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The World Bank’s 1996 publication on Regional Environmental Assessments (REA), defined them as tools “to help development planners design investment strategies, programs and projects that are environmentally sustainable for a region as a whole. REAs take into account the opportunities and limitations represented by the environment of a region and assess ongoing and planned activities from a regional perspective”. It is precisely for that purpose that this REA has been produced.

Somewhat over two years ago the Mongolian government approached the World Bank to request assistance in their development of appropriate plans for the mineral-rich southern Gobi region (SGR). The SGR faces many development constraints such as poor water availability and quality, extreme climatic events, poor soils, a scattered and highly mobile human population, wildlife which ranges over enormous areas, great distances to sizeable markets, and weak local capacity. We have responded to the request by assisting with the formulation of the Southern Gobi Infrastructure Strategy (to be published shortly), a series of background papers, some of which will be appearing in this Mongolia Discussion Papers series, and this REA.

The SGR REA has taken the approach of defining two development scenarios. The base-case assumes that the operating mines will continue and expand according to their existing plans, that the large new mines in or near their initial stages of development will proceed into production, and that all necessary ancillary developments proceed. The high-case adds in further expansions of those mines, plus the development of a number of proposed mines and a major new cement factory, plus some large-scale infrastructure projects. The REA then examines the different impacts—individual and cumulative, both direct and indirect. It also considers the institutional capacity to manage the impacts identified. The report concludes that planning and implementing a development path in the SGR that is sustainable is a major challenge. The stakes are high, but then so are the chances that Mongolia can make wise and appropriate decisions that demonstrate a pragmatic sensitivity towards the development of globally-significant mineral resources in an ecologically- and socially-fragile area. This would be an exciting demonstration for many other countries. We hope that the analyses in this report will support and inform the further discussions on this topic.
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ALAGAC</td>
<td>Administration of Land Affairs, Geodesy and Cartography</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon monoxide</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental impact assessment</td>
</tr>
<tr>
<td>EMP</td>
<td>Environmental management plan</td>
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<tr>
<td>ha</td>
<td>Hectare</td>
</tr>
<tr>
<td>km</td>
<td>Kilometer</td>
</tr>
<tr>
<td>m³/day</td>
<td>Cubic meters per day</td>
</tr>
<tr>
<td>MASIA</td>
<td>Mongolian Academy of Science, Institute of Archeology</td>
</tr>
<tr>
<td>MFA</td>
<td>Ministry of Food and Agriculture</td>
</tr>
<tr>
<td>MME</td>
<td>Ministry of Mines and Energy</td>
</tr>
<tr>
<td>MNET</td>
<td>Ministry of Nature, Environment, and Tourism</td>
</tr>
<tr>
<td>MNMA</td>
<td>Mongolian National Mining Association</td>
</tr>
<tr>
<td>MoH</td>
<td>Ministry of Health</td>
</tr>
<tr>
<td>MRPAM</td>
<td>Mineral Resource and Petroleum Authority of Mongolia</td>
</tr>
<tr>
<td>MRTCUD</td>
<td>Ministry of Roads, Transportation, Construction and Urban Development</td>
</tr>
<tr>
<td>Mt/yr</td>
<td>Million tons per year</td>
</tr>
<tr>
<td>MW</td>
<td>Megawatt</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Emergency Management Agency</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Nitrogen oxide</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate matter</td>
</tr>
<tr>
<td>REA</td>
<td>Regional environmental assessment</td>
</tr>
<tr>
<td>RMI</td>
<td>Responsible Mining Initiative (for Sustainable Development)</td>
</tr>
</tbody>
</table>
SGR  Southern Gobi Region
SMIS  Southern Mongolia Infrastructure Strategy
SO$_2$  Sodium dioxide
SPA  Strictly protected area
SPM  Suspended particulate matter
SSIA  State Specialized Inspection Agency (recently changed to GASI – Government Agency for Special Inspection)
µg/m$^3$  Micrograms per cubic meter
The report was written by Thomas Walton with inputs from Tony Whitten, Oyuna Finch, Judith Schleicher, Giovanna Dore, Dennis Sheehy, and Erdene-Ochir Badarch.

We are grateful to the authors of background studies and strategy papers:

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The report draws on information from workshops held in Mongolia, in May, September, and October 2008, and a field mission to the Southern Gobi Region in November 2008. Other information was obtained from various mining companies in Mongolia including Ivanhoe Mines Mongolia, Inc., and its consultant EcoTrade; Rio Tinto; Energy Resources LLC; and Southgobi Sands. Agencies of the Mongolian Government cooperated in the reporting, including the Ministry of Nature, Environment and Tourism, the Ministry of Roads, Construction and Urban Development, the State Specialized Inspection Agency, and the Mongolia Academy of Sciences. And information was provided by non-governmental organizations, including MercyCorps, Centre for Policy Research, Wildlife Conservation Society, Responsible Mining Initiative for Sustainable Development, Mongolian National Mining Association, and Wildlife Science and Conservation Center.

This report was discussed in draft form at stakeholder workshops held in Ulaanbaatar and Dalanzadgad in April 2009 and has been revised to reflect comments received. Thanks are due to all those who joined those discussions.

Workshop proceedings and background studies are available at www.worldbank.org/southgobi.
The primary objective of the Southern Gobi Regional Environmental Assessment (REA) is to provide guidance for sustainable management of environmental resources in the future development of the Southern Gobi Region (SGR), development that will be led by rapid expansion of mining. The REA defines two development scenarios—a base-case and a high-case—and explores their direct and indirect impacts on the natural environment, taking into account the opportunities, constraints, and vulnerabilities of the Gobi natural systems; the individual and cumulative direct environmental impacts and potential indirect impacts of the planned development; and, at a general level, the institutional capacity to manage the impacts. The REA target audience includes Government officials at central, regional, and local levels; private sector investors and the consultants who are engaged for project design and environmental impact assessment; development finance organizations; and Mongolian civil society.

The base-case scenario assumes that current mining operations will continue, expanding according to their respective plans, and that the large new mines that are in or near initial stages of development will proceed into production. The new mines are the copper and gold mine at Oyu Tolgoi, the coal mine being developed by Energy Resources LLC at Tavan Tolgoi, and a larger coal mining operation at Tavan Tolgoi. Minimal ancillary facilities required for the new mines are one coal-fired power plant, probably at Oyu Tolgoi; well fields and connecting transmission mains to supply groundwater for processes at Oyu Tolgoi and the Energy Resources LLC mine; and housing for workers and their families. Large infrastructure to support the base-case includes improved roads to transport coal and other mine outputs south to the China border crossings and, somewhat later, rail lines roughly parallel with the roads.

The high-case scenario includes the mines, ancillary facilities, and infrastructure in the base-case, with additional expansions; plus a copper-molybdenum mine at Tsagaan Suvarga, coalmines at Baruu Naran and Eldev, a large mine-mouth power plant at the existing Shivee Ovoo coal mine, uranium in situ leach projects in the northern tip of Dornogovi, and a large cement factory at Khukh Tsav. New major infrastructure included in the high-case scenario consists of a rail connection from Tavan Tolgoi northeastward to the Trans-Mongolia Railway and water pipelines from rivers to the north of SGR.

The natural resources and environmental characteristics of the SGR present unique opportunities and constraints for development. The opportunity to exploit its abundant mineral wealth—chiefly coal, gold, copper, molybdenum, fluorite, and uranium—is the basis for the development plans that warrant this REA. Besides the mineral products themselves, the extensive deposits of thermal coal will support electric power generation in amounts considerably larger than Mongolia requires, thus available for export to neighboring China. The desert and desert steppe vegetation supports animal husbandry in a
unique, semi-nomadic style that has existed in the SGR for centuries and that may be enhanced but at the same time threatened by gradual commercialization. Outputs include hides, meat, and dairy products as well as cashmere and camel’s hair. Ecotourism, because of the region’s wildlife that includes several rare species, is part of the slowly growing tourism sector.

Foremost among the constraints is water availability, which is closely linked to the SGR climatic extremes—hot, dry summers; and long, cold winters. Precipitation is low and seasonal, there are no perennial surface streams, evaporation rates are high, and groundwater recharge is about one millimeter per year. There are large reserves of fossil groundwater that have only been partially identified and assessed, but because they are not recharged, they are a nonrenewable resource that must be used with care.

With the extremes of climate come weather phenomena that can be catastrophic, especially for herder families and their flocks: prolonged droughts (dzud) in winter that kill livestock in large numbers because food and water become inaccessible due to low forage production in the previous growing season, or prolonged ice or snow cover, dust storms, and flash floods. Wild animals are also vulnerable to the climatic extremes. Some climate change predictions for Mongolia suggest that some of these extremes will worsen in frequency and duration, while others may become moderate.

Soils are thin and not readily arable; moreover, the thin surface crust that forms on them and protects what little moisture and humus they contain is easily disturbed by vehicle traffic and sharp-hooved animals, mainly goats, facilitating entrainment by vehicles and in dust storms and exacerbating land degradation that is recognized as one of the major SGR environmental challenges. Pastureland is plentiful but low in plant productivity. This, together with scarce water sources, necessitates rotation of herds from one location to another and imposes natural limits on herd sizes and composition that have been respected over the centuries.

Natural food chains are of course also based on the productivity of the desert soils. Large wild herbivores compete with domestic herds for food and water and are, in addition, sensitive to disturbance by human activities, especially those related to transportation and water resource development. Commercialization in the livestock industry, incentives to increase the numbers of goats in the herds, and individual herders’ efforts to increase income are changing traditional herding patterns and having additional impacts on the large wild herbivores as well.

The direct impacts of mine construction itself, whether in the base or high-case, are of relatively low importance on a regional scale; they result in conversion of 15,700 and 30,000 hectares, respectively. In the long term, proper implementation of mine reclamation plans will be essential. Considerably larger are the areas of land that will be affected by mine dewatering, where lowering of the surface water table will dry up the springs and shallow wells and stress the few tree species that grow in the desert and desert steppe soils and other plants dependent on the water table. Even impacts of this magnitude—approximately 31,400 and 62,800 hectares affected in the base and high-case scenarios, respectively—are not of great consequence in the context of the entire SGR, but they can be quite significant on a local or subregional scale in the context of herders and their animals, resident and migratory wildlife, and land degradation.

Water supply needs for mining and mine-related developments can likely be met by resources within the SGR up to 2020 and perhaps beyond under the base-case. The mine operations themselves are by far the largest water users, and whether the extraction of fossil groundwater as planned by the mining companies is the best use of this nonrenewable resource has to be carefully weighed. Gaps in information on groundwater resources need to be filled to support more accurate predictions and planning, and this warrants the establishment of a specialized agency to collect and consolidate information and evaluate proposals and plans for allocation of SGR groundwater resources.
Under the high-case, and perhaps even the base-case, additional water sources will be needed, and there are two schemes already under consideration to transfer surface water from central Mongolia. This raises two very significant issues of development planning. First, it means that one of the natural limits to growth in the SGR, water availability, is going to be exceeded. A decision of this magnitude demands a precautionary approach to ensure that such growth is in all ways sustainable, recognizing not only present conditions but also the future under changed climatic conditions. Second, the transfer of water may have opportunity costs in terms of constraints on future development in the river basins where other conditions are more favorable for sustainable growth. Intensive data collection and analysis as well as debate by experts and policymakers is essential on both counts before plans to move to the high-case scenario in SGR and construct the water pipelines become commitments.

Coal transport is already having significant impacts. Coal dust that spreads downwind from the coal-loading points at the mines and from unloading and reloading at coal storage and transshipment yards near the Chinese border has serious local impacts. The most significant regional-scale impact from the standpoint of residents is the dust stirred up by heavy trucks travelling on unimproved roads; it affects quality of life and the health of humans and livestock. Travel in new tracks across the desert soils adds to land degradation, which is further exacerbated when plant growth is retarded by deposition of dust around plant stems and on leaves. The physical presence of the trucks and their noise and dust interfere with movement of wildlife; for example gazelle and Asiatic wild ass no longer move between the two sections of the Small Gobi Strictly Protected Area because of traffic volume on the road that passes between them to the border crossing.

With truck volume expected to increase (from 600 per day in 2009) to 1,300 per day under the base-case—or nearly one per minute in the most intensively used corridor from Tavan Tolgoi to the border at Gashuun Sukhait—or 2,000 per day in the high-case, these impacts as well as the frequency of accidents involving vehicles, livestock, and wildlife can only worsen. In the interest of transport efficiency and economics, construction of improved roads and, eventually, railroads will occur before truck traffic reaches such high volumes; both will mitigate some of the impacts described but, at the same time, may become more significant barriers to the movement of livestock and, especially, wildlife. If however a railroad line passes through the Small Gobi Strictly Protected Area or results in its partial degazetting, the impact on two threatened large mammal species—the Asiatic Wild Ass that is regionally and globally endangered, and the black-tailed or goitered gazelle that is regionally and globally vulnerable—will likely be severe.

Population will increase dramatically in the soum centers in the vicinity of the mines. Not all of the mining companies have disclosed hiring and housing strategies, but based on the information available, total employment at the base-case mines when in full operation is projected to be more than 2,500. Some of the miners will work on a “fly-in, fly-out basis”, but most will be living integrated in the soum centers or in gated communities constructed by the mining companies. Assuming a household size of four, the number of miners and family members in SGR in the base-case will be between 12,000 and 16,000. In the high-case, this number could exceed 40,000. These numbers will not be net increases in the population of the SGR or even in the affected soums; however the distribution of employment between present residents and in-migrants cannot be predicted, dependent as it is on mining companies’ recruitment strategies and the availability in the region of interested persons with the desired skills. A significant population increase can be expected, and it will be augmented by the influx of additional people who come to the area either as employees of industries that cater to the mining operation or as job seekers or entrepreneurs in search of business opportunities. Based on a sample from global experience with mine development, the REA assumes for planning purposes that influx will be equal to the number of miners and family members. The results are that the total mining-related populations in SGR under the base and high case, respectively, will be as much
as 30,000 and 80,000, respectively. To the extent that some of the people that will be engaged in or attracted to mining are already living in the region—a number that has not been estimated—not all of that increase will translate into net population growth in SGR.

**The new base-case population will require 5,300 new housing units.** It will consume water and generate wastewater at the rate of 2,500 cubic meters per day (m³/day) of water, require 5 megawatts (MW) of power generation and heating, and produce 12.6 tons per day of solid waste. All of these amounts are more than doubled in the high-case scenario. There are presently no wastewater treatment plants in soum centers, but on-site systems will not function well at the new population densities and will pollute groundwater that may be used for drinking. Solid waste is already not well managed at the soum and aimag centers, and the problem will worsen with increased volume, leading to groundwater pollution, smoke and fire, odors, vermin and disease vectors, and aesthetic impacts. Construction and operation of urban infrastructure, including roads, municipal service buildings, heating and power plants, will all have local impacts that need to be managed. In addition, so-called induced development will follow in soum centers, near border crossing points, and along the hauling routes—some desirable, such as markets, pharmacies, vehicle repair shops, hotels and restaurants; and some undesirable, including drug dealing, prostitution, and illegal trade in endangered plants and animals.

**Air quality in SGR is routinely well within the ambient quality limits of Mongolia,** with the exception of the standard for suspended particulates that is violated along coal transport routes and during dust storms. Increased truck traffic will add substantially to air emissions (e.g., 420 kilograms per day of nitrogen oxides (NOₓ) and 290 kilograms per day of carbon monoxide (CO) plus nearly 3 tons/day of carbon dioxide (CO₂): the extent to which air quality will be degraded cannot be determined without dispersion models. Dispersion modeling should be required for the power plants at Oyu Tolgoi and/or Tavan Tolgoi in the base-case and at Shivee Ovoo in the high-case, and the plants should be designed so that they can operate without degrading air quality or producing acid precipitation in the region.

**Mitigation measures are available for many of the likely impacts.** Offsets should be required for those that cannot by mitigated. Where dewatering affects springs and wells, alternative water sources can be provided and/or other existing sources in the area can be enhanced and protected. The impacts of dewatering on trees should be monitored and mitigated through irrigation or offset by replanting and protection. Reviewers of environmental impact assessments and permit applications for mines should pay attention to whether appropriate water-conserving technology is being applied, and the impacts of fossil groundwater extraction should be carefully monitored. Major decisions regarding water resource allocation both within the SGR and from river basins to the north should only be made when adequate information is available and through agencies that have the necessary geographic reach, responsibility, authority, and provision for full stakeholder representation to deal with the issues comprehensively.

**Reducing the present impacts of the transportation of coal and other mine outputs involves a number of steps,** chief among which is improving the routes currently used and, when volume permits or necessitates, constructing rail connections at least to the China border-crossing points at Gashuun Sukhait and Shivee Khuren. It is imperative in both cases of roads and railroads that an adequate number of effective wildlife crossings (underpasses or overpasses) be appropriately located and properly designed and constructed, otherwise the mitigation of present transport impacts will come at the expense of further fragmentation of wildlife habitat and reductions in populations of large herbivores. Research should commence immediately on the movement patterns of animals that may be affected and on arrangement for

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1 As an indication of how dramatic the population increases will be on a subregional scale, approximately 3,000 persons lived in Khambogd Soum Center in 2008. Under the base-case, by 2013 there could be 15,000 inhabitants.
crossings that have worked elsewhere. Particular attention is needed to restore and protect the viability of the Small Gobi Strictly Protected Area, which is overlapped by two important bird areas and which is the habitat of at least two large mammal species that are in regionally endangered or vulnerable status. Livestock crossings will also be required to avoid unduly restricting the movements of herds moving from one pasture area to another, but these are easier to design since the animals can be guided through them by herders. What is sufficient for herded animals will not be so for wild animals. Appropriate driving rules and traffic regulations need to accompany the infrastructure improvements; they can be put in place and enforced by mining and trucking companies and police.

Aimag and particularly soum governments are unprepared to handle the population increases that will result from even the base-case development scenario. They need land use plans and zoning ordinances to guide the planning of new housing and supporting businesses and services. Mining companies have been assisting with such planning in several soum centers. Where a mining company is using a gated community to house its workers and their families, the company will be providing housing and infrastructure, but the latter needs to be coordinated with local government. Wastewater collection and treatment systems, for example, could be shared. Where the integrated community model is chosen, it is in the best interests of the mining companies to assist their employees in purchasing or constructing suitable homes and to give some assistance to local governments in providing for municipal services. However, it is clear that even for the mining families and much more so for the additional influx population, local governments urgently need to be strengthened with adequate authority, qualified staff, equipment, training, expert advice, and budgets for both large capital expenditures (water and wastewater systems, landfills, heating and generating plants) and for operations.

The largest challenge remains that of planning and implementing development in the SGR that is sustainable. This has to take into account collectively all of the constraints imposed by the region’s natural resources and all of the present and potential demands on those resources on a regional scale. Development that overcomes one constraint—water supply for mining, for example—will ultimately be unsustainable if the limits of water resources available for public supply and livestock are exceeded as a result of mining-induced population growth. It is clear that a new agency is needed to coordinate development planning and decisionmaking. Its membership should encompass aimag and soum government, private sector, and civil society. It should have access to whatever expertise it requires for its deliberations, from the Academy of Science, other academic institutions, central government agencies, specialized nongovernmental organizations, and consultants.
I. Introduction

Nature to be commanded must be obeyed.
— Francis Bacon (Novum Organum, 1620)

Mongolia’s Southern Gobi Region (SGR) is vast and richly endowed with mineral wealth, but served by few transport links. One of the most sparsely populated areas on Earth, the SGR supports a small human population, which has grown slowly but is poised to accelerate rapidly, and is habitat to many threatened plant and animal species. Many of the inhabitants are livestock herders who make their livelihood following centuries-old traditional practices. There is a trend to more commercialized animal husbandry in the SGR since Mongolia began the transition to a privatized market economy, but this is not the reason for the population growth. Most new arrivals are directly associated with or attracted by the mining industry, which is expanding rapidly in the Region as a matter of government policy as well as, of course, economic opportunity. Ecotourism is also growing in the Region, but its impact on development thus far has been small. It is the establishment of mines, together with their associated infrastructure needs and human population movements that could cause significant impacts on the SGR environment.

Objectives of the Regional Environmental Assessment

The objective of the Southern Gobi Regional Environmental Assessment (REA) is to provide guidance for sustainable management of environmental resources in the future development of the Southern Gobi Region—development that is going to be led by rapid expansion of mining as called for in the Action Plan of the Government of Mongolia for 2008–2012 (State Grand Khural of Mongolia, 2008): “[to] Accelerate the development and reform the legal environment of minerals sector, bring forward a pragmatic solution to commercialize the strategic and major minerals sites, and share the profits with the citizens.” In so doing, the REA takes into account:

- Opportunities, constraints, and vulnerabilities of the SGR natural systems with respect to development impacts and impacts of climate change;
- Individual and cumulative direct environmental impacts of SGR development plans;
- Potential indirect impacts (e.g., impacts of induced development, planned and unplanned); and
- General capacity of the regulatory framework and institutional structure to manage development impacts.

The REA is intended to promote strategic thinking with regard to a desirable development future for the SGR and to encourage consideration of development impacts in an integrated way. It does so by describing likely development scenarios in terms of their demands on natural resources and
the environment, and by evaluating their regional impacts for stakeholder consideration. The REA is prepared for a primary audience of officials responsible for development planning, implementation, monitoring, and oversight at all levels of government. It should also be useful to active and potential investors, particularly during the processes of assessing the environmental impacts of their projects and planning and designing the facilities and procedures to mitigate and monitor those impacts. International development banks, bilateral donors and lenders, and other development finance organizations should find it useful as a resource for evaluating their supported activities, or in selecting aspects of environmental management for future funding. Research institutes and civil society organizations will see in the report many of their concerns about the future of the SGR environment, along with suggestions for addressing many of them.

The REA takes into consideration the following main strategies articulated by the Ministry of Nature, Environment and Tourism (MNET) for management of the environmental issues associated with mining investment and infrastructure development in SGR (Gantulga, 2008):

- Complete a detailed survey of SGR groundwater resources in order to improve the estimates of sustainably exploitable water resources;
- Establish a groundwater monitoring network;
- Reverse increases in concentrations of dust;
- Weaken the intensity of desertification;
- Make biological and ecological surveys of keystone species in Gobi Desert;
- Develop suitable conservation and management measures for rare animals and plants, including biotechnological methods of breeding to maintain a healthy gene pool, and co-management of conservation programs with participation of local stakeholders; and
- Develop strategic environmental assessment procedures and landscape and species conservation policies.

There is a close, two-way linkage between the REA and the World Bank (2009) Southern Mongolia Infrastructure Strategy (SMIS). The REA reflects heavily on the SMIS and its companion working papers in framing the mine development scenarios; identifying the necessary infrastructure to support it; and describing associated outcomes such as population growth, waste generation, traffic, and demand for municipal services. The SMIS coverage of the environment (chapter 8) is based substantially on REA findings.

Methodology

Coverage. The SGR consists of three aimags (provinces): Dornogovi, Dundgovi, and Omnogovi (Figure 1.1). They occupy a combined area of 350,000 square kilometers and in 2007 had a total population of 153,000. Approximately 40 percent of the inhabitants live in towns—the three aimag centers of Mandalgovi, Dalanzadgad, and Sainshand, and the centers of the 41 soums (districts) into which the aimags are divided (Acacia Water, 2009).

Development scenarios. The principal SGR economic activity has been livestock farming, but the future development is going to be based primarily on exploitation of the Region’s rich mineral resources, mainly coal, copper, molybdenum, gold, and fluorospar. Mineral exploration licenses cover 55 percent of the area (BirdLife Asia, 2008), but it is of course unrealistic to anticipate that all explorations will discover economically exploitable deposits or that mining will proceed at every deposit that is discovered. For the purposes of the REA, two scenarios have been constructed. The base-case assumes that current mining operations will continue and that the large mines that are in or near initial stages of development will proceed into production. The high-case takes a more optimistic view, adding to the base-case a group of additional mines that could be developed within the next 10 to 15 years. For both scenarios, the ancillary infrastructure needed to support the mining activity is projected, including transportation systems to carry products to shipping points or markets.

Demands and impacts on natural systems. For each scenario, estimates of natural resource
Introduction:

demands and impacts on natural systems have been prepared. These demands include those of so-called induced development—growth in population and business activity that will occur in response to mine development, and the resulting planned and unplanned construction of housing, shops and offices, and supporting infrastructure—that has to be estimated for each scenario. Among the parameters considered are land conversion for the project and ancillary infrastructure; impacts of mine dewatering and disposal of tailings and waste rock; abstraction of water; power generation and transmission; transport; housing; solid, liquid, and hazardous waste generation; vibration and noise; light, barrier, and habitat fragmentation effects; and air emissions. These estimates have to take into account existing developments such as Tavan Tolgoi.

Relevant environmental and natural resources. The REA focuses on those features of the natural environment that are most important for developments in the two scenarios and/or are most vulnerable to their potential impacts:

- Groundwater in confined and unconfined aquifers,
- Springs and wells,
- Soils,
- Grazing land,
- Vegetation,
- Wildlife,
- Threatened species and their habitats
- Protected areas,
- Archaeological and cultural resources, and
- Regional air quality.

The vulnerability of the Region and its potential developments with regard to the effects of climate change are also considered in this part of the REA.
Institutional framework to manage development impacts. While institutions are not the central focus of this REA, it is important to know which agencies are responsible for the various functions necessary to manage and monitor development impacts, from enforcement of environmental regulations and laws regarding wildlife and protected areas to planning and management of land development at local-level government. It will also be important to know if there are items missing—either regulations to control certain activities or agencies to carry out certain functions such as regional water resource management—and if there are weaknesses in capacity that ought to be remedied in order to improve the effectiveness of the existing structure.

Stakeholder consultation process. The REA was first issued as a discussion draft to serve as a basis for raising stakeholder awareness, to collect additional relevant information from stakeholders, to initiate consideration of the implications and outcomes of possible development, and to obtain stakeholder views on a sustainable and acceptable development future for the SGR. The report outline was presented for stakeholder comment at an initial workshop in September 2008, and the draft report was discussed at workshops conducted in connection with the Southern Mongolia Infrastructure Strategy in April 2009. This version of the REA incorporates the stakeholder inputs and provides recommendations for achieving a desirable development outcome. Neither the SMIS nor the REA are envisioned as static documents, and so further consultations are likely to occur.

Information Sources

The REA draws heavily from companion papers prepared on key aspects of development: livestock, water, transport, power, urban infrastructure, and protected areas (see www.worldbank.org/southgobi, Sheehy, 2010, and Tuinhof, 2010). Environmental impact assessments for the large mines at Tavan Tolgoi and Oyu Tolgoi provided a great deal of information on the individual projects, the resources they may affect, their likely impacts, and their plans to manage those impacts. Special purpose studies conducted by Ivanhoe Mines Mongolia, Inc. on water and population influx were consulted, as were various World Bank papers and government reports mentioned in the text and References. While the REA does not itself contain a comprehensive review of the current state of performance in and capacity for environmental management in the mining sector, this topic is covered in detail in Mongolia: a Review of Environmental and Social Impacts in the Mining Sector (World Bank, 2006). Scholarly papers were used for topics such as impacts of, and adaptations to, climate change, trends in land cover, and groundwater resources. A field mission in November 2008 provided the opportunity to tour the Region and to speak with government officials at state, aimag, and soum levels, as well as with researchers, national and international nongovernmental organizations (NGOs), mining companies, and other representatives of the mining industry.
2. Development in the Southern Gobi Region

The base-case development scenario assumes that current mining operations will continue and that the large mines that are in or near initial stages of development will proceed into production. The high-case development scenario takes a more optimistic view, adding to the base-case a group of additional mines that could be developed within the next 10 to 15 years. For both scenarios, the ancillary infrastructure needed to support the mining activity is projected, including transportation systems to carry products to shipping points or markets.

Base-Case Development Scenario

This scenario is centered around one coal mine that has been operating for some time and that will likely be expanded, one that began coal production in April 2008, and one coal mine and one copper and gold mine that are in early stages of construction. Ancillary facilities include access roads, power and water supply systems, airstrips, and worker camps or colonies. Major regional transportation infrastructure, which is planned to support mining development, is also included. Projections of induced development for all mines are based on Mongolia Southern Gobi Region Urban Infrastructure Background Study (Castalia, Ltd., 2008) from among the discussion papers prepared for the World Bank in support of the SGR Infrastructure Strategy, and on a population influx risk model for Oyu Tolgoi prepared for Ivanhoe Mines Mongolia, Inc. and Rio Tinto (Barclay & Associates, 2007).

Mines in base-case scenario. The base-case mines are shown in Figure 2.1 and include the following:

- Small Tavan Tolgoi coal mine, operated by the aimag government and Qinhua, producing 1 million tons per year and likely to continue indefinitely;
- MAK/Qinhua joint venture Narii Sukhait, producing at 2 million tons per year;
- Southgobi Sands coal mine at Ovoot Tolgoi, which began production in April 2008, will increase to 2 million tons per year; full production of perhaps 6 to 8 million tons per year if rail connection to China is constructed;
- Energy Resources LLC coal mine at Tavan Tolgoi, just beginning construction and expected to produce at 2 million tons per year in 2009 and could reach 10 million tons per year if railroad transport becomes possible;
- Oyu Tolgoi copper and gold mine, expected to be fully under construction in 2009, producing by 2013, full-scale production in 2017;
- Big Tavan Tolgoi coal mine, commencement of construction unlikely before 2010, depends on railroad transport availability to reach full production of 15 million tons per year.²

² Information is from the environmental impact assessment for entire Tavan Tolgoi mining area (EcoTrade ERA, 2007) prepared for Energy Resources LLC. Subsequent changes to the configuration of Energy Resources LLC license area necessitate a new EIA for a smaller area that is in preparation. The estimate of total production of 15 million tons per year was taken from the 2007 EIA and therefore includes production from current Energy Resources LLC license area.
Photo 1: Oyu Tolgoi Airport

Photo by B. Bayarmaa/Oyu Tolgoi Project

Photo 2: Developing informal town-site and businesses at Tsagaankhadi, outside Gobi Strictly Protected Area B

Photo by Luke Distelhorst/Oyu Tolgoi Project
Photo 3: Oyu Tolgoi Project Shaft #1 headframe, currently providing exploration access to the deep underground deposits

Photo by Luke Distelhorst/Oyu Tolgoi Project

Photo 4: Oyu Tolgoi Project construction camp

Photo by Mike Chalker/Oyu Tolgoi Project
Figure 2.1: The Southern Gobi Region

Photo 5: Open pit mining at Tavan Tolgoi

Photo by Jim Reichert
Development in the Southern Gobi Region

Ancillary facilities for the base-case. The ancillary facilities for the base-case scenario include the following:

- Coal-fired power plant at Oyu Tolgoi, 450 megawatt, air cooled, primarily to serve the Oyu Tolgoi mine;
- Coal-fired power plant at Tavan Tolgoi, 600 megawatt in stages, probably air-cooled, to meet regional power demand that is dominated by mining;
- Well field at Gunii Hooloi and 70-kilometer transmission line for Oyu Tolgoi process water supply;
- Well field at the dry Balgas Lake and 70 kilometer pipeline to supply process water for Energy Resources LLC Tavan Tolgoi;
- Worker colony for miners of Energy Resources LLC Tavan Tolgoi and their families, near or adjacent to soum center, with shared systems possible for water supply and wastewater collection and treatment;
- Housing and supporting infrastructure (water supply, sewerage, electricity, etc.) for Oyu Tolgoi miners and families in Khanbogd and other nearby soum centers;
- Housing and supporting infrastructure for MAK/Qinhua mine;
- Housing and supporting infrastructure for big Tavan Tolgoi mine.

Planned regional infrastructure. Infrastructure planned to support the base-case mines is shown in Figure 2.2:

- Sealed road from Tavan Tolgoi via Oyu Tolgoi to border crossing with China at Gashuun  

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Figure 2.2: Planned Transportation Infrastructure for the Base-Case Scenario

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Investigation to determine water availability is ongoing.
Sukhait, total distance of 95 kilometers (Oyu Tolgoi to border) plus 165 kilometers (Tavan Tolgoi to Oyu Tolgoi) for a total of 260 kilometers;

- Sealed road from Ovoot Tolgoi via Nariin Sukhait to border crossing with China at Shivee Khuren, for total distance of 45 kilometers;
- Rail connection from Tavan Tolgoi southward via Oyu Tolgoi to Gashuun Sukhait, covering a distance of 250 kilometers;
- Rail connection from Ovoot Tolgoi to border crossing with China at Shivee Khuren, for a distance of 45 kilometers.

### Continuing importance of the livestock industry

Livestock production is detailed only in this section on the base-case (Sheehy and other, 2008) but is assumed to be similar in the high-case. Extensively managed livestock production in Mongolia is a viable system and one that is well adapted to Mongolian conditions. Livestock species present in the SGR herd reflect differences in pastureland capacity and species adaptability to the different SGR land-cover types. The desert steppes and desert environment characteristics provide most suitable habitat for camel, sheep, and goats. Although livestock herders have followed the trend toward higher goat numbers as a percentage of the national herd, they have also retained relatively high numbers of horses and cattle in the regional herd. Dry steppe pastureland in the northern part of the SGR and along the Chinese border does provide suitable habitat for these livestock species.

The extensively managed, pastoral livestock production system as it now exists presents advantages and disadvantages relative to economic development and conservation of wildlife and natural ecosystems. The major advantages of the SGR livestock production system are (a) low-input/low-cost system based on using renewable and no-cost resources; (b) production system that has adapted itself to SGR environmental conditions; (c) capacity to supply meat and off-take products desired by the Mongolian population; (d) relatively self-sufficient in meeting self-consumption needs and producing a marketable product; and (e) few negative impacts, under normal production conditions, on the natural environment or wildlife habitat.

The major disadvantages of the SGR livestock production system are (a) being a forage supply-driven livestock production system in which temperature and moisture conditions determine, during a short period of forage growth, the supply of animal feed for the entire year irrespective of animal needs; (b) having always been subject to natural climate-related catastrophe that can cause widespread livestock mortality in the short term and reduce animal and pasture productivity in the long-term; (c) lacking availability of inputs of any kind (feed, veterinary care, marketing opportunities, etc.) to support extensively managed livestock production and relieve livestock pressure on regional pastureland; and (d) herders responding to market incentives by increasing livestock numbers and changing herd structure to cashmere.
Development in the Southern Gobi Region

goats. The change in numbers and herd structure can lead to catastrophic losses among the herd population in the event of natural and commonly occurring weather events; and as livestock numbers increase and herd structure changes, opportunities for conservation of wildlife and natural ecosystems decrease.

Privatization of livestock ownership and production has increased the level of uncertainty and amount of risk to which individual herders or groups of herders must respond in making decisions relative to livestock production and use of natural resources. The risk and uncertainty normally associated with livestock production itself is being compounded by new factors, including (a) the concentration and expansion of livestock numbers, (b) a decrease in the number of herding families, (c) changes in customary herder institutions, (d) uncertainties from the marketplace and government, and (e) increased potential for conflict over use of pasture resources.

In the desert steppe and desert regions, lack of water wells is a major limiting factor to successful livestock production and livelihood sustainability. Many of the wells developed during the collective era no longer function because pump and water delivery systems have been destroyed or gravel filters used in deep wells no longer function. For example, only 1,000 of the 1,800 wells established in Dornogovi, which has virtually no permanent surface water resources, were operable in 2003. Developing new wells or rehabilitating old wells provides considerable benefit to SGR livestock producers relative to pastureland access and could be beneficial to wildlife if appropriate water distribution systems were implemented along with construction of new wells. Government and donor projects to rehabilitate existing, non-functioning mechanical wells and drill new wells in waterless pastureland areas of the Region are being implemented.

Between 1990 and 2000, SGR livestock numbers increased from 762,000 to 1,121,000 head.
(47 percent increase) following the collapse of the collective. Similar to the national situation, the increase in livestock numbers corresponded with a change in livestock composition. The most dramatic shift occurred in goats and camels with the percentage of goats increasing from 30 percent in 1970 to 58 percent in 2004, and the percentage of camels decreasing from 18 to 6 percent during the same period.

Tourism development. Tourism is a fast-growing industry in the SGR, especially in Omnogovi aimag. The current industry need for infrastructure is minimal since the clientele prefers the existing small hotels or tourist camps, which are in or near provincial centers, and engages in activities that have limited impact on the environment. Tourism, especially as it becomes more commercially oriented and the diversity of clientele expands, will benefit from infrastructure development by other industries (i.e., transportation, communication, electricity generation, etc.) and will develop its own infrastructure to meet client needs (e.g., hotels, new and improved roads, ancillary activities such as golf courses). In the longer term, commercialized tourism will require infrastructure development and will increasingly use critical resources such as water (Sheehy and others, 2008).

Estimates of population increasing from mine construction and operation and influx. Development of the mines in the base-case will cause the regional population to increase substantially. Consider the following: $E$ is existing population (with adjustments for natural increase during the projection period), $M$ is the number of miners, $F$ is the number of miner family members, and $I$ is influx or the number of people who migrate to the area for various reasons, mainly in search for employment and actual or perceived business opportunities. The increase in regional population will be the sum of $E + M + F + I$. The amount of increase will depend to a considerable extent on the recruitment and settlement models adopted by the mining companies, since these affect both the $M+F$ numbers and the amount of influx (Castalia, Ltd., 2008).
The operating life of the mines is the period of most concern since it could be 40 years or more. Energy Resources LLC, intends to begin with a “fly-in, fly-out” model, in which miners will be transported to the site, housed and fed at a camp near the mine during their work rotation, and transported back to their home towns for their time off. Energy Resources LLC, is considering a future transition to a “gated community” model in which the company will construct housing and supporting infrastructure for miners and their families adjacent to or near the Tsogttetsii soum center. Some infrastructure and municipal services may be shared with the soum. Ivanhoe Mines Mongolia, Inc., is likely to follow recommendations from its consultants for a combination of fly-in, fly-out for a small portion of its professional staff and the “integrated community” model in which miners and their families will be recruited as much as possible from the Region and will live in existing communities, mainly Khanbogd but also several other soum centers. Southgobi Sands houses its workforce of approximately 200 at a camp near the mine but also busses approximately 50 workers from nearby Gurvantes.

For Oyu Tolgoi, Castalia, Ltd. (2008) has projected population growth in Khanbogd soum as shown in Figure 2.3. This projection has population increasing from nearly 3,000 as the existing population at the beginning of operations to 12,000 within the first three years of mining and roughly 19,000 by year 15. Taking the population in year 3 as an example, it would consist of roughly 3,000 soum residents, 1,000 miners, 3,000 miner family members, and an influx population of 4,000. Castalia bases its estimates of influx on an analysis of worldwide experience with various mine recruitment and settlement models.

Ivanhoe Mines Mongolia, Inc., plans to recruit an additional 1,500 to 2,000 miners from other soums near the mine. Assuming that the number is 1,500 and that the same household size (4.1 persons) and influx rate prevail (one additional person for each miner and family member), this would add another 12,000 persons to the subregion’s population by year 3. The total population of all the soums surrounding Oyu Tolgoi could more than double, from approximately 12,000 to 29,000 as a result of Oyu Tolgoi’s operation. By year 15, it could reach 33,000 (Castalia, 2008). To the extent
that miners who already live in the Region are hired, the total of new arrivals will be smaller. The same can be said of influx; while the number will not change, a significant number of new arrivals will have come from elsewhere in the Region.

For the Energy Resources LLC, mine at Tavan Tolgoi, little influx will occur under the fly-in, fly-out model. If the mining camp evolves to become a gated community, influx would be comparable to that projected for Khanbogd: 500 mine workers plus 1,500 family members and 2,000 migrants, increasing the population of Tsogttsetsii by 4,000. In the case of Southgobi Sands, an influx of 200 migrants would be predicted because of the 50 miners that live with their families in Gurvantes. There is insufficient information on recruitment and settlement plans for other mines, including the big Tavan Tolgoi, to provide the basis for reliable predictions; however, a consultant advising Ivanhoe Mines Mongolia, Inc., hazarded a guess that Tavan Tolgoi at full production could add 8,000 to the population of Tsogttsetsii soum (Barclay & Associates, 2007). Consequently, without the big Tavan Tolgoi, the population in the Region could expand by 25,000 in 15 years, with about half of the increase being miners and families and the other half from influx. The big Tavan Tolgoi could add another 8,000 new inhabitants. The population in the soums surrounding these mines would increase to 37,000 without the big Tavan Tolgoi and 45,000 with it.

**Influx during construction.** During construction, the companies that have disclosed their plans—Ivanhoe Mines Mongolia, Inc., and Energy Resources LLC—are housing their workforces in camps on or near the mine sites and are providing all infrastructure and services. The influx assessment that was commissioned by Ivanhoe and Rio Tinto estimates that between 500 and 1,700 in-migrants will settle in the vicinity of Oyu Tolgoi, mostly in Khanbogd soum center, in February 2009, Ivanhoe Mines Mongolia, Inc., conducted a regional labor and skills assessment that will allow better predictions of net population growth.
during the construction period. The assessment also estimates that the population influx caused by construction of Tavan Tolgoi could be between 850 and 1,500 under a high-technology development scenario, and between 2,800 and 5,600 under a labor-intensive scenario. In any case, the numbers of construction workers plus migrants will be less than the total additions to the population that result from mining operations.

**Induced development.** Barclay and Associates (2007) describe the kinds of induced development likely in the SGR as a result of mining:

- Housing for workers not accommodated at the mine sites, along with family members, that will seek housing in local communities, mainly the soum centers;
- Housing for new arrivals or returning community members with or without families that are attracted by the possibility of employment at one of the mines;
- Businesses that serve the mining industry;
- Entrepreneurs that see the mine workforce and other migrants in the Region as prospective customers;
- Formal and informal businesses along transportation routes and at key locations such as the border crossing to China, including providers of food and lodging, fueling and tire and vehicle repair shops, money changers, sex workers, drug dealers, and illegal traders in plants and animals.

For the REA, it is assumed that the numbers of people moving to the Region to conduct the businesses described above are subsumed in the influx estimates. The environment and social impacts vary, of course, with the type of activity.

None of the activities is quantified in the influx assessment, with the exception of one roadside development that is highly significant—the 115 hectares at Tsagaankhad, near the border crossing, that have been leased to Mongolian trucking companies for unloading and stockpiling.
coal that is picked up there by Chinese trucks. The area used for this purpose will certainly expand if coal continues to be transshipped rather than trucked or hauled by rail directly to China.

**Base-Case Demands on Natural Systems**

**Land conversion.** The most obvious and immediate impact on natural systems is conversion of land for the mines, ancillary facilities, and regional infrastructure. The total area is estimated at 16,500 hectares, broken down as follows:5

<table>
<thead>
<tr>
<th></th>
<th>Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oyu Tolgoi</td>
<td>8,500</td>
</tr>
<tr>
<td>Tavan Tolgoi</td>
<td>5,400</td>
</tr>
<tr>
<td>Ovoot Tolgoi</td>
<td>69</td>
</tr>
<tr>
<td>MAK-Qinhuajv</td>
<td>Not available</td>
</tr>
<tr>
<td>Road construction</td>
<td>500</td>
</tr>
<tr>
<td>Railroads to border with China</td>
<td>295</td>
</tr>
<tr>
<td>Tavan Tolgoi workers community</td>
<td>1,700</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16,464</strong></td>
</tr>
</tbody>
</table>

**Land affected by dewatering.** Even in the arid Gobi, groundwater accumulates in mines and must be pumped out. Mine dewatering causes a cone of depression that, according to estimates in various environmental impact assessments (EIAs), could lower the water table and adversely affect springs and deep-rooted plants such as saxaul and Siberian elm that depend on the surface water table in a radius of from 3 to 7 kilometers around a mine. Assuming 5 kilometers to be the affected radius, 7,850 hectares could be affected by dewatering around each mine, for a total of 31,400 hectares for the 4 mines in the base-case scenario. Note that this is not in addition to the nearly 15,000 hectares disturbed by the mines; it includes nearly all of the disturbed area.

**Exclusion zones.** Ivanhoe Mines Mongolia, Inc., has defined an “exclusion zone” with a radius of 10 kilometers around Oyu Tolgoi—an area of 31 square kilometers. The primary objective was to establish sufficient distance between settlements and the mining operation to avoid impacts of noise, dust, and vibration on local communities. For example, the environmental and social impact assessment for Oyu Tolgoi predicts total suspended particulate concentrations exceeding standards for a distance of 6 kilometers downwind under worst-case conditions. By means of consultations and benefits packages, including new sites with

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5 The main information sources were EIA for Tavan Tolgoi and Ovoot Tolgoi. There were inconsistencies between land areas estimated to be disturbed by mining and areas of soils that would be disturbed by mining and various other activities. The latter have been used as being the most logical measure of impact and as being the same as the respective EIA estimates of the area of grazing land that would be affected.
water supply plus education assistance and employment for one household member, the herder families who were residing in this zone were successfully encouraged to relocate (Eco-Trade LLC, 2006). Herder complaints about dust from the mines at Tavan Tolgoi were serious enough to cause the local government to begin negotiations with mining companies about relocating as many as 15 herder families; this action attests to the utility of the exclusion zone concept, at least downwind of a mining operation. Ivanhoe Mines Mongolia, Inc., is reportedly reconsidering the concept however and may significantly reduce the size of the zone at Oyu Tolgoi or eliminate it altogether in favor of agreements to avoid residential construction too close to the mine fenceline.

**Process water requirements.** The companies proposing major new mines have been exploring for potential sources of process water. Respective volumes required, all of which are projected to be withdrawn from groundwater sources, are listed below (Acacia Water, 2009). In virtually all cases, the mineral content of the water makes it nonpotable, and drinking water for the mine workforces must be obtained from other sources:

<table>
<thead>
<tr>
<th>Mine</th>
<th>Process Water Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tavan Tolgoi</td>
<td>76,000 m$^3$/day from beneath the dry Balgas Lake</td>
</tr>
<tr>
<td>Oyu Tolgoi</td>
<td>60,000 m$^3$/day from Gunii Hooloi Aquifer</td>
</tr>
<tr>
<td>Ovoot Tolgoi</td>
<td>33 m$^3$/day for domestic use, no process water required</td>
</tr>
<tr>
<td>MAK-Qinhua JV</td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>136,000 m$^3$/day</td>
</tr>
</tbody>
</table>

**Transport requirements.** Based on assumptions about the timing of initial production and increases therein mentioned in the description of the base-case scenario, the following is a summary of the estimated volume of truck traffic that will be generated by the mine:

- The small Tavan Tolgoi coal mine reportedly generates 200 round-trips per day when coal demand is high in China. Trucks travel on the unimproved road from Tavan Tolgoi past Oyu Tolgoi to Tsagaankhad, a trans-shipment point where coal is unloaded and stock-piled for pick-up by Chinese truckers, near Gahsuun Sukhait. This is likely to continue indefinitely.
- MAK/Qinhua joint venture is generating approximately 75 round-trips per day with its output of 2 million tons per year, on an unimproved road southward to a border crossing at Nariin Sukhait.
- Southgobi Sands coal mine at Ovoot Tolgoi hauls coal to a nearby storage yard using 100-ton trucks, where it is picked up by Chinese truckers using 80-ton trucks. At projected production of 3 million tons per year in 2009, the traffic generated on the same route used by MAK/Qinhua should be 100 round-trips per day.
- The Energy Resources LLC, coal mine at Tavan Tolgoi is acquiring a fleet of 200 trucks to ship coal to the trans-shipment point at Tsagaankhad and anticipates that each truck can make one round-trip per day. Its fleet presently numbers 104, which will generate that many round-trips on the Oyu Tolgoi-Gahsuun Sukhait portion of the unimproved road from Tavan Tolgoi, increasing to 200 when the fleet is complete.
- Oyu Tolgoi copper and gold mine at peak production (some time after 2013) expects to generate 180 round-trips per day of 35-ton trucks hauling concentrate on the road to Gahsuun Sukhait.
- The big Tavan Tolgoi coal mine, with commencement of construction unlikely before 2010, depends on railroad transport availability to reach full production of 15 million tons per year. If one assumes initial production of 2 million tons per year, then 75 round-trips per day are likely on the road to Gahsuun Sukhait.

Recognizing that these numbers are rough estimates, the volume of traffic on the road to Gahsuun Sukhait could be on the order of 600 truck movements per day in 2009, increasing to at least 1,300 truck movements per day or nearly

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one every minute. At Nariin Sukhait, volume will likely be 350 movements per day, or one every four minutes, in 2009. Further increases are possible on both routes but are not being projected here because of the probability that rail will replace truck as the method of transporting coal from the Region when those increases occur. Output of an individual coal mine of 5 million tons per year and beyond makes rail haul realistic, perhaps essential (Bullock, 2008). The combined volumes of two or more mines would justify construction of rail lines sooner.

**Housing needs.** Whether in gated or integrated communities, the 10,500 miners and family members from Oyu Tolgoi, Ovoot Tolgoi, and the Energy Resources LLC, mine at Tavan Tolgoi will need housing; the 2,560 new units, based on the household size of 4.1 that Castalia, Ltd. (2008) used in its projections, was derived from Khanbogd statistics. Since responsible companies will feel an obligation to ensure that their employees and families have acceptable housing, it is likely that they will collaborate with local governments in planning for new housing construction in the integrated communities. It is also likely that they will assist their employees in securing adequate housing through measures such as loan guarantees and low interest loans. They will of course provide the housing in a gated community. More problematic is housing for the influx population of 10,500—another 2,560 units—for which the mining companies have no direct responsibility. It is fortunate that gers are the traditional housing of choice and can be easily set up where land is available. This reduces the risk that migrants will live in substandard accommodations, as Castalia, Ltd. (2008) observed in its review of global experience.

**Municipal water use and wastewater generation.** Assuming water use at an “urban” rate of 120 liters

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**Photo 12: The disposal of solid waste, as here outside Dalanzadgad, will become a major issue in the population centers of SGR.**

Photo by Erdene-Ochir Badarch
per capita per day, the additional population of 21,000 will consume 2,500 cubic meters per day and generate nearly as much wastewater. Boreholes and various levels of treatment depending on the mineral content of the raw water will be needed for public supply. Population density will make pit privies and septic systems inappropriate; sewer systems and treatment works will be necessary and in most locations must be sized for the entire population rather than just the new arrivals.

**Solid waste generation.** Solid waste is already managed poorly at the soum and aimag centers; extensive open dumps are found along the roads leading into the towns. Figure 2.4 shows a typical dump. With solid waste volume set to double or triple (with increasing affluence comes increased waste production), this bad situation will worsen. Using a standard urban waste generation coefficient for Mongolia of 0.6 kilogram per capita per day (Hoornweg and Thomas, 1999), there will be 12.6 tons of new solid waste each day to be collected, recycled, and disposed of in environmentally and aesthetically acceptable ways. Solid waste management facilities will need to be sized for the entire population since no acceptable facilities currently exist.

**Heat and electricity.** Castalia, Ltd., (2008) estimates that 5 megawatts of combined heat- and power-generating capacity will be needed for the projected population of the Region. While this could be considered under other supporting infrastructure, it is included separately because it is also an environmental management measure to reduce demands for fuelwood and use of individual heating facilities with higher emissions of air pollutants and possible negative effects on indoor air quality.

**Other supporting infrastructure.** Castalia, Ltd., (2008) also estimates the needs and costs for infrastructure, such as roads, schools, clinics and hospital rooms, public transport, and storm drainage, based on projected population increases. Castalia argues correctly that local and regional governments need to include influx population in planning for them to avoid having overloaded facilities and/or a significant unserved or underserved population.

**Induced development.** Induced development has many definitions. In this REA, the term is used to identify the development that takes place because of the mining but not as part of the mine and ancillary facilities or supporting infrastructure. It is in effect unplanned, but some of it is a logical result of the growth in mining, and much of that fulfills needs for essential commodities or services such as markets, specialty shops, workshops, petrol stations, hotels and restaurants. There are also unplanned developments that are predictable but undesirable; this may include prostitution, drug dealing, and illegal trade in plants and animals. Some of the induced development will occur in soum centers, but much of it will locate along the haul routes from the mines to their markets. Adverse environmental and social impacts can be significant if induced development is allowed to occur without any controls.

**Air emissions.** The EIA for Oyu Tolgoi mentions that the ambient air quality in the proposed transport corridor from the mine to Gashuun Sukhait is “pristine” apart from periodic dust storm events that cause suspended particulate matter (SPM) levels to exceed the Mongolian national 24-hour average standard of 150 micrograms per cubic meter (µg/m³). Monitoring at Oyu Tolgoi during June 2003 recorded a maximum 24-hour average SPM concentration of 530 µg/m³, with maxima during dust storms for PM₁₀ and PM₂.₅ of 129 and 51 µg/m³, respectively. Between 20 and 30 dust storm events can be expected in a year, with average durations from 3 to 6 hours (Eco-Trade LLC, 2006)

- **Dust.** In contrast, the dust levels along the current multi-track unimproved roads in the transport corridor between Tavan Tolgoi and Gashuun are far from pristine. Soil particles entrained by truck traffic as in Figure 2.5 are reportedly carried by normal winds a considerable distance from their sources and cause health and environmental problems. In addition, coal handling at the trans-shipment depots at Tsagaankhad generates wind-borne coal dust that affects residents and animals downwind (Figure 2.6). According to the Director of the Small Gobi Strictly Protected
Area, the environmental protection plans for the four trans-shipment yards that require dust-suppression measures show no evidence of having been implemented (personal communication, 2008).

- **Vehicle emissions.** The EIA for Oyu Tolgoi provides estimates of the emissions of carbon dioxide (2,020 grams), nitrogen oxides (320 grams), and carbon monoxide (220 grams) that could be expected from one truck making a round-trip from Oyu Tolgoi to Gashuun Sukhait based on emission factors obtained from MNET (Eco-Trade LLC, 2006). Based on these unit emission values, the truck traffic from Oyu Tolgoi in one day at full operation would emit 364 kilograms CO\textsubscript{2}, 58 kilograms NO\textsubscript{X}, and 40 kilograms CO. Adjusting the coefficients in the EIA for the different distances, CO\textsubscript{2} emissions from truck traffic from Tavan Tolgoi to Gashuun Sukhait in one day would be 2,627 kilograms. Traffic between Ovoot Tolgoi and the Chinese border would add to the regional total (but not the same transport corridor) another 177 kilograms CO\textsubscript{2}, 28 kilograms NO\textsubscript{X}, and 19 kilograms CO. Carbon dioxide emissions of nearly 3 tons per day from mineral product hauling in the Region are not inconsequential as contributions to greenhouse gas production. Whether the emissions of NO\textsubscript{X} and CO would result in health effects or violations of ambient quality standards along the haul routes cannot be determined without air quality modeling that is beyond this REA scope.

- **Other air emissions.** Central heating plants, small diesel-powered generators, and larger-coal-fired power plants will contribute additional SPM, CO\textsubscript{2}, SO\textsubscript{2}, NO\textsubscript{X}, and CO that need to be considered in assessing impacts on air quality in the SGR. This should be done when plans are more definite and the individual EIAs, which are needed for the power plants, have been completed.

### High-Case Development Scenario

The high-case scenario includes the same mines and related infrastructure in the base-case (Figure 2.7), augmented by the below-listed group of mines whose development is more speculative and by additional infrastructure particularly for water supply and transport of mine output:

- Tsagaan Suvarga Copper Molybdenum Project – Large-scale copper project, not likely before 2015.
- Baruu Naran Thermal Coal project – Northwest of Tavan Tolgoi, 6 million tons per year potential from 2012, owned by QGX, Inc., and now controlled by the MCS Group and Kerry Group of Hong Kong. Can be tied into rail exports by Energy Resources LLC.
- Scale up of operations at Ovoot Tolgoi to 10 million tons per year.
- Khukh Tsav Cement Factory (MAK company).
- Shivee Ovoo mine-mouth power plant (3,600 megawatts) with power export to China.
- Uranium in situ leach projects (at least 2) in area at the northern tip of Dorn Govi.
- Eldev Coal Mine MAK.
- Rail connection from Tavan Tolgoi to Trans-Mongolian Railway, 500 kilometers or longer.
- Possible transfer of surface water from northern Mongolia.

### High-Case Demands on Natural Systems

**Land affected by dewatering.** The most obvious and immediate impact on natural systems is conversion of land for mines, ancillary facilities, and regional infrastructure. Not knowing the actual area proposed for each mine, an estimated 5-kilometer radius around a mine that would be affected by dewatering is used as a basis for estimation. Each of the proposed new mines would dewater 7,850 hectares. Assuming that approximately 50 percent of that area is actually converted to mine and ancillary facilities, which is the ratio that occurs in the base-case, 3,925 hectares will be converted. The cement plant and expansions of existing mines are excluded. The result is that the high-case scenario would approximately double both the amount of land affected by dewatering (31,400 to 62,800 hectares) and the amount of land converted (15,000 to 30,000 hectares).
Development in the Southern Gobi Region

Estimates of land converted or otherwise affected by the uranium mines must be added but were not available at time of reporting for the REA. Construction of the rail connections to the Trans-Mongolian Railway will cause the conversion of at least 500 hectares.

**Process water requirements.** Water volumes that may be required are listed below (Acacia Water, 2008). The first four mines listed are from the base-case scenario. Water requirements for some of the high-case mines are not available. Estimates would vary depending on whether coal mines plan to ship washed coal (as in the case of Tavan Tolgoi) or unwashed coal (e.g., Ovoot Tolgoi according to the initial plans). For the time being, the high-case is assumed to double the requirements for water from the mining industry.

<table>
<thead>
<tr>
<th>Mine</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tavan Tolgoi</td>
<td>76,000 m³/day from Balgas Lake</td>
</tr>
<tr>
<td>Oyu Tolgoi</td>
<td>60,000 m³/day from Gunii Hooloi Aquifer</td>
</tr>
<tr>
<td>Ovoot Tolgoi</td>
<td>33 m³/day domestic use, no process water required</td>
</tr>
<tr>
<td>MAK-Qinhua JV</td>
<td>Not available</td>
</tr>
<tr>
<td>Tsagaan Suvarga</td>
<td>32,000 m³/day</td>
</tr>
<tr>
<td>Baruun Naran</td>
<td>Not available</td>
</tr>
<tr>
<td>Khukh Tsav cement</td>
<td>Not available</td>
</tr>
<tr>
<td>Shivee Ovoo coal mine</td>
<td>53,000 m³/day</td>
</tr>
<tr>
<td>Uranium Leach projects</td>
<td>Not available</td>
</tr>
<tr>
<td>Eldew coal mine</td>
<td>Not available</td>
</tr>
</tbody>
</table>

---

8 Washing one ton of coal requires from 500 to 800 cubic meters, depending on coal quality (Acacia Water, personal communication).
The increased water demand from the development that is forecast under the high-case scenario could exceed the SGR groundwater potential (i.e., the amount that can be abstracted from the aquifers under reasonable criteria to avoid rapid, excessive depletion) by as early as 2020 (Acacia Water, 2009). This could happen sooner in some parts of the Region and later in others; the timing depends on the match or mismatch between local or subregional demands and the supplies available from aquifers that are accessible to those demand centers at reasonable cost. Water supply could thus become a limit to growth in the SGR, and some planners would advocate that such a limit be observed in reviewing proposals for future development.

The alternative is to import additional water. Prefeasibility studies have been completed on two schemes to transfer surface water from river basins in the northern parts of Mongolia. The Herlen-Gobi Pipeline Project would carry 1,500 liters per second, or 130,000 cubic meters per day through a 540-kilometer pipeline to Shivee Ovoo, Shainsand, and Zamin-Udd, with a side branch to Tsagaan Suvarga copper mine. The Orhon-Gobi Pipeline Project would transport 2,500 liters per second, or 215,000 cubic meters per day through a 740-kilometer pipeline to Tavan Tolgoi and Oyu Tolgoi, with side branches to Mandalgovi and Dalanzadgad. Herlen-Gobi Pipeline and Orhon-Gobi Pipeline are included in the high-case scenario.

**Transport requirements.** The estimated volume of truck traffic that will be generated by the expansions and additional operations in the high-case scenario mines is also assumed, for the moment, to be double that of the base-case on the route to Gashuun Sukhait. The numbers of one-directional truck movements per day could exceed 2,000, or more than 1 per minute. It is unlikely that truck traffic would actually rise to this volume since it would imply that total tonnage of coal
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to be shipped would have increased beyond the crossover point at which rail transport becomes economical and perhaps imperative. However, new mines not adjacent to the main haul routes, whether highway or railroad, will require access roads to connect with them. Transport infrastructure may be augmented by a rail connection from Tavan Tolgoi northeastward to the Trans-Mongolian Railway for a distance of 500 kilometers or more depending on the route (Figure 2.8).

**Housing needs.** Based on the best information available from mining companies and from estimates where information is lacking, the increase in the SGR population caused by additional miners and family members plus influx that would come under the high-case scenario (which includes the base-case increase) could reach 80,000 (World Bank, 2009). Total needs for new housing would reach 20,000 units. The Government has been considering alternative strategies, including the construction of one or two new towns in the mining areas instead of assuming all new arrivals will be housed either in gated communities or existing population centers.

**Water use and wastewater generation.** The additional population of 40,000 will consume 6,000 cubic meters per day and generate nearly as much wastewater. Boreholes and various levels of treatment depending on the mineral content of the raw water will be needed for public supply. Population density will make pit privies and septic systems inappropriate, therefore sewer systems and treatment works will be necessary and in most locations must be sized for the entire population rather than just the new arrivals.

**Solid waste generation.** There will be 25 tons of new solid waste each day to be collected, recycled,
and disposed of in environmentally and aesthetically acceptable ways. Solid waste management facilities will need to be sized for the entire population since no acceptable facilities currently exist.

**Heat and electricity.** The Castalia, Ltd. (2008) estimate that 5 megawatts of combined heat- and power-generating capacity would be needed for the projected population of the Region under the base-case and would be increased to 10 megawatts for the high-case.

**Air emissions.** Transport-related air emissions would double; however, this result is hypothetical since coal hauling will shift from truck to rail. Other air emissions would increase proportionally with population.

**Other supporting infrastructure and induced development.** The descriptions of the items in these two categories remain the same as in the base-case; there will simply be more of them.
3. Environmental Resources and their Opportunities, Constraints, and Vulnerabilities

This section follows the presentation of development scenarios because the presentation on resources is not meant to be open-ended or encyclopedic. Instead, it focuses on the elements of the natural environment that offer opportunities for development, impose constraints on development, or are particularly vulnerable to development.

Geology

The mineral resources of the SGR represent the opportunity for development that warrants a regional environmental assessment. There is no comprehensive map of mineral deposits. In its absence, a map of the areas being mined and those for which mining exploration licenses have been issued is presented as Figure 3.1. It goes without saying that not all explorations will result in finds that lead to development of mines, but some certainly will. Figure 3.1 gives an indication of how much of the SGR is of potential interest to mining companies.

Climate Change

Average temperature increased in Mongolia 1.8 degrees Celsius between 1940 and 2003, with the increase more pronounced in winter temperature than in summer in the Gobi. Changes in precipitation were variable across the country; decreases of 30 and 70 millimeters were measured in the extreme southeastern part. Potential evapotranspiration increased 7 to 12 percent (Batima, 2006). The duration of heat waves increased by 6 to 8 days in the Gobi during the same period, and cold wave duration decreased by 13 days. The worst droughts were experienced in 1999, 2000, 2001, and 2002, and the ensuing dzud were devastating to livestock (Batima and others, 2005). Impacts on rangeland productivity are difficult to measure since it is probable that excessive grazing has had more effect than higher temperatures (Angerer and others, 2008).

Models to predict climate scenarios for 2020, 2050, and 2080 have shown mixed results for SGR. Plant biomass is predicted to decrease overall and in the steppe but to increase in the desert. The northern boundary of the desert area will move northward by 2080. Drought and dzud will increase in frequency. Spring snowmelt will take place one to three weeks earlier than it does at present. Overall, the summers will be hotter and the winters milder. The summer heat will shorten the hours during which animals graze (Batima, 2006). The desert steppe zone will also move northward, and its productivity may increase because of heavier precipitation in winter (Angerer and others, 2008). Milder winters might be thought to be beneficial to herders, but they tend to bring heavier snowfall, occasional melting followed by formation of ice sheets that impede grazing and frequent windstorms (Batima and others, 2005). Adaptations for the livestock...
industry would include returning to traditional management in which a pasture is used for just one season and then allowed to rest, rehabilitating pasture, creating irrigated pasture, and not allowing herd size to exceed pasture carrying capacity (Batima, 2006).

Hydrology

If minerals provide the greatest opportunities for development, availability of water is probably the single greatest constraint. Mining and mineral processing consume water in large quantities. With limited rainfall, no perennial surface water bodies, and the predictions (in section 3.2 above) of reduced precipitation and higher evapotranspiration (i.e., reduced groundwater recharge), development decisions in the SGR must consider water supply first of all.

Water availability

Water supply depends almost exclusively on groundwater in the SGR. Water for livestock and public supplies is taken from traditional, shallow and deep wells from aquifers that are recharged by rain and snow. For the large quantities of water required for mining and mineral processing, deeper aquifers are available. Many of these contain fossil water—that is, they have at some time in the past been cut off from sources of recharge by geologic changes—and many because of high salinity are not suitable for drinking without treatment. Estimates of groundwater potential in the SGR are continually subject to change as new information becomes available, for example, as mining companies explore for new sources and test potential yields. A recent estimate, based on conservative assumptions, is that the groundwater potential is 500,000 cubic meters per day for the next 25 to
Environmental Resources and Their Opportunities, Constraints, and Vulnerabilities

40 years. However, because so much of it is fossil groundwater, extraction at that rate cannot go on indefinitely. Studies of the Gunii Hooloi aquifer that is considered the primary source for Oyu Tolgoi suggest that it can be tapped at a sufficient rate to support the mine for approximately 40 years (Aquaterra, 2007). About 285,000 cubic meters per day can be withdrawn from the SGR’s shallower aquifers altogether, assuming recharge at the conservative rate of 1 millimeter per year (Acacia Water, 2009).

**Present and projected water consumption**

An estimate of the water used in existing mining and mineral processing operations and in those that will come into operation in the near future is 240,000 cubic meters per day. The present total of water consumption for livestock and rural and urban water supply is approximately at 40,000 cubic meters per day. The three urban centers—the aimag capital cities—consume together 6,500 cubic meters per day from well fields. Average per capita consumption ranges from 110 to 130 liters per day. Rural consumption includes individual supplies from herder wells and water points and deep wells for soum centers and totals approximately 6,200 cubic meters per day, with average per capita consumption between 10 and 30 liters per day. Livestock consumption is estimated at 32,000 cubic meters per day (Acacia Water, 2009). Approximately 30,000 small wells are thought to exist in the desert and desert steppe regions, and numerous mechanical wells were drilled during the collective era and maintained by the government. Most mechanical wells (i.e., engine and pump or Archimedes screw wells) have fallen into disrepair, or the underground water source has failed (Sheehy and others, 2008).

Based on conservative assumptions, there is enough groundwater to sustain projected development until 2020 (Acacia Water, 2009). There is insufficient information to support an analysis of the spatial distribution of groundwater potential across the SGR, and, while the aggregate figures cited here may give an indication of the overall limits the Region’s water resources may impose on growth, they do not provide a good basis for land use planning. Clearly, the cumulative demand several mines would exert if they tap the same aquifer needs to be considered in project-specific EIAs and approvals for water abstraction. The extent to which mining will compete with other uses—livestock, primarily, and also rural and urban public supply—depends on the characteristics of the aquifer that a mine will tap. The Gunii Hooloi aquifer that Ivanhoe Mines Mongolia, Inc. plans to tap for Oyu Tolgoi is believed not to be connected to shallow aquifers, and the EIA for the mine’s water supply considers that it is unlikely that withdrawals for the mine will affect either the 72 herders’ wells or plants such as saxaul (*Haloxylon ammodendron*) that depend on the surface water table in the area above the aquifer. In the case of the Galbyn Gobi aquifer that has been considered as an additional supply for Oyu Tolgoi, tests have shown a connection between the deep and shallow aquifers over at least part of the area the aquifer underlies (Eco-Trade LLC, 2004b).

**Vulnerability of water resources**

In addition to decreases in precipitation that may result from climate change as discussed in Section 3.2, the SGR groundwater resources are vulnerable to the projected mining development and the population growth that will result from it in a variety of ways. The aquifers containing fossil groundwater are a one-time reserve that, once exhausted or so reduced as to be unproductive, will not be replenished. They therefore warrant special care in their exploitation. Prolonged exploitation of other deep aquifers, where there is a vertical connection to the surficial aquifers, can result in lowering of the water table and failure of shallow wells on which rural residents and livestock depend (Eco-Trade LLC, 2004b). The possibility of horizontal interconnection between aquifers needs to be considered as well, though the SGR geology is such that many of the deeper aquifers such as Gunii Hooloi are bounded by relatively impermeable rock formations that would limit interconnectedness (Acacia Water, 2009). Dewatering lowers the water table in a large area—a radius of 5 kilometers around the mine is assumed in this report, based on the
EIA for Oyu Tolgoi (Eco-Trade ERA, 2007)—and this will cause shallow wells and springs to dry up. Wells that tap a surficial aquifer and are too close together will interfere with one another because of the cone of depression or drawdown that forms around each well as it is being pumped. Moreover, if the estimated rate of recharge is correct at 1 millimeter per year, water table aquifers cannot sustain heavy drawdowns, because a recharge area of 1 square kilometer would only add 1,000 cubic meters of new water in one year. Finally, the shallow aquifers are vulnerable to pollution from wastewater, leachate from solid waste dumps, and chemical spills. The potential for pollution, while low at present, will increase with population growth and urban development.

Soils

Most of the soils in the SGR can be characterized as semi-desert, desert, or arid desert soils. They are rarely deep, typically have thin A-horizons and limited humus and clay content. Freezing occurs to depths of up to 1.5 meters and lasts 6 to 7 months. Many of the soils are alkaline, with high sodium carbonate content (Eco-Trade ERA, 2007). Arsenic and fluoride are naturally occurring soil contaminants (Tuinhof, 2010). In some of the desert soils, for example the light brown semi-desert soil that is common at Oyu Tolgoi and many other locations, a thin, hard, cryptobiotic crust forms through fungal and microbial action. The crust holds moisture, protects the limited organic content of the soil, and provides some protection against wind erosion (World Bank, 2003; Eco-Trade ERA, 2007).

Opportunities

With thin to non-existent topsoil and low humus and moisture content, opportunities for cultivation are limited. Soil supplements and irrigation would be necessary. The surface crust is vulnerable to disturbance from sharp-hooved animals (mainly goats)
and vehicle traffic. Once disturbed, it no longer provides any protection against wind erosion and dust entrainment (Eco-Trade ERA, 2007). Changes in herd composition across Mongolia in recent years—relatively more goats, fewer softer-footed animals—are viewed as one of the principal causes of land degradation (MNET, 2008).

Constraints and vulnerabilities

Dust entrained by vehicle traffic using the unimproved roads, most extensively by 80-ton coal trucks, is considered one of the top 2 or 3 environmental problems in the soums that have coal mines or segments of the coal transport routes. It affects the health of humans and livestock and degrades the overall quality of life. In the words of one official, when the flow of coal trucks is at its normal volume, “It is a continuous dust storm; people cannot stay in it” (Director, Small Gobi Strictly Protected Area, personal communication, 2008).

Mercury is in widespread use by artisanal gold miners in Mongolia (World Bank, 2006). Government surveys in 2007 by the Ministry of Nature, Environment, and Tourism (MNET), the State Specialized Inspection Agency (SSIA), and the National Emergency Management Agency (NEMA) revealed widespread soil contamination caused by use of cyanide and mercury. There are sites of contamination in the three SGR aimags, most numerous in Omnogovi (MNET, 2008). The NEMA has established a processing and containment facility in Khanbogd soum, Omnogovi (Figure 3.2), and expects that it will receive 50,000 tons of contaminated soil from all 10 aimags in which contamination has been found (personal communication with facility manager, 2008).

Vegetation

The primary vegetation types in the SGR are desert steppe and desert although grass steppe occurs along the northern edge of Dundgov and

Photo 15: In wet years the vegetation in the SGR can be abundant as here in Dund Gov in an area dominated by *Anabasis brevifolia*
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Dornogov provinces. Both provinces are dominated by desert steppe (55 and 62 percent, respectively). Omnogovi aimag is equally dominated by desert steppe and desert (49.1 and 49.0 percent, respectively) although grass steppe occurs at higher elevation in the eastward extension of the Altai Mountains and the province has relatively large areas of barren and sand land (Sheehy and others, 2008).

Detailed floristic studies at Oyu Tolgoi provide useful descriptions of communities in the desert steppe vegetation zone that covers much of the SGR. They consist of drought-tolerant low shrubs and thinly distributed short grasses. The only trees in the vicinity of Oyu Tolgoi are Siberian elms (*Ulmus pumilla*) that occur infrequently along seasonal drainage channels. Overall plant cover is about 5 percent (Eco-Trade LLC, 2004b).

Elsewhere in the SGR are found groves of saxaul trees (*Haloxylon ammodendron*), which are capable of sending roots as far as 10 meters below the ground surface to reach the surface water table even in dry periods. These trees can grow to 4 meters tall if left relatively uncut and ungrazed. Saxaul groves are important in protecting arid land from erosion and desertification (World Bank, 2003; Eco-Trade LLC, 2004b).

Opportunities

Vegetation communities occurring in the SGR have variable floristic characteristics and a wide range of annual standing crop yield. Grass steppe communities have standing crop yield ranging from 650 to 1,300 kilograms per hectare. These communities are dominated by grasses including the genera *Cleistogenes*, *Stipa*, *Aneurolepidium*, *Elythrigia*, *Festuca*, *Helictotrichon*, and *Koeleria*; various *Carex* species; and forbs including *Artemisia*, *Filifolium*, and *Allium*. The shrub *Caragana* is often present in the community as a co-dominant. Most grass steppe is grazed throughout the year by all livestock except camel. Gazelle and the Asian wild ass are the most common wild herbivore grazers in grass steppe areas.

Desert steppe and desert communities generally have standing crop yields between 290–380 kilograms per hectare and contain a high diversity of vegetation communities, soils, and topography that create “forage patch” grazing opportunities for livestock and wild herbivores. Desert steppe is dominated by grasses, herbs, and shrubs. Desert steppe formerly was the habitat of the Mongolian wild horse (*Equus ferus*) and the current habitat of the Asian wild ass (*Equus hemionus*), Argali bighorn sheep (*Ovis ammon*), Saiga antelope (*Saiga tatarica*), and wild camel (*Camelus bactrianus ferox*). Deserts are especially suited to grazing by domestic camels, sheep, and goats, and provide habitat for a number of large wild herbivores (Sheehy and others, 2008). The vegetation growing season is short, from mid-May to mid-August (World Bank, 2003).
Environmental Resources and Their Opportunities, Constraints, and Vulnerabilities

**Constraints and vulnerabilities**

Government studies show that 77 percent of Mongolia’s territory is affected to some degree by desertification. The area strongly affected has increased from 16 percent in 2004 to 34 percent in 2008 (MNET, 2008). This may be overstated. From a global perspective, the 40 percent of Mongolia’s “Gobi” surface area did not change appreciably in the 40 years leading up to 2003 (World Bank, 2003). However, from local perspective, land degradation (often described loosely as desertification) is perceived as a real concern.9 Aimag and soum governors and environmental officers usually name land degradation as the foremost environmental problem in SGR. A government-funded “greenbelt” program to combat land degradation is active in SGR (personal communications with aimag and soum officials, 2008), but the area covered is as yet insignificant in comparison to the areas of land affected (MNET, 2008). Causes of land degradation in SGR include:

- Reduced precipitation, possibly related to climate change;
- Increases in herd size;
- Herd concentration in smaller areas due to decreases in functioning water points;10
- Changes in herd composition—more goats, and fewer camels, horses, and cattle;
- Damage by vehicle traffic;11
- Dust that accumulates on leaves and blankets roots, impeding plant growth (personal communication with Mongolia Academy of Science, Institute of Botany, 2008).

The two tree species mainly found in SGR, Siberian elm (*U. pumilla*) and saxaul (*H. ammodendron*) depend on moisture from the surface water table and are vulnerable to significant lowering of it (Eco-Trade LLC, 2004b and 2006). Trees are also harvested for firewood (Bedunah and Schmidt, 2000).

Illegal trade in rare plants and plants of medicinal significance occurs in SGR. The Director of the Small Gobi Strictly Protected Area has observed that illegal harvesting increases noticeably during the periods when the border crossing with China at Gashuun Sukhait is open to all trade (personal communication, 2008).12

**Wildlife**

**Opportunities**

The animal species present in SGR are important in the regional ecosystem. They also have immediate economic value for Mongolia. Wildlife is a primary attraction for tourists in the SGR. It also attracts trophy hunters that pay substantial fees for licenses—US$18,000 for the argali, or wild mountain sheep, for example (Clark et al., 2006).

**Constraints and vulnerabilities**

The 11 species listed in Table 3.1 appear on the Red List of Threatened Species issued by the International Union for Conservation of Nature (IUCN, 2009).

Threats to these species and to wildlife can be loosely grouped into four forms: destruction, degradation or fragmentation of habitat; physical disturbance; competition with domestic livestock; and illegal hunting and trade. Some examples of threats to different species follow:

- Bustards will desert otherwise appropriate habitat when power lines are constructed because they perceive the towers as perches for raptors. Collisions with power lines are responsible for some bird mortality (personal communication, 2008).

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9 There is no agreement on a single definition for “desertification”. The term “land degradation” is used in this report instead.

10 Environmental officials in Dundgobi aimag explained that concentration of animals around wells exceeds pasture-carrying capacity and that the reason 1.45 million hectares of good pasture exist in the aimag is that there are no water sources in it (personal communication, 2008).

11 Some 44,000 hectares have been degraded by truck traffic in Dundgobi aimag (personal communications, 2008).

12 The crossing at Gashuun Sukhait is open year-round for coal transport and 20 days each quarter, in April, July, October and December, for general trade.
### Table 3.1: List of Threatened Vertebrate Species in SGR

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Regional</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ovis ammon</td>
<td>Argali</td>
<td>EN</td>
<td>NT</td>
</tr>
<tr>
<td>Gazella subgutturosa</td>
<td>Goitered gazelle</td>
<td>VU</td>
<td>VU</td>
</tr>
<tr>
<td>Procapra gutturosa</td>
<td>Mongolian gazelle</td>
<td>EN</td>
<td>LC</td>
</tr>
<tr>
<td>Equus hemionus</td>
<td>Asiatic wild ass</td>
<td>EN</td>
<td>EN</td>
</tr>
<tr>
<td>Marmota sibirica</td>
<td>Siberian marmot</td>
<td>EN</td>
<td>EN</td>
</tr>
<tr>
<td>Euchoreutes naso</td>
<td>Long-eared jerboa</td>
<td>VU</td>
<td>LC</td>
</tr>
<tr>
<td>Spermophilus alashanicus</td>
<td>Alshan ground squirrel</td>
<td>EN</td>
<td>LC</td>
</tr>
<tr>
<td>Uncia uncia</td>
<td>Snow leopard</td>
<td>EN</td>
<td>EN</td>
</tr>
<tr>
<td>Oreoleuciscus humilis</td>
<td>Small osman</td>
<td>VU</td>
<td>NE</td>
</tr>
<tr>
<td>Falco cherrug</td>
<td>Saker falcon</td>
<td>NE</td>
<td>EN</td>
</tr>
<tr>
<td>Chlamydotis undulata</td>
<td>Houbara bustard</td>
<td>NE</td>
<td>VU</td>
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</tbody>
</table>

*EN= endangered; VU= vulnerable; NT= near threatened; LC= least concern; NE= not yet evaluated*

### Photo 17: The Asian Viper *Gloydius halys* is quite common in the SGR

Photo by Tony Whitten
In the steppe areas of Mongolia, there was a dramatic decrease in the number of saker falcons, a species that is valuable in the world market and can be legally exported from Mongolia under license. Dundgovi and Dornogovi provinces experienced near 100 percent falcon population loss. In 2006 the Government issued a decree establishing a quota of 300 birds per year and high fees for falcon export presumably to reverse the impact of excessive capture and export (MNET, 2008).

Ibex, wild sheep, ungulates, and marmots are the main prey of snow leopards. Decreases in the populations of these food sources have directly affected leopard populations and have also led to increases in attacks on domestic herds, which in turn have provoked killings by herders (MNET, 2008).

The SGR is the principal habitat of the regionally endangered Asiatic wild ass, or khulan, which migrates long distances in search of water and forage. Construction of fences along with the Trans-Mongolian Railway, and erection of fences along the China-Mongolia border have fragmented habitat and interfered with large-scale movement of khulan herds (Clark et al., 2006). Sub-populations of Mongolian gazelle have been isolated from the main population in eastern Mongolia by the Trans-Mongolian Railway, the highway that parallels it, and the fences along them (Clark et al., 2006). Satellite tracking has shown that gazelle move along the railway but do not cross it, despite better habitat on the other side (BirdLife Asia, 2008).

Permanent human settlements, mining development and fences degrade wildlife habitat by restricting access to water.

Ecotourism campsites are often established near watering places to increase the probability of animal sightings. Their presence disturbs wildlife and, if continued for several days, deprives the wildlife of water (personal communication, Wildlife Science and Conservation Center, 2008).
Even though no improved road or railroad yet exists, coal transport between Small Gobi Strictly Protected Area “A” and “B”, which involves transit through the designate buffer zone, has already ended periodic migration of khulan between the two parts of the protected area. With their habitat thus restricted, they have been moving eastward onto unprotected land where they are vulnerable to illegal hunters. The width of the informal roadway (close to 100 meters in places), the size and number of coal trucks, dust, and noise are factors that prevent the khulan (and to a lesser extent, black-tailed gazelle or goitered gazelle, also a long-distance traveler) from crossing (personal communication, Director, Small Gobi Strictly Protector Area Director, 2008).

Illegal hunting is partly the cause for declines in large wild herbivore populations in general and is specifically related to declining numbers of snow leopard (now popular in traditional medicines), khulan, Mongolian gazelle (hunted for meat), and wild sheep (hunted for horns). Excessively liberal quotas for legal hunting of wild sheep have also contributed to their decline (Clark et al., 2006).

There is a substantial wildlife trade in Mongolia, both internal and for export. Body parts and small numbers of living animals can be found in markets in Ulaanbaatar. Traffic is highest in winter because freezing conditions facilitate storage and transport and fur-prized animals have their more luxurious winter coats. The traffic peaks in January when temporary border crossings are open to facilitate shopping in China for two to three weeks in advance of the New Year holidays and dealers have an easy time moving in and out of China. Shipments are moved undetected inside tires or in containers under other loads, including coal (personal communication, Wildlife Conservation Society, Mongolia Office, 2008).

**Protected Areas**

There are seven Special Protected Areas in the SGR:
Small Gobi Strictly Protected Area A,
Small Gobi Strictly Protected Area B,
Gobi Gurvan Saikhan National Park,
Ergeliin Zoo Nature Reserve,
Ikh Nartiiin Chuluu Nature Reserve,
Zagiin Us Nature Reserve, and
Suikhent Uul Natural and Historic Monument.

There are 242 locally protected areas, 34 of which are designated at the aimag level and 208 by the soum (BirdLife Asia, 2008). BirdLife Asia has identified 5 important bird areas in SGR, totaling approximately 1.8 million hectares, one-third of which have some official protected status because they partially coincide with a state or local protected area. All but 76,000 hectares are in Omnogovi aimag. Figure 3.3 shows the protected areas and important bird areas as well as the extent to which areas licensed for mining or mine exploration conflict with them.

Opportunities

Fifty percent of Mongolia’s critical natural habitat is included within Strictly Protected Areas, while a further 39 percent is included within local Strictly Protected Areas. Only 5 percent of the consolidated set of critical natural habitats in Mongolia is not formally protected at the local or national level. Tourism in Mongolia is largely nature based, the main attractions being the rural population and their pastoralist lifestyle, combined with the open, vast, and attractive landscapes. Protected areas in Mongolia are popular tourist destinations, with tourists typically accommodated in tented ger camps run by tour operators, based on concessions licensed by the government.

Economic reform since the early 1990s has led to the privatization of tourism operations and the rapid development of the sector. In 2006,
385,000 tourists entered Mongolia, up from 137,000 in 1999. This growth is matched by an increase in the number of hotels and tour camps, with the latter increasing from 63 in 1999 to 200 in 2006. This is putting pressure on protected areas. The Government views tourism development as a priority for economic development. The Ministry of Roads, Transport and Tourism has adopted a strategy for tourism development covering the period 2007–2011.

**Constraints and vulnerabilities**

BirdLife Asia (2008) analyzed the overlap between protected areas and mineral exploration and mining license areas. Where state protected areas are concerned, the overlap is small—3 percent or less, except 9 percent for Ikh Nartiiin Nature Reserve and 27 percent for Suikhent Uul Monument—and is virtually entirely with exploration licenses. In the case of protected areas designated by aimag and soum, the overlap is greater—32 percent of the total protected area in Omnogovi, 56 percent in Dornogovi, and 16 percent in Dundgovi. Overlap with important bird areas ranges from negligible to substantial; the worst case is 60 percent of the Galba Gobi area (828,000 hectares) in Omnogovi.

The lack of serious overlap with strictly protected areas probably results from the facts that the review of license applications occurs at the national level and that most of the locations have been in protected status for 10 years or more. In the case of local protected areas, the designation of the protected area sometimes post-dates the issuance of the exploration or mining license, as is the case at Tavan Tolgoi (BirdLife Asia, 2008). More importantly, aimag and soum governors are not accorded much opportunity to influence decision-making, either in EIA preparation, review, and approval, or in review and approval of applications for exploration or mining permits. However, as BirdLife points out, the adverse impacts of mining on protected areas are likely to be associated with supporting infrastructure, especially roads, railroads, and water supply, and with the urban development that follows the mines, more than with the mines themselves.

To assess the impact of tourism on critical natural habitats, BirdLife has looked at the overlap, using Geographic Information System analysis, between tour camp locations and areas of critical natural habitat (state specially protected areas, local specially protected areas, and important bird areas). Over half of the total number of tour camps (101 of 200) registered in Mongolia are therefore located in or adjacent to state or local specially protected areas. A comparison of locations reveals that 65 camps are located in or adjacent to 8 important bird areas (BirdLife Asia, 2008).

As part of this study, the Department of Social Geography of the National University of Mongolia, Mongolian Tourism Association, and Wildlife Science and Conservation Center of Mongolia conducted a questionnaire survey to assess the impact of tourist camps on the environment. From a nature conservation point of view, and based on information compiled during this study, the following tourism-related threats to critical natural habitats in Mongolia are highlighted: (a) disturbance of wildlife; (b) degradation of grassland steppe and deserts; (c) pollution of lakes and rivers; (d) firewood collection; (e) depletion of water resources; (f) rubbish; and (g) tourist infrastructure.

Issues such as wildlife disturbance are of particular concern. In many cases, however, these concerns are localized, with minimal impact from a biodiversity point of view. At present, the threat posed by tourism development is considered to be of less concern than that posed by mining and infrastructure development. Many of the issues arising relate to protected areas management, particularly the lack of capacity and resources; the poor application of park zoning; and lack of awareness and visitor management programs (BirdLife Asia, 2008).

**Physical Cultural Resources**

In this category are archaeological and paleontological sites that are considered sacred or have spiritual significance to the local or regional populace, or have geological formations or other features of
the landscape that contribute to visual interest. The information presented here is fragmentary, as it is beyond the scope of the REA to provide a complete inventory of physical cultural resources, but it gives an indication of what may be encountered in the course of major development activities in SGR, such as mines, transport infrastructure, and new towns.

**Opportunities**

Much of what is known about physical cultural resources in the Region comes as a result of investigations carried out in the preparation of major development projects. Several dinosaur eggs were discovered during excavations for one of the mineshafts at Oyu Tolgoi, and construction workers have been instructed to be alert for other such finds (personal communication, Oyu Tolgoi environmental supervisor, November 11, 2008). Paleolithic and Bronze Age artifacts, ancient copper mines, and two petroglyphs have been found at the Oyu Tolgoi project site, and there are more than 200 petroglyphs at the top of nearby Javkhalant Mountain (Eco-Trade LLC, 2006). Numerous **_ovoo_** (rock piles with traditional cultural significance) have been created along vehicle tracks through SGR (Figure 3.4). A large one of religious importance is located at the summit of Javkhalant Mountain. A survey of the proposed road corridor between Oyu Tolgoi and Gashuun Sukhait conducted for Ivanhoe Mines Mongolia, Inc., in 2002–03 identified 52 artifacts including stone tools at two settlements from the Upper Paleolithic period (40,000 to 12,000 years ago) and 50 tombs from Bronze Age and earlier. Certain of the tombs that were discovered caused a revision in what was previously thought to be the southern limit of settlements by Bronze Age peoples from northern Mongolia (MASIA, 2003).

BirdLife Asia (2008) has mapped 6 natural sacred sites in SGR—2 in Dornogovi, 3 in Dundgovi, and 1 in Omnogovi (Figure 3.5). All but one of the sites in Dornogovi have fully protected status at the aimag level. These are natural areas revered by traditional local communities.
Developers may be enlisted in the effort to preserve physical cultural resources. Ivanhoe Mines Mongolia, Inc., is protecting the petroglyphs in its project area. It has also contributed funds for restoration of the main stupa that had been destroyed at the Demchig Monastery ruins, or “World Energy Center” (see Figure 3.6).

**Constraints and vulnerabilities**

Artifacts can easily be obliterated by mine and infrastructure developments. In some cases, obliteration might be an unavoidable impact and must be considered in the EIA review and the decision to approve or reject the proposed project. This situation presents itself at the ancient copper mines that were found in the future open pit area at Oyu Tolgoi. The Mongolian Protection of Cultural Heritage Law requires a developer to seek the advice of Mongolian Academy of Science, Institute of Archeology (MASIA) with regard to projects that could disturb or damage archaeological sites. The developer must obtain MASIA approval before undertaking activities that could damage or destroy the site. Procedures for chance finds are an obvious requirement for any development projects in SGR.

In many cultures, local shrines could be relocated if local traditional leaders agree and proper ceremonies are performed. This might be true for small ovoo, though probably not for the large, old ones such as the one on Javkhalant Mountain.
positive and negative impact evaluations will be summarized for both base-case and high-case scenarios based on impact intensity, spatial extent, and duration. Using this three-pronged format as a basis, the impact will be rated as having major, moderate, or minor significance in development decisionmaking. The evaluation criteria are shown in Table 4.1. Descriptors and abbreviations are described below:

Impact intensity is evaluated as high (H), medium (M), or weak (W):

- **High intensity.** Negative impact—a component of the environment is destroyed or so altered as to eliminate the ecological functions it performs or to cause a major shift in abundance or distribution in the SGR. Positive impact—there is a definite improvement in condition, function, abundance, or general distribution in the SGR.

- **Medium intensity.** Negative impact—a component is altered so it results in a reduction of ecological function or a limited shift of abundance or distribution in the SGR, but the integrity of the component is not altogether damaged. Positive impact—there is a moderate improvement in condition, function, abundance or distribution.

- **Weak intensity.** Negative impact—there is very little impact on the component in terms of ecological functions, or abundance or distribution is only slightly modified. Positive impact—there is a small improvement in condition, function, abundance, or distribution.

Spatial extent is evaluated as regional (R), subregional (Sr), or local (Lo):

- **Regional extent** is defined as affecting the entire SGR or a significant part of it. If the impact extends beyond the SGR—is global or national, for instance—that will be separately noted.

- **Subregional extent** signifies that the impact is felt in an area broader than that immediately affected by the activity in question, but smaller than the Region or significant part (e.g., one of the three aimags) of the Region.

- **Local extent** implies that the impact does not extend beyond the area directly affected by the activity.

Duration is evaluated as long-term (Lt), medium term (Mt), or short term (St).

- **Long-term** indicates that the impact is essentially permanent or is felt continuously
Table 4.1. Impact Evaluation Rules

<table>
<thead>
<tr>
<th>Criteria of analysis</th>
<th>Significance of impact</th>
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<td></td>
<td>Negative</td>
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<td><strong>Intensity</strong></td>
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or sporadically over period of more than 10 years. When an impact is irreversible, that will be separately noted.

- **Medium-term** applies to an impact that is continuous or sporadic over a period of from 1 to 10 years, hence not in any sense permanent or irreversible.
- **Short-term** means an impact that is felt over a period of less than 1 year.

### The Base-Case Scenario

Table 4–2 summarizes the impacts in the base-case scenario. In addition to the impact evaluation and the determination of significance of the impacts, the summary also reflects the extent to which impacts can be avoided, minimized, mitigated, or offset. The final column of the table presents impact-specific recommendations.

The accompanying text provides more detail on each impact or group of impacts, organized by the type of activity that needs to be managed. The impacts of the mines themselves are not described in the text because they are covered in individual EIAs. In addition, although mine impact is of high intensity and long duration in terms of permanently altering landform, possibly causing subsidence, and constituting hazards to humans and animals as well as to groundwater if not properly reclaimed, they do not have regional significance in the same way as does the infrastructure needed to support them and the development they may induce.

### Impacts of traffic and transport

Transport of mineral products from mine to market under existing arrangements are already a significant source of adverse impacts. Increases in traffic volume with no improvement in infrastructure, construction of improved and new infrastructure, and transport using new infrastructure are evaluated along with existing impacts.

#### Existing and near-term situation – at present traffic volume.

Present traffic volume is low at 200 round-trips per day between Tavan Tolgoi and Gashuun Sukhait and approximately half of that volume from Ovoot Tolgoi and Narii Sukhait to the Chinese border at Shiveehuren. The impacts of the present relatively low volumes of truck traffic traveling on unimproved routes, which are in many places unnecessarily wide because of multiple tracks, are soil disturbance/desertification, dust that affects vegetation and human and animal health, noise, and physical disturbance. The impacts are considered moderate, local (except where wildlife are concerned), and medium term. The traffic between the two sections of the Small Gobi Strictly Protected Area that transits the buffer zone of Section “A” has already disrupted the movements of khulan and Mongolian gazelle to the point that they are rarely found in that section. Because these two species are listed as regionally endangered, and because Small Gobi Strictly Protected Area is a main part of their remaining habitat, the impact is high intensity, regional, and long term. Mitigating measures consist of improving the road, restricting traffic to a single set of lanes to reduce the width of the transport corridor, enforcing speed and loading limits, constructing at least one properly designed overpass or underpass for large mammals, and implementing other measures to allow wildlife to cross the road (e.g., designating certain periods of the night when traffic would have to be halted). Spraying for dust suppression on the road has been mentioned as a mitigating measure in the EIA for Oyu Tolgoi (Eco-Trade LLC, 2004a), but experience at the Energy Resources LLC site at Tavan Tolgoi suggests that it is of limited effectiveness because of rapid drying in summer and rapid freezing in winter. Energy Resources LLC has found that improving the surface of its haul roads at the mine site with the coarser material being excavated as overburden is more effective. However, personal observations in the field show that it does not eliminate dust altogether.

#### Existing and near-term situation – at projected traffic volume.

A doubling in traffic volume will occur as early as 2009 due to commencement of operations at Energy Resources LLC mine in Tavan Tolgoi and expansion of the South Gobi Sands operation at Ovoot Tolgoi. As the base-case scenario
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unfolds, truck traffic will increase to the point that there could be nearly one truck per minute moving along the road from Tavan Tolgoi to Gashuun Sukhait. The CO₂ emissions will reach nearly 3 tons per day, other air pollutant emissions may degrade regional air quality, and dust generation will be continuous and extensive. The impacts are high intensity, regional (except global for greenhouse gases), and medium term. In the near term, the mitigation measures are the same as for the present traffic volume, but, in the medium term, a shift to rail transport is the best mitigation measure and will likely become economically preferable, perhaps imperative. It is worth noting that higher truck traffic volumes increase opportunities for traders to move endangered (as listed by the Convention on International Trade in Endangered Species) and other unsustainably harvested plants and animals out of the country. The mitigation measure is better public awareness coupled with more effective inspection and prosecution of violators.

Construction impacts of new transport infrastructure. Three stages of construction are likely to occur, either as mitigating measures for the present and near-term impacts of coal hauling or as developments that would proceed in due course to support mining development. These latter include improving the surface of present roads with gravel, sealing the roads, and constructing rail lines. When completed, these mitigating measures will have positive effects (with the exception of effects on wildlife), by eliminating or greatly reducing the adverse impacts of the present transport situation. The adverse environmental impacts during construction are short term for the most part, and include the following:

- Opening of quarries and borrow pits,
- Operation of stone crushers,
- Operation of asphalt plants,
- Noise, dust, and air emissions from hauling and heavy equipment operation,
- Waste from equipment maintenance and worker camps, and
- Poaching for food and illegal animal trade.

Adverse impacts are considered moderate in severity, local in extent, and short term in duration. Mitigating measures mostly involve establishing contractual requirements for good construction practice, which includes restoring quarries and borrow pits and proper waste management and enforcing good practice through adequate supervision. If there is not one already in place, there should be a process for selection and approval of quarry sites, overseen by aimag or soum environmental officials, to ensure that geologic features of scenic or cultural importance are not damaged.

Wildlife management should be one of the key considerations in selecting the alignments for railroads and in designing the roads and railways. These linear infrastructure features obstruct movement of wildlife in SGR, effectively fragmenting habitat. Habitat fragmentation is a significant factor leading to species becoming endangered or eventually extinct. In addition, physical barriers divide the populations of large mammals and thus may create isolated subpopulations that lack the numbers or the genetic diversity to remain viable. There have been successes in other parts of the world, notably Canada and the Netherlands, where carefully designed overpasses have been rapidly accepted by large mammals as a means of moving across highways (Swenson, 2007). This approach should work in SGR.

At present, except in the case of the Small Gobi Strictly Protected Area, not enough is known about the migration patterns of animals such as the khulan or Mongolian gazelle—whether they are regular or predictable, spatially or temporally—and so it is not possible to identify corridors where road and railroad design would best provide for wildlife passage. It is also not possible to determine whether the north-south alignment of a railroad from Tavan Tolgoi to Gashuun Sukhait is better or worse for large mammals than the longer connection to the Trans-Mongolia Railway with its northeast-southwest alignment. It is not clear, in the case of the Mongolian gazelle, whether the barrier to track crossing is the railroad itself or the barbed-wire fence running along the rail line (BirdLife Asia, 2008). All of this urgently requires intensive study, some of which the Wildlife Science and
Conservation Center plans to undertake in 2009 (personal communication with the Director, November 2008). If effective means cannot be identified and implemented, negative impacts are inevitable. In the worst case, the impacts are high intensity, regional, and not merely long term but permanent and irreversible.

The Small Gobi Strictly Protected Area provides a more immediate opportunity to implement and learn from a wildlife overpass. The fact that khulan and gazelle migration occurs or used to occur, between the “A” and “B” sections, has been established, and so the focus can be on designing an effective overpass at an appropriate location. Road improvement should be addressed at this Strictly Protected Area as a matter of first priority. Experts should be engaged for overpass design in order that its construction is connected with road improvements. Monitoring should be included in the planning to determine effectiveness of the overpass design in re-establishing regular movement of large mammals.

Livestock should also be considered in the design of roads and railroads, but the task is easier: their movements can be managed to a great extent by the herders, and they either will cross the barriers of their own accord or can be driven across, as long as ways for passage are provided. Impacts are moderate, regional, and medium term, and adequate and feasible mitigation measures exist.

**Operation of new transport infrastructure.** The shift to transport on one improved, two-lane road with adequate shoulders would have significant positive impacts. Dust entrainment would be drastically reduced and with it the local impacts on vegetation, health, and quality of life. Motorists would be less inclined to cut new tracks parallel to the existing ones for their own convenience or comfort, and there would be less consequent disturbance of fragile soils and vegetation cover that adds to desertification and exacerbates dust storms. The existing multiple tracks would begin to regenerate their surface crust and to revegetate (Eco-Trade LLC, 2004a). Better road surface would allow trucks to run more efficiently and at more constant speed, somewhat reducing fuel consumption and emissions of CO₂ and air pollutants. The positive impacts are substantial, regional, and medium term.

The main negative impact (moderate, local, and medium term) besides obstruction of wildlife movement discussed earlier will be increased risk of livestock and wildlife mortality, higher frequency of vehicle accidents because of proximity of oncoming traffic, and greater severity of accidents when they occur because of higher speeds. Some measures necessary to ensure that the benefits are realized include enforcement of truck loading limits and speed limits and rules against travelling off the roadway. Measures to mitigate potential adverse impacts are enforcing speed limits, issuing and enforcing laws and company rules (mining and trucking) that prohibit drinking alcohol while driving and driving under the influence of alcohol, demarcating zones for passage of livestock (and perhaps wildlife), and including accidents involving wildlife as reportable safety incidents under mining company procedures.

A further shift to rail transport would provide more significant positive impacts that are substantial, regional/global, and long term: elimination of dust entrainment, reduction of CO₂ and air pollutant emissions, reduction in motor vehicle traffic, and reduced risk of livestock and wildlife mortality. By reducing the number of vehicles moving from Mongolia to China, rail transport would also sharply restrict opportunities for illegal trade in plants and animals. However, an alignment being considered for the rail line from Tavan Tolgoi reportedly passes through Small Gobi Strictly Protected Area “B”. A decision to sacrifice part of the Strictly Protected Area indicates a low priority for protection of already threatened wildlife in SGR. It would be equally easy, from a cost and feasibility point of view, to avoid Small Gobi Strictly Protected Area altogether and even the buffer zone between Areas “A” and “B”. An

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13 The large numbers of empty vodka bottles left along the vehicle tracks and placed at ovoo is evidence of a culture of drinking and driving that needs to be changed as traffic increases in SGR.
alignment that avoids Small Gobi Strictly Protected Area is strongly recommended.

Coal dust from trans-shipment. The present arrangements whereby coal is unloaded and stockpiled near the border for pick-up and onward transport by Chinese truckers is not only inefficient but is a source of air pollution and adverse impacts on human and animal health. Entrained coal dust can travel several kilometers downwind from storage and handling areas. Dust suppression is required in the environmental protection plans for the coal yards but apparently rarely practiced (personal communication, Director, Small Gobi Strictly Protected Area, November 2008). The impact of the present arrangement is high intensity, local, and medium term. Effective dust suppression would mitigate it, but eliminating multiple handling at the borders by allowing direct shipment from mine to market would eliminate this impact altogether and reduce the cost of coal transport as well. Implementing this recommendation will require a bilateral agreement with China.

Impacts of mine dewatering and water consumption

Mine dewatering will lower the water table in an estimated 70,000 hectares. Local water sources such as wells and springs used by livestock, wildlife, and herder families would be interrupted. Vegetation that depends on the surface water table might not survive, with resulting impacts on habitat, plant cover, and desertification. In the aggregate, the impact on available pastureland is small. However, on a local scale, herders might find themselves displaced from grazing land. The potential impact is moderate, local/regional, and long term (persisting for some years after mine closure). The overall impact on the water table cannot be mitigated. But there are mitigation measures for some of the resulting impacts, mainly in the form of offsets to be provided by the mining companies: new water supply points; improvement and protection of other springs in the vicinity such as South Gobi Sands is doing at Ovoot Tolgoi; and monitoring the growth
of plants such as saxaul and Siberian elm, with replanting and protection programs outside the zone of dewatering effect to replace those that do not survive.

Overall, the SGR groundwater resources can sustain the development forecast in the base-case. Not enough is known about regional variations in groundwater availability to enable areas of potential water supply shortfall in the short to medium term to be identified. The necessary information should be collected since it may be useful in siting water-using facilities and in ensuring that some aquifers are not over-allocated. The establishment of a central repository to accumulate and manage information on groundwater is recommended. In the long term, water resources planning on a national scale is important since development planners evidently have in mind growth in the SGR that is likely to exceed available water resources. If the natural limits to growth that water imposes on SGR are going to be exceeded, it must be on the basis of such planning, with wide stakeholder participation. The best available information on climate change effects must be factored into the planning, and, where there is uncertainty, a precautionary approach is appropriate.

**Impacts of power generation and transmission**

Peak demand for electric power is expected to increase from a very low number in 2009 to 294 megawatts in 2012 and 650 megawatts by 2020. In the base-case scenario, the most likely power investment to go forward in SGR is a 450-megawatts coal-fired plant at Oyu Tolgoi, intended to mainly serve the needs of the mine. Coal will likely be supplied from Tavan Tolgoi or Tsagaan Tolgoi. A second plant is possible at Tavan Tolgoi, up to 600 megawatts; this one would meet part of the overall demand for the Region.
## Table 4.2: Summary of Impacts on the Natural Environment of the Base-Case Scenario

<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
<th>Significant Impacts Intensity/Extent/Duration</th>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
</table>
| Development of mines and on-site facilities | Physical conversion of 15,700 ha. | • Change in landform *M/Lo/Lt Irreversible*  
• Loss of vegetation, habitat and pasture *W/Lo/Lt*  
• Accident hazard to public, livestock, wildlife *M/Lo/Lt*  
• Dust, vibration, groundwater contamination, etc. *H/Lo/Lt* | Moderate | Company implement reclamation plan, Government officials inspect and enforce. |
| | | | Minor | Company implement reclamation plan, Government officials inspect and enforce. |
| | | | Moderate | Maintain site security; implement reclamation plan. |
| | | | Major | Company implement EIA and EMP. Government officials inspect and enforce. |
| Development of transport infrastructure | Physical conversion of 800 ha for rail and road rights of way  
• Opening of quarries and borrow pits  
• Operation of heavy equipment and concrete and asphalt plants  
• Establishment of construction camps | • Barrier to livestock movement. *M/Sr/Lt Irreversible*  
• Barrier to movement of wildlife; fragmentation of habitat. *H/R/Lt Irreversible*  
• Land degradation at quarries, borrow pits, asphalt plants, construction camps and storage yards. *M/Lo/St* | Moderate | Design and construct facilities for livestock passage.  
Investigate wildlife migration and movement patterns.  
Determine appropriate locations and appropriate designs and construct wildlife crossing facilities.  
Use quarries and borrow pits approved by local environmental authorities and comply with standards for operation and reclamation. Require contractors to prepare and implement waste management plans and to restore areas used for plants, camps and yards. |
| | | | Major | Company implement EIA and EMP. Government officials inspect and enforce. |
| | | | Moderate | No mitigation measure available. Offset with improved protection of other habitat.  
Comply with national standards for power plants. Ensure proper facilities for ash disposal. |
| Development of electric power infrastructure | Interconnection with the national grid. Construction of 450-MW coal-fired plant at Oyu Tolgoi. Construction in stages of 600-MW coal-fired plant at Tavan Tolgoi. | • Transmission towers provide perches for raptors, degrade habitat for endangered bustard species; lines cause bird mortality. *M/Sr/Lt*  
• Air emissions and ash from coal-fired plants; acid rain. *M/R/Lt Global* | Moderate | Create artificial springs; replace shallow wells with deep wells; offset loss through restoration, enhancement, and protection of other springs and wells.  
Monitor condition of trees; irrigate to avoid loss if feasible; plant and protect replacement trees in other locations to offset unavoidable. |
| Mine dewatering | Cone of depression created around mines will lower surface water table; an area of about 31,400 ha., including the area of the mines themselves plus ancillary facilities could be affected. | • Loss of local wells and springs reduces useable pasture and degrades habitat. *H/Lo/Lt*  
• Loss of elms and saxaul trees degrades habitat, contributes to desertification. *M/Lo/Lt* | Major | Create artificial springs; replace shallow wells with deep wells; offset loss through restoration, enhancement, and protection of other springs and wells.  
Monitor condition of trees; irrigate to avoid loss if feasible; plant and protect replacement trees in other locations to offset unavoidable. |

(continued on next page)
<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
<th>Significant Impacts</th>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water for coal washing and mineral processing</td>
<td>At least 136,000 m³/day abstracted from deep aquifers, mainly fossil groundwater, and transmitted by buried pipeline.</td>
<td>• Depletion of nonrenewable resource in the absence of adequate data, considered. <strong>H/Sr/Lt Irreversible</strong></td>
<td>Major</td>
<td>• Further study needed. Monitor during operation and correct problems caused by loss of surface supplies or land subsidence if they occur.</td>
</tr>
</tbody>
</table>
| Transport of mine products by road            | 600 truck movements/day to Gashuun Sukhait in 2009, increasing to 1,300 or nearly one per minute. 100 truck movements/day in Narin Sukhait increasing to 350 or nearly one every four minutes | • Dust from unimproved roads causes human and animal health problems, affects vegetation, and contributes to land degradation. **H/Sr/Mt**<br>• Dust from coal loading and unloading at mines and transshipment points. **H/Ao/Mt**<br>• Traffic presence and noise disturbs and repels wildlife in general and in the Small Gobi SPA in particular. **H/R/Mt**<br>• Increased frequency of accidents with wildlife, livestock, pedestrians and other vehicles. **M/Sr/Mt**<br>• Emissions of NOₓ, CO, HC, SPM degrade air quality—see text for quantities. **W/Sr/Mt**<br>• 3 tons/day of CO₂ contribute to global warming. **W/R/Lt Global** | Major        | • Improve road surfaces and thereafter restrict trucks to the improved road lanes, enforce loading and speed limits, prohibit off-road driving by truckers; assist residents in relocating homes and herds if dust cannot be mitigated. Long-term fix is to shift most hauling to rail.  
• Enforce dust control measures in EIAs for mines and coal depots. Eliminate transshipment operation at border.  
• Improve road surface, restrict trucks to established lanes, enforce speed and loading limits, set hauling schedule that provides for no traffic during hours in which wildlife are most likely to cross the road. Long-term solution is to shift most haul traffic to rail, with well-designed crossings for wildlife.  
• Enforce speed and loading limits, provide well-designed crossings for livestock, set and enforce regulations against drinking and driving, make accidents reportable safety incidents under mining company rules with disciplinary action as appropriate, including termination for alcohol-related incidents. Shift most hauling to rail.  
• Require mining and trucking companies to inspect trucks annually and test for compliance with air emission standards.  
• Shift most hauling to rail. |

(continued on next page)
### Table 4.2: Summary of Impacts on the Natural Environment of the Base-Case Scenario (continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
<th>Significant Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport of mine products by railroad</td>
<td>One train can replace a large number of trucks</td>
<td>* Elimination of substantial amount of dust from hauling and transshipment. H/Sr/Lt * Reduced disturbance to wildlife because of quieter and less-frequent movements. H/R/Lt * However, if alignment chosen is through Small Gobi SPA, the impact will be negative instead. H/R/Lt * Reduced accident risk due to fewer trucks on the road. M/Sr/Mt * Reduced emissions of air pollutants. W/Sr/Lt * Reduced greenhouse gas emissions. W/R/Lt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>Need to ensure common rail gauge with China. Need bilateral agreement to allow trains to cross border.</td>
</tr>
<tr>
<td>Major</td>
<td>To have full positive impact, effective wildlife crossings have to be designed and constructed.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Select railroad alignment around rather than through Small Gobi SPA.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>Local government to enforce basic good practice.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Mining companies planning gated communities for workforce will provide housing and all services. Companies planning integrated communities need to work with local government to provide housing. Local government needs to plan for housing for influx population, using five-year projection and monitoring outcomes.</td>
</tr>
<tr>
<td>Major</td>
<td>Develop new boreholes and provide treatment systems for public supply.</td>
</tr>
<tr>
<td></td>
<td>Construct treatment works for entire soum population, as on-site systems will not accommodate the larger populations and there are no collection and treatment systems in place now.</td>
</tr>
<tr>
<td></td>
<td>Poor solid waste management already is having adverse impacts. Construct solid waste collection and recycling/disposal facilities to serve the entire soum populations.</td>
</tr>
</tbody>
</table>

(continued on next page)
Table 4.2: Summary of Impacts on the Natural Environment of the Base-Case Scenario  (continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
<th>Significant Impacts on the Natural Environment</th>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Air emissions and ash (if coal-fired) from heating and generating facilities.</strong> <strong>W/Lo/Mt</strong></td>
<td>Minor</td>
<td>Design and operate plants according to national standards. Coordinate ash disposal with solid waste management.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Medical waste from clinics and hospitals poses health hazard.</strong> <strong>M/Lo/St</strong></td>
<td></td>
<td>Provide proper storage and disposal facilities for medical waste and train medical personnel in approved methods.</td>
</tr>
<tr>
<td></td>
<td>Service industries, hotels, shops, restaurants, desirable and undesirable entertainment industries (including prostitution, drugs) will spring up in towns along highways, and near mines.</td>
<td><strong>Unplanned/under-serviced developments cause land use conflicts, pollution, land degradation, visual impacts.</strong> <strong>M/Lo/Mt</strong></td>
<td>Moderate</td>
<td>Land use planning and zoning and enforcement thereof by local government.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Prostitution and drug use spread HIV/AIDS and other infectious diseases.</strong> <strong>M/Sr/Mt</strong></td>
<td></td>
<td>HIV/AIDS awareness and prevention programs. Enforce prohibitions on illegal activity.</td>
</tr>
</tbody>
</table>
Impacts of planned and unplanned urban development

Housing. An estimated 5,000 new units of housing will be required, half for house miners and their families and half for influx. Mining companies will provide some of the miners’ housing and will probably assist those who are going to be housed in local towns in finding suitable accommodations. The housing for the influx population—an estimated 10,500 people who will be attracted to the area because of the mining development—is more problematic. If there is no housing available, the migrants may end up living in informal settlements. If housing is constructed but without a formal town plan to guide its location and that of shops and other businesses, development will not be orderly or easy to service. Impacts will be moderate, local, and long term. Mitigation measures include town planning, support administration of land development in accordance with plans, and enforcement of local laws such as zoning. While government may not be the provider of the housing, it will want to create an enabling environment in addition to the necessary plans and infrastructure so that private developers and individual owners can construct it.

Municipal infrastructure and services. The additional population, most of which is likely to settle in soum centers, will generate wastewater and solid waste. Population densities would rise to the point that pit privies and septic tanks will not be suitable means of wastewater treatment, and informal dumping of solid waste, already a problem, will rapidly result in environmental degradation. Impacts will be high intensity, local (or regional if an aquifer is contaminated by untreated wastewater or leachate from solid waste dumps), and medium term. Corrective measures will be considerably more difficult and expensive than prevention. Mitigation specifically requires design, construction, and operation of appropriate wastewater and solid waste management facilities. Expanding towns will also need streets, water supply, and electricity. Clinics and schools will have to be provided as population expands and demands increase. Their development should be provided for in town plans and budgets.

The High-Case Scenario

Table 4.3 summarizes the impacts in the high-case scenario. In addition to the evaluation of intensity, spatial extent, and duration and the determination of significance of the impacts, the summary also reflects the extent to which impacts can be avoided, minimized, mitigated, or offset. The final column of the table presents impact-specific recommendations. The accompanying text highlights comparisons and contrasts with the base-case.

Impacts of traffic and transport

Moving from the base to the high-case will have negative and positive impacts. In general, the same kinds of impacts described for truck traffic and transport in the base-case (section 4.1.1) will occur in the high-case but at higher levels because of increases in truck traffic. Certain differences between the two scenarios are highlighted in the following:

- **There will be more roads.** Additional mines will require connecting roads to reach the main highway or railroad. If these are not developed from the outset as improved roads with the same mitigating measures in design, construction, and use as are recommended for the base-case, they will make more widespread the adverse impacts of dust, noise, accident hazard, and related disturbance to wildlife and deterioration in the health of citizens and livestock.

- **Emissions of air pollutants and CO\textsubscript{2} will increase at a rate that is higher than one that would be directly proportional to the increases in traffic volume, at least on the road from Tavan Tolgoi to Gashuun Sukhait.** With more than one truck movement per minute, congestion will increase, causing trucks to run at slower speeds and with more frequent and protracted periods of idling, consuming more fuel.

- **The shift to rail haul will be all but inevitable.** If the potential cost and time savings at the higher volumes of coal and other mine outputs even in the base-case have not already caused a shift to rail transport, the combination of higher truck volume and lower
efficiency on the roads will accelerate that shift. It is not difficult to imagine the road to Gashuun Sukhait being choked with traffic, and the delays and attendant costs will be intolerable to mine operators. Most of the impacts of that shift will be positive in comparison to those of even present-day coal hauling by truck (as discussed in base-case).

Further fragmentation of wildlife habitat is likely. Rail connections from the mining areas to the Trans-Mongolian Railway will constitute an additional barrier to the movement of livestock and wildlife. The rail lines will be oriented more or less in a northeast-southwest direction. Already affected by the north-south road and rail lines of the base-case, the habitats of wildlife that migrate or move widely within SGR will be further fragmented. The studies, which are necessary to better understand wildlife migration patterns and to design and locate crossings that will perform well, should be conducted on an urgent basis.

Transshipment of coal at border crossings must be eliminated. The greater coal volumes in the high-case merely add justification for altering the arrangements that lead to unloading, stockpiling and reloading coal at the border crossings.

Impacts of mine dewatering and water consumption

Mine dewatering will lower the water table in an estimated 60,000 hectares in the high-case. While the total area is still small in comparison to the amount of available pastureland in SGR, this means that local water sources such as wells and springs used by livestock, wildlife, and herder families will be interrupted in more locations. Vegetation that depends on the surface water table may exist in some of the new locations and may not survive, with resulting impacts on habitat, plant cover, and desertification. On a local scale, more herders may find themselves displaced from grazing land. See 4.1.2 for the details on the evaluation of this impact and its mitigating measures.

Keeping in mind that lack of data on groundwater resources makes predictions difficult and that water consumption information is not available for some of the mines, it is possible that the demand for water from the developments in the high-case scenario will exceed the overall SGR groundwater potential. There are several uncertainties: in sufficient data on groundwater availability that make it difficult to define limits, unknown timing of new mining developments and related population growth, and decisions still to be made regarding processing (e.g., Will the various mines export washed or unwashed coal?). There is little doubt that there is adequate groundwater to support development anticipated in the next 10 to 12 years and perhaps, given the conservative assumptions underlying current estimates (Acacia Water, 2009), up to 25 years. It is probable, though, that planned development plus necessary supporting development (housing, for example) and induced development will generate demand that exceeds the potential of subregional or local groundwater sources. More data are needed, and water availability needs to be an ingredient in planning and review of all major developments.

Transfer of surface water from the north. The Herlen-Gobi Pipeline and Orhon-Gobi Pipeline projects are looked upon as the logical sources to augment water supply and support development in SGR, and they may well meet that objective. However, in addition to feasibility studies, environmental impact assessments, and other necessary preparatory work, they should be analyzed with respect to three “big picture” development planning concerns.

The first of these is the sustainability of development in arid regions. Since the beginnings of urban development, cities have formed along rivers and near coastlines of oceans and large lakes—in short, in places where water is available for drinking, irrigation, transport, and industrial use. There are few large cities in arid locales, and those that do exist, such as Phoenix, Arizona, and Los Angeles, California, depend heavily on imported water at considerable cost. Mongolia needs to be sure that the costs of maintaining cities that are in many respects artificial—not, in the words of the late environmental planner Ian McHarg, “designed with nature”—are justified and sustainable.
The second concern is large-scale water resource management. Transferring a significant fraction of the flow of two rivers to SGR will have impacts on the flow regime and consequently on the ecology of the rivers. These impacts may have implications for future water use and development in the exporting river basins. Planning must be done at a broad enough scale to reveal impacts and balance water needs for both ecology and economic activities in both the importing and the exporting regions.

The third concern is, not surprisingly, impacts of and adaptation to climate change. Here again, more data and more analysis are needed. The implications of climate change are not clear or simple in Mongolia; there is little doubt that average temperatures are rising but the implications for precipitation could vary across the country. Milder winters in SGR could, for example, result in more winter precipitation and earlier thawing (Batima and Dagvadorj, 2000). Droughts are likely to be more frequent and to last longer. In view of the uncertainty in exactly what ways climate change will affect Mongolia, a precautionary approach is essential in making major natural resource allocation decisions such as allocating surface water for interbasin transfers. Fortunately, a National Integrated Water Resource Management Plan that should examine these questions is in preparation (Acacia Water, 2009).

**Impacts of power generation and transmission**

In addition to the medium-sized, coal-fired generating stations that will be constructed in the base-case scenario at Oyu Tolgoi and probably at Tavan Tolgoi, the high-case scenario includes a large, coal-fired plant at Shivee Ovoo. The generating capacity may be as much as 3,600 megawatts, and some or all of the power will be exported to China. Such a plant will have major environmental impacts on regional air quality and greenhouse gas emissions. Fly ash and bottom ash will require recycling and/or disposal. Strict standards should be applied and aggressively enforced. As explained in the base-case description, transmission towers degrade bustard habitat by providing perches for raptors, and there is no realistic mitigation measure. The transmission line from Shivee Ovoo to a connection point in China is long, hence a great deal of habitat will be affected. An offset in the form of improved protection for another important bird area will be appropriate.

**Impacts of planned and unplanned urban development**

**Housing.** An estimated 10,000 new units of housing will be required, half to house miners and their families, and half for influx. Mining companies will provide some of the miners’ housing and will probably assist those who are going to be housed in local towns in finding suitable accommodations. The housing for the influx population—an estimated 10,500 people who will be attracted to the area because of the mining development, is more problematic. If there is no housing available, the migrants may end up living in informal settlements. If housing is constructed but without a formal town plan to guide its location and that of shops and other businesses, development will not be orderly or easy to service. Impacts will be moderate, local, and long term. Mitigation measures include town planning, support administration of land development in accordance with plans, and enforcement of local laws such as zoning. While government may not be the provider of the housing, it will want to create an enabling environment in addition to the necessary plans and infrastructure so that private developers and individual owners can construct it.

**Municipal infrastructure and services.** The additional population, most of which is likely to settle in soum centers, will generate wastewater and solid waste. Population densities will rise to the point that pit privies and septic tanks will not be suitable means of wastewater treatment, and informal dumping of solid waste, already a problem, will rapidly result in environmental degradation. Impacts will be high intensity, local (or regional if an aquifer is contaminated by untreated wastewater or leachate from solid waste dumps), and medium term. Corrective
measures will be considerably more difficult and expensive than prevention. Mitigation specifically requires design, construction and operation of appropriate wastewater and solid waste management facilities. Expanding towns will also need streets, water supply, and electricity. Clinics and schools will need to be provided as population expands and demands increase. Their development should be provided for in town plans and budgets.

Photo 24: A water kiosk in Huldt Soum from which a herder who lives 40 km away is collecting water
Table 4.3. Summary of Impacts on the Natural Environment of the High-Case Scenario

<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
<th>Significant Impacts</th>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of mines and on-site facilities</td>
<td>Physical conversion of 30,000 ha.</td>
<td>- Change in landform. M/La/Lt Irreversible</td>
<td>Moderate</td>
<td>- Company implement reclamation plan. Government officials inspect and enforce.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Loss of vegetation, habitat and pasture. W/La/Lt</td>
<td>Minor</td>
<td>- Company implement reclamation plan. Government officials inspect and enforce.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Accident hazard to public, livestock and wildlife. M/La/Lt</td>
<td>Moderate</td>
<td>- Maintain site security; implement reclamation plan.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Dust, vibration, groundwater contamination, etc. H/La/Lt</td>
<td>Major</td>
<td>- Company implement EIA and EMP. Government officials inspect and enforce.</td>
</tr>
<tr>
<td>Development of transport infrastructure—connecting roads for new mines, and rail connection to Trans-Mongolian Railway</td>
<td>Physical conversion of 1,300 ha. for rail and road rights of way.</td>
<td>- Barrier to livestock movement. M/Sr/Lt Irreversible</td>
<td>Moderate</td>
<td>- Design and construct facilities for livestock passage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Opening of quarries and borrow pits.</td>
<td>Moderate</td>
<td>- Investigate wildlife migration and movement patterns. Determine appropriate locations and appropriate designs and construct wildlife crossing facilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Operation of heavy equipment and concrete and asphalt plants.</td>
<td>Major</td>
<td>- Use quarries and borrow pits approved by local environmental authorities and comply with standards for operation and reclamation. Require contractors to prepare and implement waste management plans and to restore areas used for plants, camps and yards.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Establishment of construction camps.</td>
<td>Major</td>
<td></td>
</tr>
<tr>
<td>Development of electric power infrastructure</td>
<td>In addition to the power plants and transmission lines of the base-case (to be described when more fully known) there will be a mine-mouth plant of 3,600 MW capacity at Shivee Ovoo, which more than doubles generating capacity of the base-case, with at least 300 km of 500-kV transmission line to China and additional lines for connection to the national grid.</td>
<td>- Transmission towers provide perches for raptors, degrade habitat for endangered bustard species; lines cause bird mortality. H/Sr/Lt</td>
<td>Major</td>
<td>- No mitigation measure available. Offset with improved protection of other habitat.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Air emissions and ash from coal-fired plants. H/R/Lt Global</td>
<td>Moderate</td>
<td>- Comply with best available technology to control emissions. Recycle fly ash. Construct and operate ash disposal facility.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Acid precipitation. M/R/Lt</td>
<td>Minor</td>
<td>- Use low-sulfur coal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Water consumption for cooling. H/R/Lt</td>
<td>Major</td>
<td>- Use closed-loop cooling system. (continued on next page)</td>
</tr>
</tbody>
</table>
Table 4.3. Summary of Impacts on the Natural Environment of the High-Case Scenario (continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
<th>Significant Impacts Intensity/Extent/Duration</th>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
</table>
| Mine dewatering                               | Cone of depression created around mines will lower surface water table; an area of about 60,000 ha including the area of the mines themselves plus ancillary facilities could be affected. | • Loss of additional local wells and springs reduces useable pasture and degrades habitat. \( H/S\_Lt \)  
• Loss of additional elms and saxaul trees degrades habitat, contributes to desertification. \( M/Lo/Lt \)  | Major          | • Create artificial springs; replace shallow wells with deep wells; offset loss through restoration, enhancement, and protection of other springs and wells.  
• Monitor condition of trees; irrigate to avoid loss if feasible; plant and protect replacement trees in other locations to offset unavoidable |
| Water for coal washing and mineral processing | Water demand for mining and energy will rise to at least 280,000 m\(^3\)/day | • Coupled with projected increases in domestic and livestock demand, overall groundwater potential of SGR will be exceeded. \( H/R/Lt \)  
• Fossil aquifers will be depleted, causing local shortage. Competition for supply from surface aquifers causing local shortages. \( H/Sr/Lt \)  | Moderately     | Obtain more complete data on water resources. Limit development to that which water resources can accommodate.  
• Insist on state of the art water conserving facilities and equipment for all new industrial or commercial development. Monitor impacts of groundwater extraction. |
| Construct one or both water transfer schemes (Herlen-Gobi and Orhon-Gobi Pipelines) | 130,000 or 215,000 or 345,000 m\(^3\)/day abstracted from Herlen or Orhon Rivers, or both. Impact temporarily rated as major because of high risk and lack of adequate information. | • Reduction in river flows degrades water quality, adversely affects aquatic ecosystems. \( ?/?? \)  
• Existing users experience water shortage. \( ?/?? \)  
• Future uses of river water foreclosed. \( ?/?? \)  
• Unsustainable development enabled in SGR. \( ?/?? \)  | Major          | Collect adequate data and prepare a comprehensive water resource management plan for Mongolia, with full stakeholder participation.  
• Establish a water management agency with commensurate responsibility and authority. |
<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
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<th>Management Measures</th>
</tr>
</thead>
</table>
| Transport of mine products by road | Increase to 2,000 truck movements/day to Gashuun Sukhait in 2020, more than one per minute. 100 truck movements/day in Narin Sukhait, increasing to 350 or nearly one every four minutes. | Dust from unimproved roads causes human and animal health problems, affects vegetation, and contributes to land degradation. \( H/Sr/Mt \)  
Coal dust from loading and unloading at mines and transshipment points. \( H/Sr/Mt \)  
Traffic presence and noise disturbs and repels wildlife in general and in the Small Gobi SPA in particular. \( H/R/Mt \)  
Increased frequency of accidents with wildlife, livestock, pedestrians and other vehicles. \( M/Sr/Mt \)  
Additional emissions of \( NO_x \), \( CO \), \( HC \), \( SPM \) degrade air quality—see text for quantities. \( M/Sr/Mt \)  
4.7 tons/day of \( CO_2 \) contribute to global warming. \( W/R/Lt \ Global \) | Major | Improve road surfaces and thereafter restrict trucks to the improved road lanes, enforce loading and speed limits, prohibit off-road driving by truckers; assist residents in relocating homes and herds if dust cannot be mitigated. Long-term fix is shift to rail.  
Enforce dust control measures in EIAs for mines and coal depots. Eliminate transshipment operation at border.  
Improve road surface, restrict trucks to established lanes, enforce speed and loading limits, set hauling schedule that provides for no traffic during hours in which wildlife are most likely to cross the road. Long-term solution is to shift most haul traffic to rail, with well-designed crossings for wildlife.  
Enforce speed and loading limits, provide well-designed crossings for livestock, set and enforce regulations against drinking and driving, make accidents reportable safety incidents under mining company rules with disciplinary action as appropriate, including termination for alcohol-related incidents. Shift most hauling to rail.  
Require mining and trucking companies to inspect trucks annually and test for compliance with air emission standards.  
Shift most hauling to rail. |
### Table 4.3. Summary of Impacts on the Natural Environment of the High-Case Scenario (continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Significant Impacts</th>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport of mine products by railroad</strong></td>
<td></td>
<td></td>
<td>• Elimination of substantial amount of dust from hauling and trans-shipment. H/Sr/Lt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduced disturbance to wildlife because of quieter and less-frequent movements. M/R/Lt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>However, if alignment chosen is through Small Gobi SPA, the impact will be negative instead, H/R/Lt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduced accident risk due to fewer trucks on the road. M/SrMt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduced emissions of air pollutants. W/Sr/Lt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduced greenhouse gas emissions. W/R/Lt</td>
</tr>
<tr>
<td><strong>Recruitment of miners:</strong></td>
<td></td>
<td></td>
<td>• Need to ensure common rail gauge with China. Need bilateral agreement to allow trains to cross border.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• To have full positive impact, effective wildlife crossings have to be designed and constructed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Select railroad alignment around rather than through Small Gobi SPA.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Local government to enforce basic good practice.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Mining companies planning gated communities for workforce will provide housing and all services. Companies planning integrated communities need to work with local government to provide housing. Local government needs to plan for housing for influx population, using five-year projection and monitoring outcomes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Develop new boreholes and provide treatment systems for public supply.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Construct treatment works for entire soum population, as on-site systems will not accommodate the larger populations and there are no collection and treatment systems in place now.</td>
</tr>
</tbody>
</table>

Recruitment plus family members plus influx add at least another 40,000 to the populations of the soums surrounding mines over 15-year period. The effect is a total increase of as much as 80,000.
Table 4.3. Summary of Impacts on the Natural Environment of the High-Case Scenario (continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Demands on Natural Resources</th>
<th>Significant Impacts Intensity/Extent/Duration</th>
<th>Impact Rating</th>
<th>Management Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• Visual impact, groundwater contamination, land degradation, potential source of disease and injury from solid waste disposal by current practices. <strong>H/Lo/Lt</strong></td>
<td>Major</td>
<td>• Poor solid waste management already is having adverse impacts. Construct solid waste collection and recycling/disposal facilities to serve the entire soum populations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Air emissions and ash (if coal-fired) from heating and generating facilities. <strong>L/Lo/Mt</strong></td>
<td>Minor</td>
<td>• Design and operate plants according to national standards. Coordinate ash disposal with solid waste management.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Medical waste from clinics and hospitals poses health hazard. <strong>M/Lo/St</strong></td>
<td>Minor</td>
<td>• Provide proper storage and treatment/disposal facilities for medical waste and train medical personnel in approved methods.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unplanned and unserviced developments cause land use conflicts, pollution, land degradation, and visual impacts. <strong>M/Lo/Mt</strong></td>
<td>Moderate</td>
<td>• Land use planning and zoning and enforcement thereof by local government.</td>
</tr>
<tr>
<td>Induced development follows mining and related infrastructure development.</td>
<td>Service industries, hotels, shops, restaurants, desirable and undesirable entertainment industries (the latter including prostitution, drugs) will spring up in towns along highways, and near mines.</td>
<td>• Prostitution and drug use spread HIV/AIDS and other infectious diseases. <strong>M/St/Mt</strong></td>
<td>Moderate</td>
<td>• HIV/AIDS awareness and prevention programs. Enforce prohibitions on illegal activity.</td>
</tr>
</tbody>
</table>
5. Institutional Arrangements for Implementation of the REA

This chapter summarizes the responsibilities of the agencies and other organizations that need to be involved in the implementation of the recommended actions and programs in the REA. These management measures are proposed in Tables 4.2 and 4.3 for the impacts of the base-case and high-case development scenarios, respectively. Table 5.1 summarizes the management measures and identifies the entities that will be tasked for carrying them out and, where relevant, those that will be responsible for monitoring and oversight. The discussion is organized by agency, presenting the functions recommended for each of them, along with brief comments on their capacity and readiness to undertake those responsibilities. In addition, two new agencies are proposed—a regional development coordinating body and groundwater management information center.

Soum Government

The soum governors and their staffs and the soum citizens’ representative khurals should be key players in planning for the rapid urban development that is going to follow the expansion of mining and construction of new large infrastructure in SGR, even in the base-case scenario. The governors themselves acknowledge that their tasks will be substantial and varied, and they are concerned about their readiness to undertake them (personal communication with the Governors of Khanbogd and Tsoot-Tsetsii Soums, November 2008).

Simply put, soum governments are going to have to prepare their towns for rapid increases in population and business activity and maintain basic municipal services as the increases occur. This will involve a range of activities:

- Update land use plans and develop zoning to support orderly development and “livable” soum centers;
- Enforce compliance with land use plans and procedures for reviewing and approving development proposals;
- Work with mining companies to plan for housing construction, with a five-year planning horizon (Castalia, 2008);
- Obtain and operate additional public water supply;
- Obtain and operate expanded power and heating systems;
- Obtain and operate wastewater collection and treatment systems; and
- Work with bag governors to replace present ad hoc solid waste dumps on town outskirts with appropriately located sanitary landfills.

Capacity and readiness. Soum government staffs are small and do not have all of the necessary skills to deal with the tripling populations in the soum centers and maintain desirable and efficient places to live. Planners, building inspectors, health
<table>
<thead>
<tr>
<th>Activity</th>
<th>Management measures</th>
<th>Implementation responsibility</th>
<th>Oversight responsibility</th>
</tr>
</thead>
</table>
| Development of mines and on-site facilities | - Implement reclamation plan  
- Maintain site security  
- Implement EIA and EMP | Mining company for all items | MNET and SSIA officers in aimags |
| Development of transport infrastructure—connecting roads for new mines, and rail connection to Trans-Mongolian Railway | - Design and construct facilities for livestock passage.  
- Investigate wildlife migration and movement patterns. Determine appropriate locations and appropriate designs and construct wildlife crossing facilities.  
- Use quarries and borrow pits approved by local environmental authorities and comply with standards for operation and reclamation  
- Prepare and implement waste management plans and restore areas used for plants, camps and yards. | - MFA to design crossings for livestock; roads contractor or mining company to construct.  
- Academy of Science and MNET to design wildlife crossings in collaboration with conservation NGOs and other experts.  
- Contractor or mining company  
- Contractor or mining company | - MRTCUD to ensure highway and railway designs include crossings as recommended.  
- MNET and SSIA officers in aimags  
- MNET and SSIA officers in aimags |
| Development of electric power infrastructure | - Offset bustard habitat degradation with improved protection of other habitat.  
- Comply with best available technology to control emissions. Use closed loop cooling system.  
- Recycle fly ash. Construct and operate ash disposal facility.  
- Use low-sulfur coal | Developer (mining company or energy company)  
- Developer (mining company or energy company)  
- Operator  
- Operator | MNET  
MNET; MME  
MNET and SSIA officers in aimags  
MNET and SSIA officers in aimags |
| Mine dewatering | - Create artificial springs; replace shallow wells with deep wells; offset loss through restoration, enhancement, and protection of other springs and wells.  
- Monitor condition of trees; irrigate to avoid loss if feasible; plant and protect replacement trees in other locations to offset unavoidable losses | Mining company for all items | MNET officers in aimags |
| Water for coal washing and mineral processing | - Obtain more complete data on water resources.  
- Limit development in SGR to that which water resources can accommodate, or construct pipelines from rivers to the north  
- Insist on state of the art water conserving facilities and equipment for all new industrial or commercial development | Proposed groundwater management information center.  
Aimag governors; proposed regional development coordinating body; MRTCUD  
Line ministries; aimag government | MNET-Water Authority  
GMIC; MNET-Water Authority  
MNET | (continued on next page)
Table 5.1. Summary of Institutional Responsibilities for Impact Management Measures (continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Management measures</th>
<th>Implementation responsibility</th>
<th>Oversight responsibility</th>
</tr>
</thead>
</table>
| Construct one or both water transfer schemes (HGB and OGB) | - Establish a water management agency with commensurate responsibility and authority.  
- Collect adequate data and prepare a comprehensive water resource management plan for Mongolia, with full stakeholder participation. | - Government of Mongolia (MNET to lead)  
- New water management agency | |
| Transport of mine products by road | - Improve road surfaces and thereafter restrict trucks to the improved road lanes.  
- Enforce loading and speed limits, prohibit off-road driving by truckers;  
- Assist residents in relocating homes and herds if dust cannot be mitigated.  
- Long-term fix is to shift most hauling to rail.  
- Enforce dust control measures in EIAs for mines and coal depots.  
- Eliminate transshipment operation at border.  
- Set and enforce hauling schedule that provides for no traffic during hours in which wildlife are most likely to cross the road.  
- Set and enforce regulations against drinking and driving.  
- Make accidents including those involving wildlife reportable safety incidents under mining company rules with disciplinary action as appropriate, including termination for alcohol-related incidents.  
- Require mining and trucking companies to inspect trucks annually and test for compliance with air emission standards. | - Mining companies; MRTCUD  
- Mining companies; police  
- Soum governments; mining companies  
- Mining companies; MRTCUD  
- SSIA officers in aimag centers  
- Government of Mongolia  
- Mining companies; trucking companies; aimag governments; MNET  
- Police at aimag level  
- Mining companies  
- SSIA in aimag centers | - MNET  
- MRTCUD; MNET and SSIA officers in aimags  
- MNET officers in aimags  
- MRTCUD  
- SSIA  
- MNET  
- MRTCUD  
- SSIA  
- SSIA |
| Transport of mine products by railroad | - Need to ensure common rail gauge with China.  
- Need bilateral agreement to allow trains to cross border so that transshipment can be eliminated.  
- To have full positive impact, effective wildlife crossings have to be designed and constructed. | - Government of Mongolia  
- Government of Mongolia  
- MRTCUD | - MNET |

(continued on next page)
### Table 5.1. Summary of Institutional Responsibilities for Impact Management Measures (continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Management measures</th>
<th>Implementation responsibility</th>
<th>Oversight responsibility</th>
</tr>
</thead>
</table>
| Recruitment of miners: Recruitment triples populations of soums surrounding mines by adding 20,000 miners and family members over 15-year period. Mining development triggers population “influx” for additional population growth 20,000 over same period. Combined with recruitment, net effect is five-fold increase of population in soums surrounding mines. | - Local government to enforce basic good practice in constructing new housing, shops, etc.  
- Mining companies planning gated communities for workforce will provide housing and all services. Companies planning integrated communities need to work with local government to arrange for housing. Local government needs to plan for housing for influx population, using five-year projection and monitoring outcomes.  
- Develop new boreholes and provide treatment systems for public supply.  
- Construct treatment works for entire soum population, as on-site systems will not accommodate the larger populations and there are no collection and treatment systems in place now.  
- Poor solid waste management already is having adverse impacts. Construct solid waste collection and recycling/disposal facilities to serve the entire soum populations.  
- Design and operate power and heating plants according to national standards. Coordinate ash disposal with solid waste management.  
- Provide proper storage and treatment/disposal facilities for medical waste and train medical personnel in approved methods.  
- Establish a new coordinating body for sustainable development of SGR. | - Soum government  
- Mining companies and local governments  
- Soum governments  
- Soum governments  
- Soum governments  
- Soum or aimag governments  
- Aimag governments | - Aimag government  
- Aimag government  
- Aimag government  
- Aimag government  
- Aimag government  
- MNET and SSIA officers in aimags  
- MoH; SSIA  
- MRTCUD; MNET, etc. |
| Induced development follows mining and related infrastructure development. | - Update land use plans and enforce compliance.  
- HIV/AIDS awareness and prevention programs. Enforce prohibitions on illegal activity. | - Aimag and soum governors  
- Aimag and soum governors, Ministry of Health officers in aimags, SSIA | MRTCUD |
Institutional Arrangements for Implementation of the REA

officers, and utility operators are some of the new jobs that require new skills. The typically small budgets set by the aimag will need to be increased prior to mining development. Budgets should not be a problem for those soums where mines are located and have begun operating provided a sufficient portion of the mine revenue is allocated to the soum for capital and operating expenses. Tsogt Tsetsii Soum, which contains Tavan Tolgoi coalmine, takes in ample revenue to cover the costs of government operation (personal communication with the Governor, November 2008). However, soums near mines that house some of the miners and experience population influx and induced development do not have that ready source of revenue and will need budget support.

Soum governors and soum citizens representative khurals need to have adequate voice in regional development decisions that affect their jurisdictions. Preparation of regional development plans, review and approval of EIAs for mines and major infrastructure, and issuance of mining permits are centralized functions that do not afford the soums much opportunity to influence outcomes.

Aimag Government

In addition to land use planning and development management activities, the three aimags in SGR have environmental impact management functions that will be important in REA implementation. The aimags are somewhat better equipped than are the soums to undertake their responsibilities, primarily because officers from central ministries are posted there and are provided budgets by their respective ministries. However, in terms of the sheer number of REA-related activities requiring implementation, the aimags have the most challenging task menu. There are significant gaps that need to be filled to enable aimags to fulfill their functions.

The functions listed for the aimags in Table 5.1 are summarized below. Where a function is being carried out by MNET or SSIA staff posted to the aimag and reporting jointly to the governor and their central agencies, it is shown as an aimag function (in contrast to functions performed by MNET and SSIA from their offices in Ulaan Baator).

- Update land use plans and enforce compliance;
- Monitor and enforce implementation of EIAs and mine reclamation plans;
- Enforce compliance with environmental standards, including for quarries and borrow pits during road construction, management of wastes from construction sites, and power plants;
- Enforce power plant emission standards, vehicle emission standards;
- Enforce wastewater treatment plant effluent standards;
- Monitor impacts of mine dewatering and implementation of offsets (replacement wells and springs, replanting of trees, etc.);
- Limit development to that which can be accommodated by available water resources;
- Require state of the art water conservation facilities in new commercial and industrial developments;
- Enforce truck loading and speed limits and restrictions on off-road driving by truckers;
- Enforce dust control measures in EIAs for mines and coal depots;
- Enforce hauling schedules to permit wildlife movement across highways;
- Set and enforce regulations against drinking and driving;
- Require mining and trucking companies to inspect trucks annually for compliance with air emission standards;
- Oversee, advise and facilitate coordination between soum governments and mining companies on issues including housing, municipal services, infrastructure for workforce and influx population;
- Oversee, advise, and facilitate soum governments in providing water supply, wastewater collection and treatment, solid waste disposal for rapidly growing population;
- Provide for proper storage and disposal of medical wastes;
- Implement HIV/AIDS awareness and prevention programs;
Establish a new coordinating body for sustainable development of SGR.

**Capacity and readiness.** The magnitude and range of tasks of aimag governments is huge with the expectations of increasing the probability that mining-based development in SGR will be sustainable and will lead to desirable outcomes for the Region’s natural and human environments and its economy. Advance preparation is essential. The staffing, skills levels, facilities and equipment, and levels of expenditure on environmental management and development management and planning need to be reviewed in each of the three SGR aimags for the present situation and projected for the base-case or high-case scenarios. Adequate resources should be made available in advance of need. In addition, described below are several issues of responsibility and authority that need to be addressed.

**Expanded role in reviewing mining license applications.** Local governments are decisionmakers on land possession. Aimag governors exercise the right to issue land use permits for infrastructure development projects that are in the land management plan approved by aimag citizen representative’s khural. The governors are formally allowed to participate in mine licensing. However, the limited time provided does not allow adequate consultation with soum and aimag citizen representative’s khurals and soum governors. For a mining permit, the aimag governor whose territory contains the proposed site is formally notified by the Mineral Resource and Petroleum Authority of Mongolia (MRPAM) in writing. The governor can organize consultations or public hearings and can reject the application with justification but has only 30 days to respond. Under the Law on Minerals (Article 19.4), MRPAM would consider the application to be approved by the aimag governor if no response is forthcoming within the 30-day period. Aimag governors should be accorded a longer time for review of mine license applications, and a positive or negative reply from the governor concerned should be required prior to MRPAM approval.

**Participation in review of EIA.** Because EIA reviews and approvals are centralized at MNET, the EIA is perceived as an MNE task rather than a tool for decisionmakers. Ideally, approval of EIA reports should include a voice from local administrations since the local administration carries most of the responsibility of implementation of environmentally preferred products and environmental management plans (EMP) included in the EIAs. Moreover, since an applicant for a mine license must submit the EIA with the application (The Asia Foundation, 2007), review of the EIA is an appropriate way for the aimag governor to become involved in a decision on mineral resource development. Currently, the local administration is not involved in decisions on approval of EIAs. This needs to be changed.

**Expanded role in development policymaking and planning.** Another gap is the lack of a framework and systems to ensure that local governments and citizens are consulted in the process of formulating development policies, strategies, plans, and regulations. Policymaking is largely seen to be the realm of the national government, with weak mechanisms to gain informed input or to circulate drafts to key stakeholders or to the general public. The same situation applies to other sectors. Development policy and strategies are often carried out at the national level with little contribution from local administrations including citizen representative’s khurals (councils), even though local authorities are expected to play a significant role in the implementation of these strategies. Much of the land use planning function in Mongolia is centralized in the Administration of Land Affairs, Geodesy and Cartography (ALAGAC).

**Mechanism for inter-aimag coordination in planning.** As explained above, local administrations should be much more involved in EIA and development planning and decisionmaking that affects SGR, including approvals for mines and major infrastructure. There should be a mechanism for coordination of these functions among the SGR aimags when the activities under consideration have implications for the SGR. The proposed regional development planning committee would meet this need, provide it includes private sector and civil society members and has access to the necessary scientific, engineering and planning expertise. The committee would have
formal responsibility to review, analyze, and make recommendations on mine licenses, EIAs, risk mitigation plans, mine closure plans, environmental rehabilitation plans, and all other development projects with potential environmental and social impacts. The aimag governors could chair the committee on a rotating basis.

Ministry of Nature, Environment and Tourism

The functions listed for the MNET at the central level in Table 5.1 are detailed below:

- Design and locate wildlife crossings along railroads and highways, in collaboration with the Academy of Science, conservation NGOs, and other experts;
- Oversee implementation of offsets for degradation of houbara bustard habitat caused by installation of electricity transmission lines;
- Oversee compliance with best available emissions control technology in design and operation of electric power plants, in collaboration with MME;
- Oversee, through the Water Authority, the establishment of the proposed groundwater management and information center to obtain more complete data on groundwater resources in SGR and to serve as the focal point for water resource management in SGR;
- Oversee development of decision making that conforms to the limitations imposed by available water resources;
- Oversee implementation of state of the art water conservation facilities and equipment in new industrial or commercial development;
- Lead the Government in establishing a water management process to develop plans and make decisions on national water resource issues such as north-south transfer of surface water to support economic growth in SGR, perhaps resolving overlapping and unclear

Photo 25: Female houbara bustard photographed during a recent NEMO-Rio Tinto financed survey in SGR

Photo by B. Bayarjargal
mandates that limit the effectiveness of the existing institutions;
- Oversee improvement of main road surfaces in SGR;
- Oversee enforcement of loading and speed limits and limitations on off-road driving by truckers;
- Set hauling schedule that provides for no traffic during hours when wildlife are most likely to cross highways, and oversee enforcement;
- Oversee inclusion of effective wildlife crossings in railways;
- Collaborate with MRTCUD in forming a new development coordinating body in and for SGR.

**Capacity and Readiness**

The MNET plays a key role in management of development impacts through the EIA process. Within MNET, the Department of Environment and Natural Resources is responsible for formulation of EIA guidelines and implementation. It carries out EIA screening, review, and approval, but there are only 7 staff to do this work. It also manages the licensing of consulting companies to prepare EIAs. The MNET Department of Protected Area Management develops policies, action plans, and protected area development proposals and coordinates management of state protected areas in Mongolia. The MNET officers at the aimag level do not have the equivalent authority as their SSIA counterparts to impose penalties and fines. There are fewer MNET officers than SSIA inspectors. The MNET employs 211 rangers at the soum level, working in protected areas. The World Bank (2006) mining sector review stated that monitoring and enforcement in the mining sector was improving, but that effectiveness was constrained by two factors: first, lack of an appropriate structure to ensure the timely enforcement of rules and procedures for local government and land user permissions/contracts, governors’ approval of environmental submissions, and notifications and enforcement of sanctions for license violations; and, second, poor coordination among the MNET, SSIA, and aimag and soum administrative bodies. There is not much of a track record on implementation of environmental management plans and reclamation plans in SGR because there are few mines actually operating. At mines elsewhere in Mongolia, it is common to find failure of the Government to collect the required reclamation deposit (50 percent of the estimated annual cost of reclamation), inadequate reclamation planning, and insufficient attention to the environmental impacts of tailings and waste rock deposits (World Bank, 2006). These problems are more prevalent at operations of domestic mining companies; international companies generally comply with environmental requirements (personal communication, Mongolian National Mining Association, November 2008). Project-specific EIAs, such as the one prepared for Oyu Tolgoi, devote a great deal of attention to mine reclamation and closure, addressing both social and environmental aspects. Mine closure is therefore not considered in detail in the REA.

The EIA has great potential to assist in guiding development in SGR in the direction of sustainability. However, for this to occur, EIA review and approval will need to be less centralized, with greater opportunity for aimag and soum and civil society inputs to the process. In addition, line ministry decisionmaking will need to be better linked with EIA so that MNET environmental management function can have more effect. The MNET staff in the aimags need to be trained and empowered in environmental planning, and MNET will need to be engaged with the proposed SGR development committee, perhaps by providing trained staff to support its work. Clarification of the respective roles of environment officers and SSIA inspectors and better coordination between them and with local government are also desirable.

**Ministry of Roads, Transportation, Construction and Urban Development**

The REA-related functions listed for the MRTCUD in Table 5.1 are detailed below:
- Ensure that railway and highway designs include livestock and wildlife crossings as recommended respectively by Ministry of Food
and Agriculture (MFA) and by MNET and the Academy of Science;

- Assist aimag governors and new regional coordinating body in limiting development in SGR to that which can be sustained by available water resources;
- Improve road surfaces in SGR;
- Oversee enforcement of loading and speed limits and prohibition on off-road driving by truckers, in collaboration with MNET and SSIA officers at aimag level;
- Plan and oversee development of railways to shift most coal hauling from highway to rail, which includes ensuring a common rail gauge with Chinese rail system;
- Lead Government in eliminating trans-shipment of coal at border crossings by allowing trucks and trains to continue into China;
- Oversee implementation of regulations prohibiting drinking and driving;
- Ensure that railroads include effective wildlife crossings;

- Collaborate with MNET in leading the establishment of a new coordinating body for sustainable development in the SGR;
- Oversee and support updating of land use plans for aimags and soums;
- Play a lead role in assessing and meeting needs for strengthened development planning and management capacity at aimag and soum levels.

State Specialized Inspection Agency

The Department of Environment, Geology, Mining and Radiation Inspection is the relevant part of the SSIA for most of the functions involving mining and environmental management. The REA-related functions listed for the SSIA at the central level in Table 5.1 are detailed below:

- Oversee enforcement activities of SSIA inspectors in the aimags, with special attention to implementation of EIA provisions,
dust control in coal hauling, mining company safety programs regarding highway accidents, annual inspections of trucks;
■ Oversee aimag and soum governments’ provisions for proper storage and disposal of medical waste.

**Capability and Readiness**

The SSIA functions do not have to change radically, but the magnitude of its task will grow rapidly with development of new mines, power plants, wastewater treatment plants, landfills, and other industry and infrastructure. At present the Department of Environment, Geology, Mining, and Radiation Inspection has 3 to 5 environmental inspectors in each aimag. There are about 380 rangers employed at the soum level who report to the Aimag Specialized Inspection Unit. They are responsible for reporting illegal activities including unlicensed hunting, littering, and disturbance in local communities. As mining development and related urban development proceeds, SSIA will need to monitor workloads and provide additional trained staff in advance of need.

**Mining Companies and Other Private Sector Entities**

The REA-related functions listed for the mining companies and other private sector entities in Table 5.1 are detailed below:

■ Implement EIA and EMP recommendations;
■ Implement mine reclamation plans;
■ Use quarries and borrow pits approved by local environmental authorities and comply with standards for operation and reclamation;
■ Offset bustard habitat degradation by power transmission lines with improved protection of other habitat;
■ Manage impacts of dewatering; create artificial springs; replace shallow wells with deep wells; offset loss through restoration, enhancement and protection of other springs and wells; monitor condition of trees and irrigate to avoid loss if possible, otherwise plant and protect replacement trees in other locations;
■ Improve road surfaces and thereafter restrict trucks to the improved lanes;
■ Enforce truck loading and speed limits and prohibitions on off-road driving by truckers;
■ Shift hauling from road to rail;
■ Set and enforce hauling schedules that provide for no traffic during hours when wildlife are most likely to cross highways;
■ Make accidents including those involving wildlife reportable safety incidents under mining company rules;
■ Take disciplinary action as appropriate, including termination for alcohol-related incidents;
■ Inspect trucks annually and test for compliance with air emission standards;
■ Work with local communities to arrange for housing where integrated community is the company’s approach;
■ Assist local government in land use planning, infrastructure and municipal service planning to cope with population increases;
■ Support and participate in the establishment of a regional body to coordinate development in SGR.

Miscellaneous functions of other private sector entities are listed below:

■ Construct facilities for livestock and wildlife crossing, according to designs developed by Government—roads and railroad contractors;
■ Use quarries and borrow pits approved by local environmental authorities and comply with standards for operation and reclamation—roads, railroad and utility contractors;
■ Prepare and implement waste management plans and restore areas used for plants, camps, and yards—roads, railroad, and utility contractors;
■ Offset degradation of bustard habitat caused by power transmission lines, with improved protection of other habitat—electric utility companies and their contractors;
■ Comply with best available technology to control emissions; used closed loop cooling systems—electric utilities;
■ Construct and operate ash disposal facility; recycle fly ash where possible—electric utilities;
■ Use low-sulfur coal—electric utilities.
NGOs in the Mining Sector

Mongolian National Mining Association (MNMA). The REA-related functions for the MNMA are detailed below:

- Advocates principles of responsible mining among its more than 100 members;
- Works with environmental NGOs such as Nature Conservancy;
- Lobbies for improved legislation and regulations to promote sustainable mining.
- Emphasizes value of transparency;
- Sees need to improve local government capacity to deal with mining companies.

Responsible Mining Initiative for Sustainable Development (RMI). The REA-related functions for RMI are detailed below:

- Began as a multi-stakeholder forum including industry, government, parliamentarians, and academics, from which have emerged a definition of responsible mining and a list of the principles to be observed in achieving it;
- The forum established RMI as an NGO that would promote transparency, knowledge-sharing, and stakeholder participation.
6. Summary of Recommendations

The Tables 4.2 and 4.3 details the many recommended measures aimed at avoiding or mitigating the potentially negative environmental impacts of mining-centered development in SGR. The recommendations summarized in this final chapter of the REA are for the broader activities, mainly institutional in nature, that need to be carried out in order to support sustainable development and enable effective environmental impact monitoring and management in the SGR.

Strengthening Capacity of Existing Government Agencies

Aimag and soum governments. The most urgent needs are to strengthen the capacities of aimag and soum governments in order to plan for and manage mining-based land development in SGR. This can be accomplished in three steps: (a) needs assessment and action planning, (b) action plan implementation, and (c) financing for initial activities and ongoing operations. Two options exist to begin the process: the needs assessment and planning could be undertaken by an interagency task force led by MRTCUD, or these functions could be the first activities of a new agency, the proposed development coordinating body for SGR. The choice depends in part on how quickly the coordinating agency can be established and made operational.

Ministry of Nature, Environment and Tourism. The implementation activities logically relegated to MNET and observations on some areas of strengthening, though not comprehensive, are reviewed in Section 5.3. The recommended next step for MNET is to establish an internal task force, supplemented if necessary by outside experts, to detail capacity-building needs and develop an action plan. It is likely that more staff are needed in the EIA review division as well as in the SGR aimags to monitor environmental management plan and reclamation plan implementation by mining companies. One action of particular importance, to be undertaken jointly with SSIA, is to improve coordination so that the resources of MNET and SSIA will be used to their best advantage in overseeing management of the environmental and social impacts of mining sector development.

Ministry of Roads, Transportation, Construction and Urban Development. The actions that MRTCUD will need to take in order to implement the REA are covered in section 5.4. The REA process did not include an assessment of the ministry’s capacity to undertake these actions, and it may be that no strengthening is necessary. However, it would be helpful to have an individual or a unit assigned the responsibility of coordinating REA-recommended functions for SGR.

State Specialized Inspection Agency. Collaboration would help to improve SSIA-MNET coordination. It would be wise for SSIA to assign an individual or a unit to monitor workloads in SGR as mining development proceeds, in order to provide early warning of needs for additional staff, training, equipment, or other resources.
Creating New SGR Institutions

Regional development coordinating body. Independently, the REA and the SMIS have recommended the establishment of a new coordinating body for sustainable development in SGR. This body would focus primarily on timely and well-planned provision of the infrastructure necessary to support mining development and to meet related environmental protection and resource management priorities. This will not happen without a champion in the central government. The REA recommends that MRTCUD take the lead, in close collaboration with MNET and the Ministry of Mines and Energy.

Groundwater management information center. The REA and the Groundwater Assessment Study for the South Gobi Region (Acacia Water, 2009) agree on the need for an agency to act as a focal point for information and initiation of new studies essential for a more complete understanding of the potential for SGR groundwater, and to develop guidelines for its sustainable allocation and use. This would help to ensure that groundwater is presented as a single resource and that the full range of prospective uses is considered in allocation decisions. The logical institutional home for this agency is under the oversight of the Water Authority, and MNET should therefore take the lead in setting it up.

Developing Standards and Guidelines

The REA has identified needs for standards and guidelines in several areas. The main ones and the institutions that could logically undertake their development are listed below.

- Designs and standards for effective road and railroad crossings for wildlife, based on international best practice—MNET in collaboration with Mongolia Institute of Sciences, Wildlife Conservation Society, Wildlife Science and Conservation Center, and MTRCUD.
- Designs and standards for effective road and railroad crossings for livestock—MNET in collaboration with Ministry of Agriculture and MTRCUD.
- Determine hauling schedules and speed limits to minimize disturbance to wildlife in critical areas—MNET in collaboration with Mongolian Academy of Sciences, Wildlife Conservation Society, Wildlife Science and Conservation Center, and MTRCUD.

Improving Mine Permit and EIA Procedures

Local and regional government participation in mine permit issuance. Issuance of mining permits needs to be more closely linked to decisionmaking on land use and infrastructure decisionmaking, given the demands for housing, municipal services, and infrastructure that the new mines will impose. The process should also allow for deliberation at the proposed development coordination agency that the REA and SMIS have recommended. The 30-day period allowed for permit application review by the aimag governor needs to be extended to 60 or even 90 days, to allow adequate consultation with soum and aimag citizen representative’s khurals and soum governors and, if desired, public meetings or hearings. Ministry of Minerals and Energy should take the lead in amending the mining permit application, review, and approval procedure.

Decentralization and wider participation in EIA review. Since an applicant for a mine license must submit the EIA with the application (The Asia Foundation, 2007), review of the EIA is an appropriate way for the aimag governor to become involved in decisionmaking on mineral resource development. Currently, the local administration is not involved in decisions on EIA approval, and the review process is seen as a centralized function of MNET. The MNET needs to modify the procedures to provide for parallel reviews by the affected aimag and soum governments (and/or the proposed regional development coordinating body) and to incorporate a requirement that MNET approval not be issued until the relevant aimag and soum governors have provided their views on the proposed project and their recommendations for EIA approval, request for specified revision by applicant, or rejection.
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