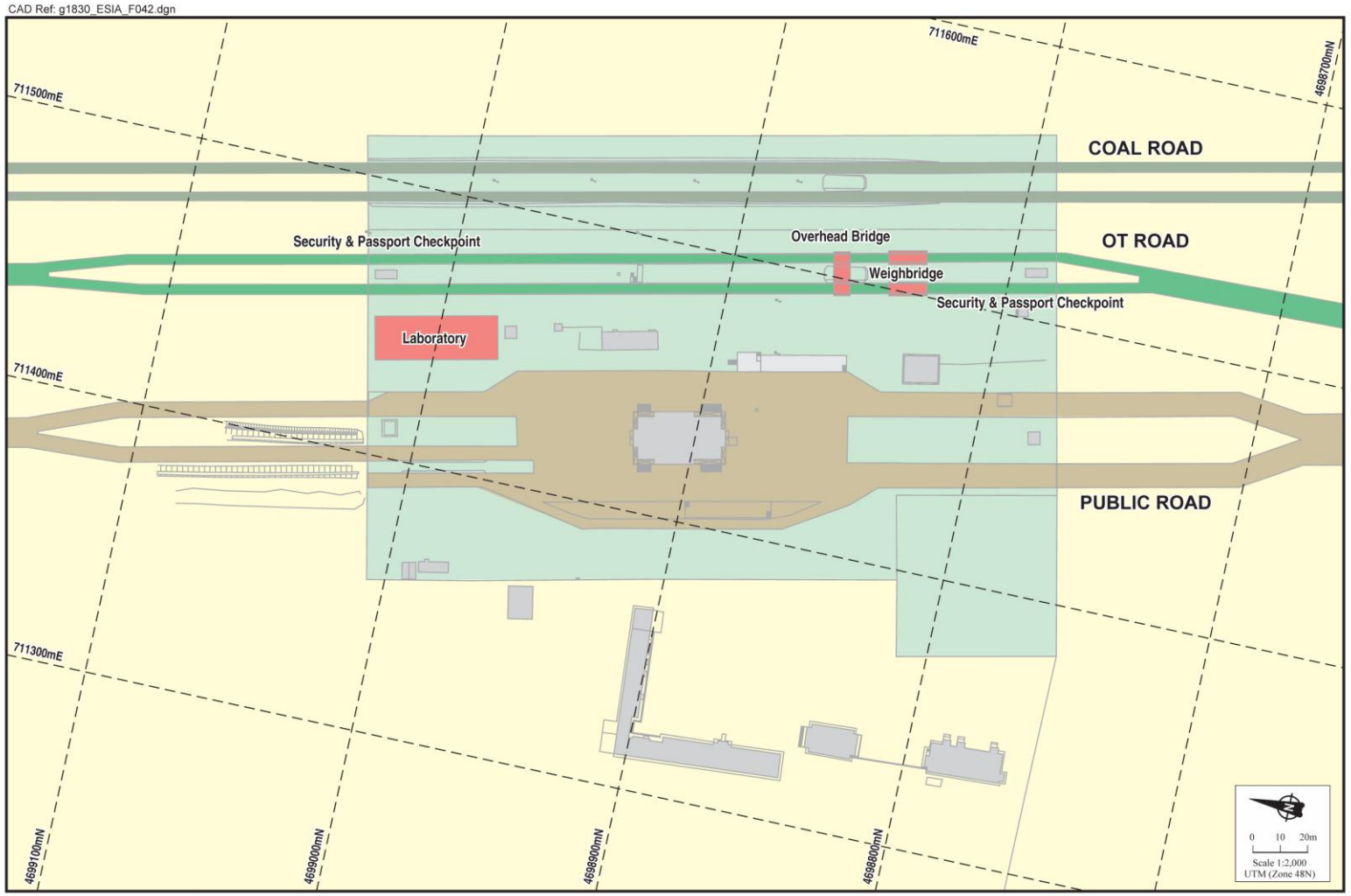
As part of the development of the Access Road to China there will be a link between the existing Mongolian Customs Facility at the Mongolian border in Gashuun Sukhait and the existing Chinese Customs Facility at the Chinese border in Ganqimaodu. The currently existing inter-linking roads between the borders will be upgraded by Oyu Tolgoi subsequent to the discussions with the Mongolian Government to meet the expected Project-related traffic needs at the border-crossing facilities. To maintain the access road, a small full-time maintenance team will be required for re-compacting pavement, re-shaping cross-sections, restoring drainage systems, clearing blocked drains and culverts, and repairing floodways. This border area will not require any significant additional land take than is currently used by the military, customs and coal trucks.

4.14.3 Border Crossing

The transportation of concentrate from Oyu Tolgoi into China will be through the Gashuun Sukhait-Ganqimaodu border crossing - most probably to a bonded area on the Jiayou International Logistics (JIL) yard, where the 20 foot 25 tonne containers will be unloaded in Ganqimaodu. Once the containers have cleared customs the containers will be loaded to the client's trucks and transported by road to the nearest smelter or rail head for shipment to the end smelter.

The existing border crossing at Gashuun Sukhait will be upgraded. The existing facilities are inadequate to cater for current coal company access, general access and Oyu Tolgoi access through the Gashuun Sukhait border crossing. A combined proposal has been developed that will cater for coal company access, general access and Oyu Tolgoi access. Under the proposed approach, coal operations will have sole access to a dedicated lane and Oyu Tolgoi will have sole access to its own dedicated lane, with common facilities such as a chemical testing laboratory, accommodation and offices located centrally. This operation will require the construction of a warehouse transfer station and weighbridge. The proposed layout is set out below.

Figure 4.28: Schematic of the Gashuun Sukhait Border Crossing



Oyu Tolgoi will have no responsibility for the transport of concentrate through China as the concentrate will be sold to market from a point of sale at the border crossing.

4.15 POWER SUPPLY

The Project is energy-intensive with an energy requirement to commence operations in excess of 200 MW with further growth to around 310 MW in the longer term.

4.15.1 Construction Power Supply

Oyu Tolgoi owns and operates a Diesel Power Station (DPS) located within the Mine Licence Area, to provide power to the Project during the construction phase. Following the development of the Project's long term power supply, the DPS will provide stand-by power for the operational mine site.

The DPS currently comprises 10 x 2 MW containerized diesel generator sets and associated containerized switchgear. The diesel engines are V12 supercharged diesels coupled to 10.5 kV, 50 Hz alternators. Alternators are slightly oversized to assist in the dynamic response of the standby power system. The 10.5 kV generated voltage is stepped up to 35 kV for eventual use.

4.15.2 Initial Power Supply

Oyu Tolgoi's preferred option for initial power supply is to import power at the Mongolian/Chinese border from the Inner Mongolia Power Company (**IMPC**). The imported power will be transmitted to the Project via a dedicated 220 kV overhead transmission line that is currently under construction by Oyu Tolgoi. The terms on which power will be imported and made available to Oyu Tolgoi will be detailed in a power purchase agreement between Oyu Tolgoi, IMPC and the Government of Mongolia.

4.15.3 Long Term Power Supply

The Investment Agreement requires Oyu Tolgoi to secure its total power requirements for the Project from within Mongolia within 4 years of the commencement of commercial operations. However, Oyu Tolgoi expects to source all of its total power requirements from within Mongolia approximately 2 years earlier than required under the Investment Agreement.

A long term power supply solution is required to replace the initial power supply described above. Initial studies by Oyu Tolgoi considered a number of power generation alternatives and concluded that the most appropriate long-term power supply for the Project would be to generate power by using the coal available in the southern Gobi region. Accordingly, Oyu Tolgoi has commenced the review of a coal-fired power plant option within the Mine Licence Area (Power Plant). This has included the development of a Detailed Environmental Impact Assessment (DEIA) which has been approved by the Mongolian Ministry for Environment and Tourism (MINET). The DEIA describes a power plant comprising 3 x 150MW units, with provision for subsequent expansion to a total of 5 x 150MW units (with room for a sixth unit in the Project layout). The final configuration and timing of the development of the Power Plant is subject to continuing discussions between Oyu Tolgoi and the Government of Mongolia. The Power Plant will be the subject of a supplemental Environmental and Social Impact Assessment commissioned by Oyu Tolgoi in accordance with international Lender standards.

Oyu Tolgoi will require 3 x 150MW units to meet its power requirements once commercial production commences. Oyu Tolgoi's preference is to obtain additional power for any further expansion of its operations from the power plant proposed for the Tavan Tolgoi project in the southern Gobi region. However Oyu Tolgoi will also consider the option to build a fourth 150MW unit for this purpose. Oyu Tolgoi has accelerated the development of the Power Plant and expects to award an EPC contract for construction of the Power Plant in 2012. Construction is expected to commence immediately after the EPC contract is awarded, subject to the necessary approvals being in places.

4.16 WORKFORCE

Since 2005, the Project has been actively working to advance workforce projections, risks and opportunities for both Construction and Mining Operations phases of the Project. The central goal to all workforce issues is to ensure that preference is given to hiring from Southern Gobi region communities and that at least 90% of the workforce will be Mongolian. A key advantage of theProject is that in addition

to training new workers, it will also allow established Mongolian trades people to have a viable local alternative to overseas work.

The Oyu Tolgoi recruitment strategy includes conducting a labour census of the population in the Southern Gobi region to understand the sources of skilled and unskilled labour. Where possible, the Project will cooperate with other organisations conducting labour studies related to the minerals sector, such as the Mongolian National Mining Association.

The construction workforce peaked at approximately 14,800 in December 2011, making the Project the largest employer in Mongolian at that time. Almost 10,000 workers, equalling 67% of the total workforce were Mongolian citizens. In addition, Oyu Tolgoi is undertaking training for an additional 3,300 Mongolian workers from which it can recruit staff, while providing additional trained workers into the Mongolian economy.

The operational workforce will be approximately 3,000 and a summary from the workforce estimates for Oyu Tolgoi (excluding construction contractor workers is outlined below.

Table 4.7: Project Workforce Estimate (excluding construction workers), 2011 to 2013

	2011	2012	2013
Mongolian Nationals	1,789	3,029	3,053
Expatriates	303	427	395
Total Workforce	2,072	3,456	3,448
% Mongolian Nationals	86%	88%	89%

Source: Oyu Tolgoi Workforce Database, 2011

A significant proportion of the available and qualified workforce in Khanbogd has been employed by Oyu Tolgoi and its contractors. Oyu Tolgoi training and local supplier development programmes are ongoing to maximise the employment of the local workforce. Further details can be found on *Chapter D17: Labour Management Plan*.

4.16.1 Recruitment Objectives

Under its labour strategy, Oyu Tolgoi gives preference to local workers from the neighbouring *soums* and the wider Omnogovi province. Clause 4.11 of the Investment Agreement clearly states that: *"...The Investor shall make as a priority training, recruiting and employing citizens of local communities in the southern Gobi region, with preference to Umnogovi Aimag..."* However, it is likely that the Project will have to recruit workers from elsewhere in the Gobi and Mongolia as a whole.

Oyu Tolgoi, in partnership with all applicable Mongolian Government and non-government agencies, intends to work to ensure that there is a suitably qualified Project workforce available to meet the requirements of the Project.

All staff are covered by a comprehensive human resources policy and are paid salary packages in compliance with Mongolian Labour Law. Oyu Tolgoi has made the following commitments to human resources for the Project:

- In line with the Investment Agreement, Oyu Tolgoi will use its best efforts to work with contractors who maintain a greater than 60% Mongolian workforce for construction work; and a greater than 75% Mongolian workforce for contractors involved in direct mining operations. For the remainder of the Oyu Tolgoi operating workforce from the commencement of production the figure is 90%.
- Within 5 years of the commencement of production, Oyu Tolgoi will use its best efforts to ensure that no fewer than 50% of its employed engineers are Mongolian nationals and, within 10 years of the commencement of production, that no fewer than 70% of its employed engineers are Mongolian nationals.

4.17 PROJECT CONSTRUCTION

4.17.1 Construction Management

The Project Management Team for construction comprises Oyu Tolgoi as Owner, supported by Fluor Corporation acting as engineering, procurement, construction management (EPCM) consultant. Redpath Mongolia is the underground development contractor.

4.17.2 Construction Activities

The status of the construction activities at the time of this ESIA is as follows:

- Accommodation and camp facilities – *completed;*
- Shaft 2 head frame and associated infrastructure – *completed in 2011*;
- Shaft 2 sinking and underground development –*commenced in late 2011*;
- Open pit – *pre-stripping underway*;
- Concentrator – *building is complete and process plant is being installed*;
- Tailings storage facility – *preparation commenced in late 2011*;
- Airport – *Temporary airport completed and operational, Permanent Airport construction commence in 2011;*
- Oyu Tolgoi to Gashuun Sukhait road – *Construction commenced in 2011*;
- Power line –*Construction commenced in 2011;* and
- Gunii Hooloi pipeline and borehole field – *Construction commenced in 2011.*

Each of these is discussed below.

4.17.3 Accommodation and Camp Facilities

A number of different accommodation camps have been constructed and operated in alignment with the IFC/EBRD guidance of worker's accommodation and camp accommodation (as outlined in *Section 4.11.3*):

- Operations camp;
- Site Construction camps;
- Camps for CIS and Nomads catering and cleaning staff, located adjacent to Khanbogd; and
- Remote construction camps – one for the road and one for the borefield development.

The camps within the Mine Licence Area are operated by a site management company, CIS Catering, who will provide a common service across all camps with food menus appropriate for the nationality housed in each camp. CIS and Nomads (another catering and cleaning company employed by Oyu Tolgoi) have accommodation camps for their catering and cleaning staff adjacent to Khanbogd.

The construction camps are sized for up to 14,800 workers and accommodate Mongolian and expatriate workers, supervisory and management staff.

The operations camp will be sized for 4,000 and will accommodate Mongolian and expatriate workers, supervisory and management staff.

Camps are equipped with mess halls (offering Mongolian meals and other specific meals in recognition of the international composition of the workforce as appropriate), recreational facilities and medical facilities operated by SOS. All camps within the Mine Licence Area are linked into the site infrastructure (power, water, wastewater etc).

Two remote construction camps located on the road corridor and in the borefield accommodate an aggregate total of up to 2,000 workers and are sustained by supplies from the central facilities at Oyu

Tolgoi. This approach has previously been used successful by Oyu Tolgoi during the last borefield drilling campaign. Process water will be provided from local boreholes which have been chosen to avoid any impact on other users in the area. All waste and wastewater will be transported back to the main Project infrastructure and dealt with in accordance with Oyu Tolgoi's waste and wastewater management procedures. Upon demobilisation of these camps the area will be restored with the aim of restoring the site to as close to the original condition as can be feasibly achieved.

4.17.4 Site Infrastructure

Site infrastructure construction is being undertaken under Fluor's supervision and includes:

- Infrastructure buildings (truck shop, administration building, north gate house and Operations Camp);
- Site drainage;
- Site roads;
- Security fencing;
- Undai and other ephemeral water course diversions;
- Water distribution;
- Wastewater collection;
- Site heating and distribution;
- Waste management;
- ICT (communications backbone, LAN, VOIP, Fire alarm system, CCTV and access control system);
- Raw water system; and
- 220kV power line and the 220kV substations (central, concentrator and mine).

4.17.5 Shaft 2 Head Frame

Surface works related to the Shaft 2 head frame are being managed by Fluor with support from Redpath. Construction work is being undertaken by a Fluor subcontractor and currently is focused on the head frame, ventilation shaft and conveyor corridor.

4.17.6 Shaft 2 Sinking and Underground Development

The sinking of Shaft 2 and underground development is being undertaken by Redpath and will commence once the head frame is complete.

4.17.7 Open Pit

The open pit is being managed and constructed directly by Oyu Tolgoi and not by contactors. .

4.17.8 Concentrator

The construction of the concentrator plant is being managed by Fluor and construction work is being undertaken by sub-contractors to Fluor. Contractors are undertaking work packages for the foundations for the concentrator, concentrator steel erection and mechanical, electrical and pipe (MEP) works.

4.17.9 Tailings Storage Facility

The construction of the tailings storage facility is being undertaken by Oyu Tolgoi operations. Site preparation, construction of the tailings pipelines and water return pipe, installation of seepage management systems and construction of starter dam structures will be undertaken prior to start-up and commissioning of the concentrator.

4.17.10 Airport

The original Oyu Tolgoi Airport located within the Mine License Area and used for exploration and early phase construction has been relocated as the original location is required for the open pit and crusher. The airport is now located approximately 7 km north of the Oyu Tolgoi mine lease area and was commissioned in September 2010.

The new airport comprises the Temporary airport and is south of the location for the final permanent airport. The Temporary airport is to be used solely by Oyu Tolgoi for approximately 24 months. The interim airport consists of basic infrastructure, such as runway (single gravel-surface strip), terminal building, control tower and other associated facilities.

The Permanent airport will be constructed prior to the commencement of operations. Airstrip construction will be undertaken and phased such that uninterrupted operation is maintained during the relocation process. The Temporary airport will be decommissioned and rehabilitated to return the land to its former state.

4.17.11 Oyu Tolgoi to Gashuun Sukhait Road

The road from Oyu Tolgoi will run from the north gate of the Mining Licence Area to the border post of Gashuun Sukhait. This route has been agreed with the Government of Mongolia and will be adopted by the Government of Mongolia as the National Road to the border once it is constructed by Oyu Tolgoi. The work is being managed by Flour. The road is currently under construction and will be completed in 2012, in the interim the construction traffic is using the unsealed route which has been subject to some foundation works by Oyu Tolgoi near to the Mine Licence Area. The road construction utilises water from wells already installed by Oyu Tolgoi in the Galbyn Gobi area and use new temporary wells which will be installed away from current groundwater users. Borrow-pits are utilised along the route and restored on completion.

The improvements to the coal transportation road which are being undertaken by coal companies not related to Oyu Tolgoi was completed in 2011 and therefore the southern section of the current coal road (from 23 km north of the border to the border) will revert to Oyu Tolgoi and therefore allow uninterrupted and safe access to this route during the period of Oyu Tolgoi's construction work on the road in 2011/12.

4.17.12 Power Supply

The 220 kV power line was constructed in 2011 to run from the Bayinhanggai switching station in Inner Mongolia Autonomous Region (IMAR) in China through to the border and then up to the Oyu Tolgoi site entering the Mine License Area on the south-western corner. The section in IMAR has been constructed by the IMPC. The Mongolian section has been constructed by Oyu Tolgoi and may be handed over to the Government of Mongolia once built. Within IMAR, IMPC has undertaken the environmental permitting for the route to meet IMAR regulatory requirements.

4.17.13 Gunii Hooloi Pipeline and Borefield

The initial phase of the pipeline and borehole supply field commenced in 2011 which lead to the connection of the borefield to the Oyu Tolgoi and enabled the site to transition to borefield water rather than water from the local construction water supply within the Mine Licence Area. Installation of new boreholes will continue in 2012 and these will be connected to the pipeline.

4.18 PROJECT OPERATIONS AND MANAGEMENT

Rio Tinto is the manager and operator for the Project and once in operation the Project will be managed in accordance with Rio Tinto policies, standards and guidelines[32].

First production is scheduled to occur in late 2012. The Investment Agreement requires the Project to commence within 2 years and production to commence within 5 years of signature of the Investment Agreement (which took place in 2010).

[32] Further details can be found at http://www.riotinto.com/index_ourapproach.asp

4.19 PROJECT DECOMMISSIONING AND CLOSURE

A Preliminary Mine Closure Plan (PMCP) has been prepared for the Project. This was submitted to the Government of Mongolia in April 2010 as part of an approved Mongolian Feasibility Study. A Mine Closure and Reclamation Framework document (*Chapter D21*) is included in this ESIA. This sets out the key principles and requirements which Oyu Tolgoi will implement as international good practice as contained within the Rio Tinto mine closure standard[33] and in the IFC EHS Guidelines for Mining and the EU Mine Waste Directive (2006/21/EC).

As part of the development of the Project, a *Mine Closure Plan* is being developed and will be completed in mid-2012. This will define in greater detail how Oyu Tolgoi will meet the requirements of the Rio Tinto mine closure standard, Mongolian regulatory requirements and international good practice.

4.19.1 Vision and objectives

The closure vision for Oyu Tolgoi is to leave a positive social, environmental and economic legacy at eventual closure.

Short-Term Objectives

Oyu Tolgoi's short-term reclamation objectives (during construction and operations) can be summarised as follows:

- Progressively reclaim disturbed areas as soon as they are no longer active;
- Minimise the risk and impact of wind and water erosion and sediment transportation;
- Stabilise slopes;
- Restore drainage; and
- Cover ground to prevent soil drifting/dust.

Long-Term Objectives

The long-term objectives are to:

- Reclaim the land to a condition where long-term environmental degradation does not take place with minimal care and maintenance;
- Reclaim the land to a condition where safety risks associated with the mine to the public are minimised;
- Reclaim the land to a condition where local communities can use the site without inheriting significant future liability;
- To the extent practical, create an aesthetically pleasing environment;
- Ensure public health and safety is protected; and
- Minimise adverse socio-economic impacts and provide positive social-economic benefits.

Objectives of the Mine Closure Plan

The *Mine Closure Management Plan* will:

- Outline applicable standards with regards to mine closure with which Oyu Tolgoi will comply with;
- Define Oyu Tolgoi requirements and procedures to guide Oyu Tolgoi management and contractors;
- Define mitigation measures to manage and minimise adverse impacts;
- Define roles and responsibilities;
- Define monitoring and reporting procedures; and
- Define training requirements.

[33] Closure Standard. Rio Tinto plc. 1 May 2009.

Closure costs will be accounted for in line with the Rio Tinto Closure Standard. The closure cost estimate, as reported in the Project financial statements, will be updated annually during the operation's life to reflect known developments, including scope changes, the effect of a further year's inflation, exchange rate differentials and new regulatory requirements. Closure cost estimation procedures will ensure that identified post closure costs, whether ongoing or one-off, are realistically estimated and incorporated into the estimate.

Article 39 of the Minerals Law of Mongolia (2006) outlines the restoration and management obligations of mining licence holders. These obligations include the requirement to develop mine reclamation plans within the Environmental Protection Plan (EPP), which is a component of the approved Environmental Impact Assessment. The EPP is required to include measures to minimise environmental impacts and reclamation including backfilling, re-grading and re-vegetation to achieve designated post-mining uses.

The Minerals Law also requires a mining licence holder to deposit funds equal to 50% of its environmental protection budget for the particular year into a special bank account established by the State central administrative agency in charge of the environment. The environmental protection deposit funds are to be used if a mining licence holder fails to fully implement the environmental reclamation measures. The agency would then use the funds to complete reclamation work and the licence holder would be responsible for any additional funds required. If the licence holder complies with all the obligations of the EPP, the deposited funds are returned to the licence holder. The agency may halt mining activities in accordance with the approved EPP.

The Mine Closure Management Plan goes beyond the requirements of the Government of Mongolia and provides a structure to ensure that full closure costs will be fully funded throughout the Life of Mine as required by international good practice (for example the EU Mine Waste Directive 2006/12/EC and the IFC EHS Guidelines for Mining).

Further information on mine closure planning is included in *Chapter D21: Mine Closure & Reclamation Framework*.