Oyu Tolgoi LLC

Health, Safety and Environment

Net Positive Impact forecast

Net Positive Impact Forecast		
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2 INTRODUCTION

2.1 Document Number

This document is the Net Positive Impact (NPI) forecast for the Oyu Tolgoi (OT) project. The document reference number for this Management Plan is OT-10-E9-PLN-1001.

2.2 Purpose

This document updates the project ESIA's NPI forecast (TBC & FFI 2012) to align with the current Biodiversity Management Plan (Oyu Tolgoi LLC 2016a) and Offsets Management Plan (Oyu Tolgoi LLC 2016b). It assesses whether OT's mitigation and offset measures will deliver NPI. Future revisions to the BMP or OMP that occur as a result of adaptive management may require OT to update this NPI forecast, provide the results to project lenders, and publicly disclose updated versions.

2.3 Application

This forecast assesses losses and gains from OT impacts and mitigation (including offsets) on all priority biodiversity features (Oyu Tolgoi LLC 2016a - BMP Annex 2). Only losses from impacts identified as critical or high risks, based on assessment of their likelihood and consequence, are included (Oyu Tolgoi LLC 2016 a - BMP Annex 3: Table 1).

The project has averted some biodiversity losses through avoidance and minimisation of project impacts outlined in the BMP (Oyu Tolgoi LLC 2016a). These 'gains' are important but can be difficult to quantify. Instead, this forecast focuses on quantifying residual impacts (after avoidance and minimisation), gains from rehabilitation outlined in the Land Disturbance Control & Rehabilitation Management Plan (Oyu Tolgoi LLC 2016c), and offsets outlined in the OMP.

2.4 Approach

This forecast updates metrics used to assess project impacts in the ESIA NPI forecast (TBC & FFI 2012). The ESIA forecast combined losses and gains from different impacts using Quality Hectares as a catch-all extent × condition metric. For example, direct loss of habitat for a species was compared with gains from reduced poaching pressure, both expressed as extent × condition (for that species). That was a pragmatic approach at the time, given the very limited data available. Where practical and feasible, it is preferable to disaggregate different types of losses and gains. This assessment uses data newly available from OT surveys and monitoring to inform a disaggregated approach (Table 1).

Table 1: Separate metrics used to assess different types of losses and gains

Impact (loss)	Offset (gain)	Analysis	Metric
Direct habitat loss	Sustainable cashmere	Habitat quality	Vegetation condition (scored 0-1) × area (QH)
Direct habitat loss	Fence removal	Habitat quality	Vegetation condition (scored 0-1) × area (QH)
Indirect habitat loss	Anti-poaching	Human disturbance	Human disturbance (scored 0-1) × area (QH)

Indirect habitat loss	Fence removal	Human disturbance	Human disturbance (scored 0-1) × area (QH)
Direct mortality	Powerline standard	Mortality	Number of individuals
Direct mortality	Powerline insulation	Mortality	Number of individuals
Indirect mortality	Anti-poaching	Mortality	Number of individuals
Fragmentation	Anti-poaching	Landscape connectivity	Connectivity (scored 0-1) × area (QH)
Fragmentation	Fence removal	Landscape connectivity	Connectivity (scored 0-1) × area (QH)

Four analyses use four separate metrics listed in the fourth column of Table 1 to estimate losses and gains of biodiversity. Each analysis is designed to account for losses from one negative impact caused by OT, and a related offset designed to compensate for that impact. For each priority biodiversity feature, losses and gains were measured at a landscape level for each relevant metric, generating (occasionally) up to four loss-gain measures for each species. Although three of the four analyses report the net position reached in QH, each of these analyses examines a different aspect of 'quality', so losses from one impact cannot be compared with gains from an unrelated offset—only gains from the paired offset specifically designed to compensate that impact.

2.5 Commencement

This NPI forecast applies from 1 April 2016.

2.6 Authority and Management

The OT General Manager HSES is the custodian of this NPI forecast. Any requests for changes to this NPI forecast must be addressed to this person and will be subjected to the appropriate review and approval processes.

3 SCOPE

3.1 Scope of this NPI forecast

This NPI forecast assesses losses from all significant project impacts on all impacted priority biodiversity features, and compares them with gains for each of those priority biodiversity features derived from rehabilitation and offsets. The assessment involves analysis of a geographic area that therefore encompasses both direct and indirect impacts, and anticipated gains from offsets.

Offset actions may be implemented within Bayan-Ovoo, Khanbogd, Khatanbulag, Khuvsgul, and Nomgon Soums. In addition, a proposed offset action is to remove sections of the fence along the Ulaanbaatar – Beijing railway. This will generate gains across a large area east of the railway. A broader offset area has thus been used to assess the potential benefits from this activity (Figure 1).

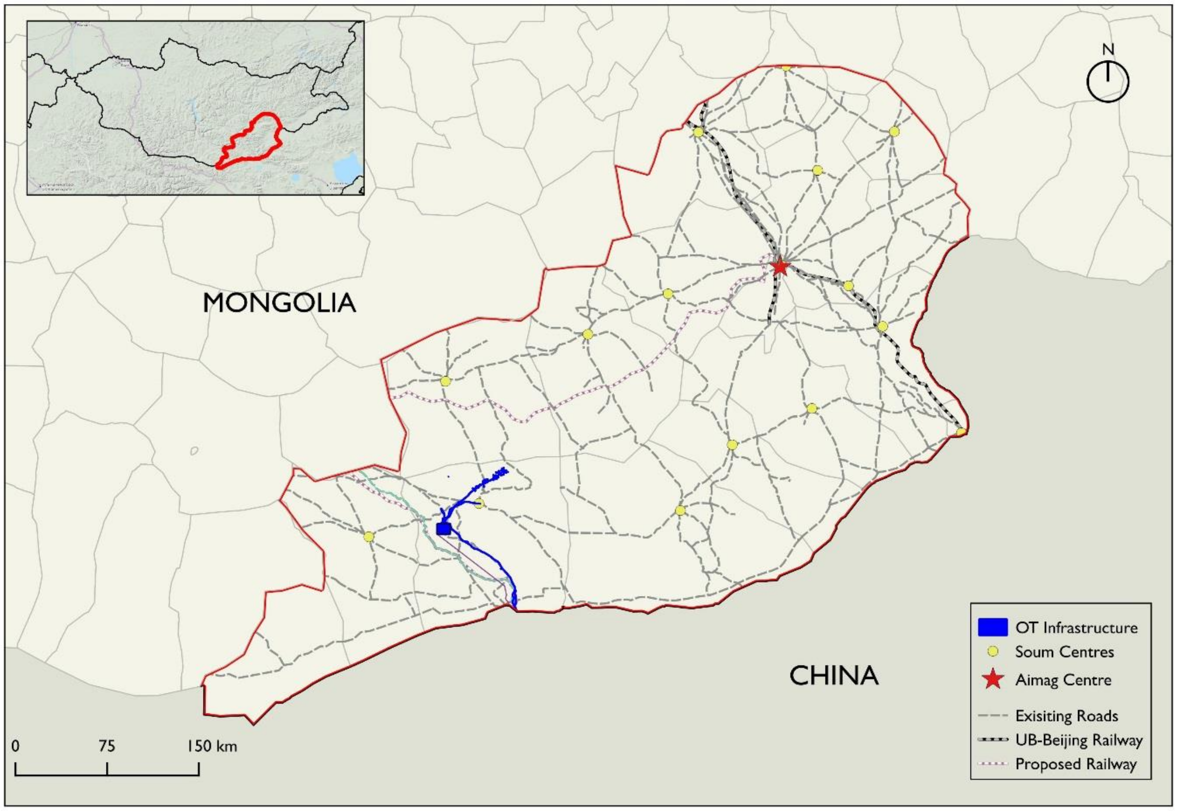

Figure 1: Mitigation and offsets landscape (area within the red boundary).

3.2 Overlaps with other Management Plans

This NPI forecast is one of a suite of documents that collectively outline Oyu Tolgoi's approach to managing biodiversity risk. The ESIA Appendix 1: Oyu Tolgoi LLC Biodiversity Strategy continues to accurately outline OT's overall approach to biodiversity management. Underneath this, the following documents will be periodically updated, to reflect changes in knowledge and adaptive management:

- Oyu Tolgoi LLC Biodiversity Management Plan (BMP) - details how OT has followed Rio Tinto's approach to biodiversity action planning. It identifies priority biodiversity for the project, and assesses project risks to this biodiversity. It then outlines mitigation of critical and high risk project impacts through avoidance and minimisation;
- Oyu Tolgoi LLC Land Disturbance Control and Rehabilitation Management Plan (LDCRMP) – addresses, in more detail, mitigation of project land disturbance impacts on priority biodiversity, with a focus on rehabilitation;
- Oyu Tolgoi LLC Offsets Management Plan (OMP) - outlines a suite of biodiversity offset projects designed to address residual impacts after mitigation outlined in the BMP & LDCRMP;
- Oyu Tolgoi LLC Net positive impact forecast (NPI forecast; this document) - quantifies biodiversity losses from critical and high risk impacts (after avoidance and minimisation, for which impact baseline is challenging to quantify), estimates projected gains from rehabilitation and offsets, and weighs losses against gains to predict OT's ability to reach no net loss/net positive impact goals for priority biodiversity; and

- Oyu Tolgoi LLC Biodiversity Monitoring and Evaluation Plan (BMEP) - details monitoring to assess the state of priority biodiversity in the South Gobi, impacts/pressures, and project response in terms of mitigation and offsets. As such, monitoring informs the NPI forecast, clarifies whether the project is likely to remain on track to achieve NPI, and provides feedback for adaptive management of the BMP, LDCRMP and OMP.

4 ROLES AND RESPONIBILITIES

4.1 Key Roles and Responsibilities for the NPI forecast

Principal roles and responsibilities for the implementation of this plan are outlined below.

Table 2: Key Roles and Responsibilities

Role	Responsibilities
General Manager HSES	• Overall responsibility for update and disclosure of this NPI forecast.
Manager Environment & Biodiversity, Superintendent Biodiversity, and Specialist Fauna	• Work with OT's biodiversity advisors to ensure this NPI forecast is updated on an as-needs basis. • Work with BMEP and offsets contractors to ensure the collection of relevant data, and implement adaptive management via updates to the Biodiversity Management Plan and Offset Management Plan and associated contractor Scopes of Work. • Ensure OT collects relevant metrics to inform the NPI forecast.
Biodiversity advisors	• Work with OT and contractors to ensure the NPI forecast is updated on an as-needs basis.
Contractors	• Work with OT to feed relevant data from monitoring and offset implementation into the NPI forecast.

4.2 Key Interfaces

OT is likely to need ongoing support from its biodiversity advisors and contractors implementing the BMEP and offsets, to update this NPI forecast and ensure it remains current. This will involve interpretation of monitoring results and notification of any monitoring thresholds crossed that require adaptive management, and assistance with updating biodiversity loss-gain calculations.

5 PROJECT STANDARDS

This NPI forecast meets action 9 of OT's Biodiversity Action Plan (Oyu Tolgoi 2015).

6 METHODS

Supplementary technical methods (by the project's biodiversity advisors, Global Biodiversity Conservation) are available in a separate document (GBC 2016). Sections 6.1-6.4 summarise the methods used to complete four analyses that calculate losses and gains from paired negative and positive impacts. The summary methods below clarify the logic by which losses (negative residual project impacts) and gains (from rehabilitation and offsets) have been estimated.
Direct habitat loss (footprint) analysis

This assessed changes in the extent and condition of natural habitats (including tall saxaul forest) based upon measured and predicted changes to vegetation. Losses from the direct project footprint were compared against gains from rehabilitation of disturbed habitat (described in the LDC&RMP - Oyu Tolgoi LLC 2016c) and from sustainable cashmere offsets (described in the OMP - Oyu Tolgoi LLC 2016b).

6.1 Tall saxaul forest

Losses of tall saxaul forest were assessed from OT reports of construction impacts (12 ha of poor quality saxaul). Gains were estimated from planned rehabilitation (6 ha, anticipated able to reach baseline quality), and enrichment planting within another degraded saxaul forest as an offset (improving baseline quality by 25% across 24 ha - see Oyu Tolgoi LLC 2016c).

6.2 Rangeland

The project is using rangeland, the predominant Natural Habitat in the southern Gobi, as a surrogate for priority biodiversity facing only low or moderate risk impacts. Offset activities designed to improve rangeland condition (OMP Section 7.2 - Oyu Tolgoi LLC 2016b) will compensate for low and moderate risk impacts to Natural Habitat and the priority biodiversity it supports, particularly the impact of direct loss of habitat under project infrastructure. While this impact is not identified as a significant impact for any priority feature individually (except for three priority plants), because it affects all priority features simultaneously it is regarded as significant overall.

Vegetation condition (or 'quality') can be viewed in a number of ways, of which three are particularly relevant to this plan. First, its intrinsic condition as a vegetation type. Second, its condition as a habitat for biodiversity – in particular for OT as a habitat for priority biodiversity; notably for individual species of grazing ungulates. Third, its condition for ecosystem service – in particular for OT as grazing pasture for local herders' animals. Indicators for these three types of condition would ideally be subtly different. For example, the first will involve measures of a greater diversity of species (particularly perennial plants), whereas the second would focus on measures of palatable species (particularly annual plants). Further, species-specific indicators, e.g., for Asiatic Wild Ass versus Goitered Gazelle, would differ. For example, condition for a water-dependent grazing ungulate will be based more on the availability of water and annual plants compared to that of a water-independent mixed grazing/browsing ungulate. Current ecological knowledge and monitoring data do not, however, allow for precise identification of indicators relevant to each type of condition (or, further, for individual species). The NPI forecast does not identify a need for quantified gains for any priority species from rangeland management (such as the proposed sustainable cashmere offset project), only for rangeland itself as Natural Habitat. A single intrinsic vegetation condition indicator (i.e., type one) will thus be used for biodiversity, and assumed to broadly reflect qualitative gains for priority biodiversity features. This approach will be revisited as monitoring data and ecological knowledge improve. To demonstrate value to herders from the sustainable cashmere offset project, it will be important to measure and monitor ecosystem service condition of rangeland (i.e., type three). This will need to be addressed in the ecosystem services monitoring framework.

Baseline

A baseline was modelled, based upon an estimate of pre-project vegetation condition, with mapped human influences in the landscape used to define areas where poorer vegetation condition was expected. The model divided the entire area of analysis into a raster grid of 10m × 10m pixels, and assigned each a value between 0 and 1 (representing the quality or condition of vegetation, from 0-100%).

Since there is relatively little information available (and some information is conflicting), a precautionary approach was taken to assessing baseline vegetation condition (TBC & FFI 2012a). Vegetation in pixels away from human impacts in the landscape was precautionarily assessed to be in very good condition befire the project and given a score of 0.9 (90%). In areas with known degradation (e.g., close to human infrastructure or in heavily populated areas), relevant base layers of human pressures and threats in the landscape were used, following WWF (Chimed-Ochir *et al.* 2010) or a human disturbance index created by

The Nature Conservancy (TNC: Heiner *et al.* 2013). To reflect decreasing severity of impacts with increasing distance from disturbance, a distance decay function was applied following TNC guidance (Anonymous 2008). Impact layers were overlapped and the minimum pixel value (minimum vegetation quality) from all layers used. This gave an overall total baseline of quality hectares (QH) for vegetation in the study area.

Losses

Losses were estimated as direct OT infrastructure impacts plus a DDF to reflect disturbance because of OT-induced population growth in Khanbogd. Potential degradation near infrastructure was not included in calculations as it will not always occur (e.g., the most significant feature, the OT- Gashuun Sukhait road uprade, may improve neighbouring baseline vegetation condition by reducing off-road driving The revised total QH for the study area was compared with the baseline to estimate the project impact in QH.

Gains from rehabilitation

Rehabilitation gains in this forecast are estimated to be improvement to 50% of pre-disturbance condition of each pixel that will be rehabilitated (precautionarily just temporary construction camps, the OT-Gashuun Sukhait diversion road, and above the OT-Gunii Hooloi water supply pipeline). Existing studies suggest that rehabilitation in steppic habitats can occur as quickly as within five years (Le Houerou 2000) and that, when best-practice is followed, it can be effective at recovering most natural characteristics (Conservation Ecology Research Unit 2013). The more precautionary rehabilitation assumption followed in this forecast reflects the fact that habitat to be restored is more challenging because it is desertic and, to some extent, non-equilibrium.

Gains from a sustainable cashmere offset

Gains in habitat quality are predicted from a sustainable cashmere offset project (described in the OMP). A gain (or improvement) in the quality (or condition) of vegetation (rangeland) is integral to the cashmere project as it underpins its sustainability. Precautionary predictions of gains are made within this forecast, given lack of prior similar projects in the Gobi. The most similar to date was a 1995–2006 German and Mongolian government ‘Conservation and Sustainable Management of Natural Resources’ project. This had many similarities to the planned sustainable cashmere project, and resulted in 83 community organizations involving 1,175 households—about 14% of the households in the 13.5 million hectares project area (Leisher *et al.* 2012). Gains measured in that project were 15% in overall green season NDVI and 14-15% in plant biomass. The Wildlife Conservation Society Mongolia program believes that 15% gain is a reasonable prediction for the OT cashmere project (S. Jambal *in litt.* 2015). Compared to the 1995–2006 project, the OT cashmere project will have more binding requirements for participants, will offer a wider range of support (such as alternative incomes), will be more explicit in promoting vegetation and wildlife gains, and aims to continue in perpetuity. Nonetheless, given the more challenging drier environment facing the cashmere project, predicted gains have been precautionarily scaled down by a third (the difference in average annual precipitation with the 1995–2006 project) to an estimated 10% gain over ten years. The percentage rangeland quality gain will be monitored and actual measured values used to update the NPI forecast. To be even more precautionary and account for potential limited uptake, a conservative estimate of 50% of full uptake and participation (including reducing animal numbers) has been used.

Although the theory of non-equilibrium habitats predicts that vegetation quality is determined largely by rainfall and little by grazing intensity, a number of empirical studies show impacts from grazing in the Gobi and similar regions (e.g., Hilker *et al.* 2012). This suggests that successful implementation of the cashmere project, leading to a reduction in livestock density, will lead to increased vegetation quality. It also suggests that vegetation quality gains can accrue in non-equilibrium habitats such as semi-desert as well as equilibrium habitats such as desert-steppe.

A number of project partners are collaborating in the sustainable cashmere project. OT will take credit for outcomes commensurate with the proportion of the overall project budget contributed by OT (accounting for prior investments by other partners). This will be agreed collectively by project partners when the 2016 workplan is finalised. For the purpose of illustration, it is estimated in this forecast as [75%]. This 50% uptake × [75%] credit × 10% biomass gain (= 3.75% gains overall) is an average across participating herder rangeland. In 2016, the project aims to engage 12 community groups of 10-15 households grazing about 120,000-180,000 ha across Nomgon soum and the northern third of Bayan-Ovoo soum. In subsequent years, the project aims to engage more community groups over at least 350,000 ha. Total gains are thus assessed as 3.75% of 350,000 (=13,125 QH).

6.3 Indirect habitat loss (disturbance) analysis

This assessed changes in the extent and severity of human disturbance in the landscape, measured as the area avoided by animals because of actual or potential hunting near human infrastructure.

6.3.1 Asiatic wild ass and Goitered Gazelle

Baseline

A baseline was modelled, with mapped pre-project human influences in the landscape used to define areas where greater disturbance was expected. The area of analysis was divided into a raster grid of 100m × 100m pixels. Each pixel was assigned a value between 0 and 1: 0 represented completely disturbed habitats entirely avoided by wildlife; 1 represented undisturbed habitats where wildlife display no avoidance behaviour. There is almost no published data on the response of the project's priority biodiversity to artificial infrastructure and poaching rates. In the ESIA, effects and distances were estimated from published data on other species, environments and hunting levels, and expert opinion. The Nature Conservancy (2013) have subsequently published a method for developing a disturbance index in the Gobi. Until monitoring data from ground and aerial ungulate surveys, and collared animals, better informs avoidance distances, this NPI forecast combines the ESIA and TNC approaches. TNC methods (euclidean distance or radius moving window) were used to estimate avoidance functions around roads, at buffer distances identified by TNC (if available) or during the ESIA (if not estimated by TNC). For example, bustards were predicted – for the purposes of this forecast – to avoid Khanbogd town by 5km. Each disturbance layer gave each pixel a value from zero to one. Values were summed for all layers within each category (population centres, transport, mining, herder camps), and re-scaled to give a value between 0 and 1 for each pixel. Values for each category were then also summed and re-scaled to give a final value of 0-1 for each pixel. Finally, all pixel values in the area of analysis were summed to give a landscape value for quality hectares (QH) for disturbance in the study area.

Losses

Project impacts were considered from (a) avoidance by animals of new project infrastructure, (b) avoidance by animals of areas where human populations are increasing owing to project-induced influx, and (c) increased landscape-wide avoidance by animals owing to an elevated poaching rate resulting from OT-induced human population influx. All these impacts are predicted to only affect species that show avoidance behaviour – i.e., wild ungulates and bustards. To quantify impacts, additional disturbance caused by OT infrastructure and OT-induced human population influx were added into the landscape analysis. Pixel values were estimated in the same way, to give the number of quality hectares lost owing to disturbance.

*Gains*Gains were considered from reduced wildlife avoidance of human infrastructure resulting from anti-poaching offsets. The primary driver of avoidance behaviour is thought to be hunting pressure (TBC & FFI 2012a). It is estimated that illegal hunting could potentially be reduced across the proposed Principal Offsets Landscape (28,245 km^2) by a similar level to that achieved by the WWF 'MAPU' project (which experts estimated as a 50% reduction in hunting across 75% of landscape) (TBC & FFI 2012a). Stankowich (2008) recorded an effect size of 17% in flight distances of ungulates in hunted versus non-hunted populations. Assuming flight responses translate directly into changes in avoidance behaviour, and assuming hunting pressure is reduced by 50%, an effect size of 8.5% is predicted within all pixels where anti-poaching work is implemented (within Nomgon, Bayan Ovoo, Khatanbulag, Khuvsgul and Khanbogd soums).

Further gains are predicted from fence removal as an offset activity (OMP) opening a substantial additional area up to use by Asiatic Wild Ass (1,300,000 QH).

6.3.2 Houbara bustards

Breeding bustards are expected to avoid infrastructure, but monitoring has shown that population densities in the area are extremely low, and so it is unlikely that sufficient data can be collected to assess the degree of avoidance. Instead, the human disturbance area was estimated following The Nature Conservancy (2013), and this was translated into a population-level impact by multiplying the area potentially lost through disturbance by a conservative estimate of the number of individuals that would be displaced (0.0022 individuals/ha: Batbayar *et al.* 2011, Purev-Ochir *et al.* 2014). An additional productivity impact (to reflect impacts on the breeding population) can be estimated by multiplying the estimated number of impacted breeding females (conservatively two thirds of those impacted) by the annual chick survival rate (0.827: Combreau *et al.* 2002). A residual loss of 11,000 ha (owing to avoidance of power lines and direct footprint of project infrastructure) thus translates to a direct impact of 24 individuals permanently displaced by OT and an additional 13 individuals per year that are no longer recruited to the population, i.e. 37/year in total.

6.4 Direct and indirect mortality analysis

This assessed changes in direct and indirect mortality resulting from OT's presence in the landscape, specifically from power lines and induced increases in poaching/collection pressure.

6.4.1 Direct mortality of houbara bustards

Direct mortality from collision with, or electrocution by, OT power lines is estimated directly from OT monitoring data, with a baseline rate of zero. Power line inspections recorded four houbara bustards in 2013 and four in 2014, suggesting – after adjustments for collisions not detected – an approximate annual mortality of 13 individuals colliding with power lines despite mitigation being put in place (P. Tsolmonjav *in litt.* 2015). No feasible offset options have yet been identified that can deliver gains to offset these residual project impacts. Development of a national power line standard and insulation of non-project powerlines are expected to deliver significant gains in priority biodiversity (especially for saker falcon, on which the project has had non-significant impacts to date), but these are in very preliminary design stages and so assessed qualitatively rather than quantitatively in this forecast (Table 3).

6.4.2 Indirect mortality of *Cynomorium songaricum*

OT's risk assessment has identified a high risk of indirect mortality to *Cynomorium songaricum* (caused by collection of wild plants) and high and critical risks, respectively, to goitered gazelle and Asiatic wild ass (caused by poaching of wild ungulates) (Oyu Tolgoi LLC 2016a - BMP Annex 3). The former risk is under further investigation at present: it may not be accurate since this species may not be a priority for OT (some sources report it as abundant in the region). This is a parasitic species and offsets are unlikely to be feasible for any impact.

6.4.3 Indirect mortality of Asiatic wild ass and goitered gazelle

The latter impact is estimated here by estimating OT's per capita contribution to current poaching rates of Asiatic wild ass and goitered gazelle in the South Gobi. This was done by estimating the overall poaching rate in the landscape (~8% or ~2,500 Asiatic wild ass/year and ~20% or ~7,000 goitered gazelle/year: SEA & WCS 2016), dividing that by the number of people living in the landscape (44,383: Mongolian Statistical Information Service 2016) to assess the per capita contribution (i.e. how many animals on average does one person poach), and then apportioning OT's contribution to overall poaching rates based upon the number of people moving to the region as a result of OT (2,684 people into Khanbogd Soum since construction began, excluding mine workers, according to OT data). For Asiatic wild ass, this equates to an annual OT contribution to mortality of 151 individuals, against a baseline of 2,349. For goitered gazelle this equates to an annual OT contribution to mortality of 423 individuals, against a baseline of 6,577. This assumes poaching rate increases proportionate to OT-induced human population increases. This may be an under- or over-estimate: such migrants are unlikely to poach for their own subsistence (so may have lower per-capita poaching rates than the wider population), but they may have more disposable income to spend in wildlife restaurants (so may generate higher per-capita poaching rates than the wider population).

If OT did not mitigate its impact, projected human population influx into Khanbogd Soum is predicted to reach 20,000 by 2020 (OT ESIA ref), representing an inherent (unmitigated) impact of 993 Asiatic wild ass and 2,780 goitered gazelles per year. However, anti-poaching measures implemented as project mitigation are expected to prevent any future increase in poaching rate, leaving residual impacts at 151 and 423 individuals, respectively, per year.

It is estimated that illegal hunting could potentially be reduced across the proposed Principal Offsets Landscape (28,245 km^2) by a similar level to that achieved by the WWF 'MAPU' project (which experts estimated as a 50% reduction in hunting across 75% of landscape) (TBC & FFI 2012a). This equates to a 37.5% reduction in poaching rate where implemented. Anti-poaching offsets are being implemented across roughly half of the landscape, equating to 18.75% gains across the whole landscape. Baseline poaching rates were thus multiplied by 19% to estimate averted losses of Asiatic wild ass (2,349×0.19= 446) and goitered gazelle (6,577×0.19= 1,250).

6.5 Fragmentation analysis

This assessed changes in landscape connectivity as a result of OT building and upgrading roads in the southern Gobi. Connectivity was assessed spatially by modelling the ability of Asiatic wild ass to move in the landscape. The analysis assumed that achieving a net positive position for Asiatic wild ass would deliver a net positive position for gazelles. However, this may not be a precautionary approach because gazelles: (i) have smaller home ranges, resulting in shorter daily (and perhaps seasonal) movements; (ii) are less dependent upon water sources; and (iii) already occur east of the UB-Beijing railway.

Baseline
Landscape connectivity was assessed using a 'least cost path analysis' on a grid of 1 km grid squares across the area of analysis. The main impediments to movement through the landscape, defined as 'costs' within each grid cell, come from (a) human disturbance – animals avoid disturbed areas so are less likely to want to move through such areas, and (b) linear infrastructure with barrier effects. To capture reduced connectivity owing to human disturbance, the baseline grid developed for human disturbance (Section 6.2) was converted into a 1 km grid (using the average value of all 100 m cells within each 1 km square). Linear infrastructure was given crossing cost values according to type, and all cells intersected by that infrastructure were given that cost value. Crossing cost values were derived from OT data on collared Asiatic wild ass, comparing the observed number of crossings of the paved OT and Energy Resources roads with the expected number (Kaczensky & Payne 2015a), and extrapolating these data for other infrastructure in the landscape. Most cell values in the landscape are low because there are few impediments. The analysis assumes that a cost of 1 represents a complete barrier to Asiatic wild ass movements. These animals have been known to walk up to 143km in response to an impermeable barrier (Kaczensky & Payne 2015a), before abandoning attempts to cross. This was extrapolated to estimate the baseline cost of crossing an unobstructed 1 km cell (1/143 = 0.007).

Each cell in the grid was then assigned a cost value between 0.007 and 1 based upon the additive totals of all 'cost' values present within that cell (e.g., baseline + infrastructure 1 + infrastructure 2). Some impassable cells had values exceeding 1 (because several pieces of infrastructure in the same cell had values summing to >1). The result was a baseline cost surface that captured all impediments to movement within the landscape.

A least cost path analysis then assessed landscape connectivity by identifying the cost of travelling from any one cell in the landscape to any other cell in the landscape. The cost path is the sum of the values for all cells that the path crosses. For the first grid cell in a cost surface raster, grid cell 1, the analysis identifies the least cost path of moving from another grid cell to grid cell 1. It repeats the process identifying the least cost paths of moving from every single grid cell in the landscape to grid cell 1. Then the mean least cost path is calculated for grid cell 1. The resultant value represents how connected grid cell 1 is with the rest of the landscape. Cells with high values are poorly connected while those with low values are well connected. Each step of the analysis was repeated until all cells in the landscape had a mean least cost path value. All grid cell cost paths were normalised between 0 and 1: the grid cell with the highest cost of accessing the rest of the landscape was given a value of 1, and so on. At this stage, smaller landscape values represented higher overall connectivity. To ease interpretation and comparison/combination with the other landscape-level analyses, all grid cell values were inverted and then summed to give an overall landscape connectivity value (now, the higher the value, the better connected the landscape is as a whole).

Losses

To estimate losses, additional OT-related infrastructure and the influence of Khanbogd Town following population influx were added to the baseline to calculate a 'with project' cost surface. The main scenario assumed that crossing costs for the OT-GS paved road remain as they are at present. Another test scenario, assuming that traffic volumes increase in the future to the point where the road becomes a functional barrier to wildlife, produced similar results.

Gains

Gains from offset actions were then estimated, using the 'with project' cost surface as a starting point. One proposed action is removal of parts of the UB-Beijing railway. An area of potentially suitable Asiatic wild ass habitat east of this is currently inaccessible owing to this fence running the length of the railway (Kaczensky *et al.* 2011). The analysis tested gains from removal of a 2 km section of fence being opened up in an area with relatively low human influence between Sainshand and the Chinese border. Rather than being impermeable, the cost of crossing cells within the unfenced section were reduced in line with base costs of crossing linear infrastructure. This produced 700,000 QH gains for Asiatic wild ass. As in Section 6.2, anti-poaching offsets are expected to reduce the avoidance behaviour of wild ungulates around herder camps. Such an effect would lead to improved landscape connectivity because costs of traversing cells near herder camps are reduced. This analysis reduced the cost of crossing cells within the influence of herder camps by 8.5% for all pixels within Nomgon, Bayan Ovoo, Khatanbulag, Khuvsgul and Khanbogd soums where OT is currently implementing anti-poaching offsets. This produced 85,000 QH gains for both Asiatic wild ass and goitered gazelle.

7 NPI forecast

The Biodiversity Management Plan qualitatively details the risks to priority biodiversity, the management controls in place to mitigate impacts, and anticipated residual impacts. The Offset Management Plan qualitatively details the management controls planned or underway to address those residual impacts. This NPI forecast compares measured/predicted residual losses experienced by priority biodiversity to gains that are expected to be delivered by rehabilitation and offsets (Table 3). Losses and gains were quantified through landscape analyses (Sections 6.1 - 6.4). Each analysis addresses a different component of 'quality' so losses and gains cannot readily be traded. To achieve its goal of having a net positive impact on the biodiversity of the South Gobi, OT aims to deliver NPI for each line of Table 3. A significant number of assumptions underlie this forecast, many of which are discussed in Section 6. These assumptions are actively being refined by monitoring (Section 8).

Table 3: Predicted net position of each priority biodiversity feature following offsets

	CH-qualifying feature?	Significant residual risk impact[1]	Metric	Residual impact	Offset	Gain	Net position[2]	Lender requirement	Requirement met?
Natural Habitats									
Riverine elm and poplar		No significant residual impacts. Elm will benefit from off-site rehabilitation						NNL	Yes
Ephemeral Lakes and Pools		No impacts						NNL	Yes
Granite outcrop floral communities	Yes	No significant residual impacts						NPI	Yes
Rangeland		Direct habitat loss (footprint)	QH	8,500	Rehabilitation	190	4,800	NNL	Yes
					Sustainable cashmere	13,125			
Tall saxaul forest		No significant residual impacts	QH	12	Rehabilitation	12	0	NNL	Yes
Mammals									
Asiatic Wild Ass	Yes	Indirect habitat loss (disturbance)	QH	17,000	Anti-poaching	44,000	2,500,000	NPI	Yes
					Fence removal	2,500,000			
		Indirect mortality	No. individuals per year	150	Anti-poaching	450	300		
		Fragmentation	QH	23,000	Anti-poaching	85,000	2,600,000		
					Fence removal	2,500,000			
Goitered Gazelle	Yes	Indirect habitat loss (disturbance)	QH	17,000	Anti-poaching	44,000	27,000	NPI	Yes
		Indirect mortality	No. individuals per year	420	Anti-poaching	1,260	840		

	CH-qualifying feature?	Significant residual risk impact[1]	Metric	Residual impact	Offset	Gain	Net position[2]	Lender requirement	Requirement met?
		Fragmentation	QH	23,000	Anti-poaching	85,000	62,000		
Argali	Yes	No significant residual impacts. This species will benefit from anti-poaching offsets						NPI	Yes
Mongolian Gazelle		No significant residual impacts. This species will benefit from anti-poaching offsets and sustainable cashmere						NNL	Yes
Long-eared Jerboa		No significant residual impacts						NNL	Yes
Marbled Polecat		No significant residual impacts						NNL	Yes
Birds									
Ferruginous Duck		No significant residual impacts. This species may benefit from power line offsets						NNL	Yes
Short-toed Snake-eagle		No significant residual impacts. This species may benefit from power line offsets and sustainable cashmere (rangeland improv)						NNL	Yes
Lammergeier		No significant residual impacts. This species may benefit from power line offsets and sustainable cashmere (rangeland improv)						NNL	Yes
Great Bustard		No significant residual impacts. This species may benefit from power line offsets						NNL	Yes
Houbara Bustard		Indirect habitat loss (disturbance)	No. individuals per year[3]	37	Powerline standard[4]	?[5]	?[5]	NNL	Unlikely
		Mortality	No. individuals per year	13	Powerline standard	?[5]	?[5]		
Saker Falcon		Indirect mortality	No. individuals per year	-ve[6]	Powerline insulation	+++ve[6]	+++ve	NNL	Yes
Relict Gull		No significant residual impacts. This species may benefit from power line offsets						NNL	Yes
Pallas' Sandgrouse		No significant residual impacts. This species may benefit from power line offsets and sustainable cashmere (rangeland improv)						NNL	Yes
Mongolian Accentor		No significant residual impacts. This species may benefit from power line offsets and sustainable cashmere (rangeland improv)						NNL	Yes
Mongolian Ground-jay		No significant residual impacts. This species may benefit from power line offsets and sustainable cashmere (rangeland improv)						NNL	Yes
Yellow-breasted Bunting		No impacts						NNL	Yes
Dalmatian Pelican		No significant residual impacts. This species may benefit from power line offsets						NNL	Yes
Plants									
Amygdalus mongolica	Yes	No significant residual impacts. This species will be avoided following the LDC&RMP procedures						NPI	Yes

	CH-qualifying feature?	Significant residual risk impact[1]	Metric	Residual impact	Offset	Gain	Net position[2]	Lender requirement	Requirement met?
Cistanche deserticola		No significant residual impacts. This species will be avoided following the LDC&RMP procedures						NNL	Yes
Cistanche lanzhouensis (formerly C. feddenana)	Yes	No significant residual impacts. This species will be avoided following the LDC&RMP procedures						NPI	Yes
Incarvillea potaninii		No significant residual impacts. This species will be avoided following the LDC&RMP procedures						NNL	Yes
Spongiocarpella (Oxytropis) grubovii	Yes	Direct habitat loss (footprint)	QH	?[7]	Rehabilitation	+?[8]	+?[8]	NPI	Likely
Zygophyllum potaninii	Yes	Direct habitat loss (footprint)	QH	?[7]	Rehabilitation	+?[8]	+?[8]	NPI	Likely
Cynomorium songaricum		Indirect mortality	Volume collected	-ve	None available	0	-ve	NNL	No[9]
Lycium truncatum		Direct habitat loss (footprint)	QH	?[7]	Rehabilitation	+?[8]	+?[8]	NNL	Likely

1 - see BMP Annex 3 (Oyu Tolgoi LLC 2016a)
2 - to two significant figures
3 - impacts have been converted into population level impacts by multiplying the area of impact by population density so that impacts can be addressed through the same offset
4 - this species may benefit from sustainable cashmere offsets but population-level impacts are unquantified
5 - a Mongolian national power line standard may benefit houbara bustards in the long-term, but no plans for power line developments within houbara range are known - hence the gain is unquantified, and NPI is unlikely within OT's 25 year timeframe
6 - minus signs represent unquantified negative impacts, plus signs represent unquantified positive impacts
7 - negative impacts on this species are currently being quantified by the project - see LDC&RMP and associated procedures
8 - positive impacts on this species are being researched by the project, but have not yet been quantified - see LDC&RMP and associated procedures
9 - this species is a parasitic plant, and thus one for which rehabilitation and offsetting options are unlikely. Unless further research reveals rehabilitation options, residual impacts will remain

7.1 What are the risks to NPI, and how can they be managed?

This NPI forecast aims to interpret limited data on biodiversity in the southern Gobi, and OT's impacts and mitigation actions. It is inevitably based on many assumptions. These are transparently summarised in Table 4.

Most of these assumptions are self-cancelling – e.g., if avoidance distances have been over-estimated, losses will be smaller than forecast but so will gains. Most uncertainties could affect outcomes in two ways – either there is a risk of failing to achieve NPI and a need to expand offset activities, or conversely offsets are overly precautionary and surplus offsets might be implemented. The offset planning is intentionally precautionary. An overall recommendation is to plan for a contingency in both the scale of the offset actions and gains and in the portfolio of offset actions (i.e. bet-hedging).

Table 4: Key assumptions and risks to NPI.

Analysis	Assumption	Basis	Risk	Recommendation
All priority species	All species were precautionarily assumed to occur throughout the area of analysis	In the absence of accurate distribution data, preliminary OT baseline and monitoring data suggests that this is true for most significantly-impacted species (e.g. Asiatic wild ass, Goitered Gazelle and Houbara Bustard).	Impacts and gains to some species could be over-estimated	Develop species occupancy models based on OT and other data.
Habitat quality	Human population influx is assumed not to impact vegetation condition.	The analysis follows published approaches for measuring human impacts in Mongolia.	Impacts and offset liabilities could be under-estimated.	Monitor the impact of increased human populations on vegetation condition.
Habitat quality	Sustainable cashmere offsets will result in a 3.75% gain in habitat quality.	A similar project generated 15% increase in plant biomass through improved rangeland management (Hess et al. 2010) but other similar projects have not demonstrated gains; we have precautionarily assumed half of this improvement in habitat quality.	Gains could be over-estimated and offsets might need to be expanded.	Monitor gains from field trials of rangeland management offsets.
Habitat quality	Sustainable cashmere offsets are socio-politically feasible across the required offset area	It is precautionarily estimated that socio-political barriers to reducing livestock grazing pressure can be overcome across 50% of equilibrium habitats.	Gains could be over-estimated and offsets might need to be expanded.	Consult widely, including remotest areas, to assess socio-political acceptability.
Habitat quality	Sustainable cashmere offsets generate gains in equilibrium and non-equilibrium habitats	Mongolian rangeland experts believe that habitat quality in non-equilibrium habitats, such as true desert and semi-desert, cannot be improved by improved grazing management.	Gains could be over-estimated and offsets could be scaled-down.	Field-test the potential for gains in non-equilibrium habitats.
Habitat quality	Sustainable cashmere offsets will benefit all priority biodiversity.	Vegetation condition is a suitable proxy for habitat quality for all priority features	NPI is not achieved for all features.	Field-test the relationship between priority features and vegetation condition.
Human disturbance	Poaching pressure can be reduced by 19% across the southern Gobi.	Experts suggested that the WWF 'MAPU' project led to a 50% reduction in hunting across 75% of landscape. OT is implementing offsets in approximately half of the southern Gobi	Gains could be over-estimated and offsets might need to be expanded.	Field-test anti-poaching offsets and monitor changes in poaching rates.
Human disturbance	Avoidance can be reduced by 8.5% in areas where anti-poaching is	Based on 17% effect size in flight distances of hunted versus non-hunted ungulates, assuming	Gains could be over-estimated and offsets	Field-test anti-poaching offsets and monitor avoidance distances.

Analysis	Assumption	Basis	Risk	Recommendation
	implemented.	that reduced hunting pressure translates directly into reduced avoidance distances[1].	might need to be expanded.	
Direct and indirect mortality	Baseline poaching rate is 8% of the population per year.	Sustainability East Asia LLC and Wildlife Conservation Society (2016).	Gains could be over-estimated and offsets might need to be expanded.	Continue to collect and analyse survey data to refine the baseline poaching rate.
Direct and indirect mortality	Poaching pressure can be reduced by 19% across the southern Gobi.	Experts suggested that the WWF 'MAPU' project led to a 50% reduction in hunting across 75% of landscape. OT is implementing offsets in approximately half of the southern Gobi	Gains could be over-estimated and offsets might need to be expanded.	Field-test anti-poaching offsets and monitor changes in poaching pressure.
Direct and indirect mortality	Poaching pressure on Asiatic wild ass is the same (or lower) east of the UB-Beijing railway as it is to the west.	Expert opinion (e.g. P. Kaczensky pers. comm. 2015).	Poaching pressure is higher east of the railway creating a source-sink dynamic.	Assess poaching rates east of the railway prior to any fence removal. Trial the likely outcomes by moving some Khulan east of the railway to assess survival, movements etc.
Landscape connectivity	The least cost model used to quantify connectivity is based on limited empirical data.	The model estimates the 'cost' of movement based on a single datum from OT's Khulan tracking data.	The potential value of wildlife crossings could have been underestimated.	Continue to collect and analyse tracking data to refine the connectivity analysis.
Landscape connectivity	Animals cross the UB-Beijing railway line freely where fencing is removed.	Collaring data shows animals are capable of finding gaps in the Mongolian border fence.	Animals do not cross and remain unable to access areas to the east of the railway.	Collar additional Khulan to the west of the fence. Field-test fence removal to assess crossing frequency. Adaptively manage by facilitating crossing.
Averted losses	Gain from averted losses have not been included.	A static baseline is more precautionary.	Gains could be under-estimated and offset liabilities over-estimated.	Discuss the acceptability of averted loss offsets to stakeholders, and the required counterfactual data and models.
Cumulative impacts	The offset strategy is valid regardless of other regional development.	Other development could impact e.g. grazing pressure; poaching rates; fragmentation	OT needs to adaptively revise its offset strategy	Clarify stakeholder acceptance of the static baseline. Monitor regional developments and adapt the offset strategy.
Government regulations	Developing national and local government offset regulations are consistent with OT's strategy.	National government and their advisors have suggested some guidance inconsistent with OT's strategy for NPI; local governments are passing prescriptive regulations.	OT needs to re-design its offset strategy to meet government regulations.	Continue active dialogue with governments and their advisors.
Management	OT can effectively manage all components of the offset programme.	OT has managed massive-scale logistic and engineering projects, but has limited demonstrated success in managing socio-political and land-use change.	Components under-perform.	Explicitly consider the management structure and capacity, and consider strategic out-sourcing.
Financing	Financial performance allows OT to promptly and	There has been limited direct investment in offset	Resourcing is inadequate,	Commit to an offset funding schedule or plan.

[1] A meta-analysis of flight distances in ungulates recorded a mean effect size of 17% in flight distances of hunted versus non-hunted populations (Stankowich 2008). We assumed that a 50% reduction in hunting pressure in the offset areas (see preceding uncertainty) translates directly into an effect size 50% of that between flight distances in hunted and non-hunted populations. We assumed that a 50% reduction in flight responses translates directly into 50% reduction in avoidance distances. We therefore applied an effect size of 8.5% to areas with anti-poaching work.

Analysis	Assumption	Basis	Risk	Recommendation
	fully fund the offset strategy.	implementation to date.	inconsistent and/or too late.	

8 MONITORING

8.1 Overview of Monitoring Requirements

OT is implementing a Biodiversity Monitoring and Evaluation Program (BMEP) to track progress towards NPI by quantifying residual impacts (pressures) on priority biodiversity, the state of priority biodiversity and management responses.

8.2 Key Performance Indicators

The NPI forecast is heavily reliant on monitored data, such as species' distributions, avoidance of infrastructure, and poaching rates. In the absence of such data, precautionary estimates or assumptions have been made in order to assess biodiversity losses owing to residual project impacts (which equate to OT's offset liability), and gains that may be generated by offsets. These assumptions can be found in the methods (Section 6), the risks associated with them are presented in Table 4, and the targets derived for NPI based upon assumptions are listed in Table 5. The OT BMEP aims to improve the accuracy and precision of data used by the NPI forecast, and to reduce the number of underlying estimates and assumptions.

OT aims to develop and monitor at least one pressure, state and response indicator for each priority biodiversity feature, as detailed in the BMEP. The data from these indicators provide the information for revision of this NPI forecast.

This NPI forecast uses four key analyses (Table 1). Having assessed baseline and losses, gains are based upon the predicted outcomes of offsets in order to estimate the forecast project net position. The predicted outcomes of offsets translate into targets – success levels that offset projects aim to deliver. These targets apply to a sub-set of the indicators being monitored by the BMEP, and are presented in Table 5.

Table 5: Target outcomes from offsets needed to deliver gains as predicted by this NPI forecast

ID	KPI	Target to achieve NPI	Monitoring measure	Corresponding OMP management control
Reduced illegal hunting and collecting		18% reduction in poaching rate		
OMP-KPI-1	Asiatic wild ass (and goitered gazelle) carcass density within the anti-poaching offset landscape	18% reduction from 2015-2016 baseline	Driven line transects - see BMEP	
OMP-KPI-2	Asiatic wild ass and goitered gazelle population over approx. 100,000 km^2	Detectable increase ($p<0.2$) [unless decreases are linked to non-OT pressures]	Driven line transects - see BMEP	
OMP-KPI-3	Avoidance by Asiatic wild ass and goitered gazelle of human infrastructure	8.5% reduction in avoidance where anti-poaching work is implemented	Satellite collaring - see BMEP	

Sustainable cashmere		3.75% improvement in rangeland quality across 350,000 ha		
OMP-KPI-4	Rangeland condition	3.75% improvement in monitoring plots in offset area compared to controls	Vegetation plots – see BMEP	
Fence removal		Wild ungulates cross the railway regularly and use suitable habitat on both sides		
OMP-KPI-5	Extent of Occurrence of Asiatic wild ass in the southern Gobi	Expanded range includes 5,000 km^2 of suitable habitat east of the UB-Beijing railway	Ground-based and aerial surveys – see BMEP	
OMP-KPI-6	Total number of detected crossings of UB-Beijing railway by Asiatic wild ass and goitered gazelle	Both species crossing >10 times per month	Camera-trapping and satellite-collaring – see BMEP*	
National power line standard	Non-OT power lines built in Mongolia to a new national standard to reduce bird collisions and electrocutions	Substantive reduction in collisions and electrocutions of various bird species considered by independent experts to adequately offset OT impacts on houbara bustard	-	
	Kilometers of non-OT power line built in Mongolia following a new national standard	Target not yet set (see Annex 1)	Method to be developed	
Insulation of non-OT power lines	Non-OT power lines insulated to prevent bird electrocutions	Substantive reduction in electrocutions of various bird species considered by independent experts to adequately offset OT impacts on houbara bustard	-	
	Kilometers of non-OT power line with insulation installed	Target not yet set - this will be developed as part of the feasibility study. See OMP mgmt. control ID 17.4	Method to be developed	

For each of the targets, the BMEP has developed:

- Orange Thresholds - preliminary quantified orange thresholds are set in the BMEP for all targets based on the predicted deviances acceptable before OT needs to investigate causes and solutions of these deviances from the predicted progress towards NPI/NNL; and
- Red Thresholds - preliminary quantified red thresholds are set in the BMEP for all targets based on the predicted deviances acceptable before OT needs to urgently investigate causes and solutions of these deviances from the predicted progress towards NPI/NNL.

Monitoring results are screened as soon as possible, and at least annually, against thresholds and targets, and OMP/BMP work plans are adapted as necessary. Evaluation procedures and actions triggered by crossing thresholds are detailed in the BMEP.

9 REFERENCES

GBC (2016) Supplementary technical methods to the Oyu Tolgoi LLC Net Positive Impact forecast. Global Biodiversity Conservation, Cambridge, UK.

Oyu Tolgoi (2012) Oyu Tolgoi Biodiversity Action Plan. Dated December 2nd 2015.

Oyu Tolgoi LLC (2016a) Oyu Tolgoi LLC Health, Safety, Environment, Security, and Communities: Biodiversity Management Plan.

Oyu Tolgoi LLC (2016b) Oyu Tolgoi LLC Health, Safety, Environment, Security, and Communities: Offsets Management Plan.

Oyu Tolgoi LLC (2016c) Oyu Tolgoi LLC Health, Safety, Environment, Security, and Communities: Land Disturbance Control and Rehabilitation Management Plan.

TBC & FFI (2012) ESIA Appendix 5: Oyu Tolgoi Net Positive Impact Forecast. Unpublished Draft Report of The Biodiversity Consultancy Ltd and Fauna & Flora International, May 2012.

10 AUDITING AND REPORTING

10.1 Internal Auditing

Conformance with tasks and management controls outlined in Section 7 will be monitored via annual internal audit program in accordance with Element 16 Performance Assessment and auditing. This will be undertaken to assess compliance with requirements of HSE management system (including ESIA and management plans).

All incidents and non-conformances identified during these inspections are reported as per the requirements of the OT HSE Management System as described in the Environmental ESMP Framework Document.

10.2 External Auditing

Conformance with this plan will be subject to periodic assessment as part of the Rio Tinto HSES Business Conformance Audit programme and by Project Lenders.

10.3 Record keeping

Records of audits, inspections and incidents will be managed in accordance with Element 8 Documentation and Document Control and Element 15 Data and Records Management.

Rio Tinto Business Solution shall be used to record Internal and External Audit findings and related actions and Incidents and related investigation and actions.

11 DOCUMENT CONTROL

File Name	Net Positive Impact Forecast
Description	This document updates the project ESIA's NPI forecast (TBC&FFI 2012) to align with the current Biodiversity Management Plan and Offsets Management Plan. It assesses whether OT's mitigation and offset measures will deliver NPI.
Original Author(s)	Global Biodiversity Conservation
Creation Date	2016.01.01
Approved By	Dennis Hosack, Manager Environment and Biodiversity
Approval Date	2016.05.01
Change Record Number	##

Risk Ranking	Assessment Date	Risk Assessor	Review Schedule	Next Review Date
Moderate	2016.04.01	Environment and Biodiversity team	Bi-annually	2018.04.01

Revision	Revision Date	Author(s)	Approved By	Revision Notes
1.0	2016.04.01	Various	Dennis Hosack	Approved.