EXECUTIVE SUMMARY

OF THE

ENVIRONMENTAL ASSESSMENT

FOR THE

SHANXI COAL BED METHANE

DEVELOPMENT AND UTILIZATION PROJECT
<table>
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<th>Acronyms</th>
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<tr>
<td>BOP</td>
<td>Blow-out Preventers</td>
</tr>
<tr>
<td>CO$_2$</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CBM</td>
<td>Coal Bed Methane</td>
</tr>
<tr>
<td>CMM</td>
<td>Coal Mine Methane</td>
</tr>
<tr>
<td>CNG</td>
<td>Compressed Natural Gas</td>
</tr>
<tr>
<td>CTU</td>
<td>Central Treatment Plant</td>
</tr>
<tr>
<td>DP</td>
<td>Displaced Persons</td>
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<tr>
<td>EA</td>
<td>Environmental Assessment</td>
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<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>EMP</td>
<td>Environmental Management Plan</td>
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<tr>
<td>EPB</td>
<td>Environmental Protection Bureau</td>
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<td>GGS</td>
<td>Gas Gathering Station</td>
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<td>GHG</td>
<td>Green House Gas</td>
</tr>
<tr>
<td>LNG</td>
<td>Liquid Nitrogen Gas</td>
</tr>
<tr>
<td>NCBPC</td>
<td>North China Branch of Petro China</td>
</tr>
<tr>
<td>RAP</td>
<td>Resettlement Action Plan</td>
</tr>
<tr>
<td>SECBMIH</td>
<td>Shanxi Energy Coal Bed Methane Investment Holding Company Ltd.</td>
</tr>
<tr>
<td>SEPA</td>
<td>State Environmental Protection Agency</td>
</tr>
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<td>Shaxi EPB</td>
<td>Shanxi Environmental Protection Bureau</td>
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<tr>
<td>SO$_2$</td>
<td>Sulfur Dioxide</td>
</tr>
<tr>
<td>STP</td>
<td>Standard Temperature and Pressure</td>
</tr>
<tr>
<td>TA</td>
<td>Technical Assistance</td>
</tr>
<tr>
<td>TOR</td>
<td>Terms of Reference</td>
</tr>
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<td>WHO</td>
<td>World Health Organization</td>
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1. Summary of Environmental and Social Documents Prepared for the Project

This executive Summary is a synthesis report of the salient points of the various environmental and social safeguards documents for the Shanxi Coal Bed Methane Development Project. The full details of the Project Description are outlined in Chapter 2 of this document but Table 1.1 illustrates the three distinct sections of the project area with their corresponding set of environmental safeguards documents. Whereas Table 1.2 below shows the same for the social safeguards documents

<table>
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<tr>
<th>Project Section</th>
<th>Source of Finance</th>
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<tr>
<td>Zheng 6 Block consisting of 350no. vertical CBM production wells, 3 Gas Gathering Station(GGS), compressors, 150.6 km pipeline (15.6km collecting feeder line+ 135 km gas recovery pipeline), 1 gas metering and pigging station, wastewater treatment plant, 11.7 km station entrance roads and 57 km well entrance roads</td>
<td>This project</td>
<td>Environmental Assessment Volume I</td>
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<tr>
<td>The Central Treatment Unit (CTU).</td>
<td></td>
<td>Due Diligence Environmental Audit Report (Vol. IV).</td>
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<td>20km pipeline from Zheng 6 GSS-to-CTU, approx. 2-3 km pipeline Fanzhuang Coal Bed-to-CTU.</td>
<td></td>
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<td>Liquid Nitrogen Gas (LNG) Plant.</td>
<td></td>
<td></td>
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<tr>
<td>1.434 km Gas pipeline from CTU-to-LNG plant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1.1 Environmental reports Prepared and Disclosed by Project Appraisal

<table>
<thead>
<tr>
<th>Project Section</th>
<th>Source of Finance</th>
<th>Social Documents Prepared and Disclosed before Project Appraisal</th>
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<tr>
<td>Zheng 6 Block consisting of 350no. vertical CBM production wells, 3 Gas Gathering Station (GGS), compressors, 150.6 km pipeline (15.6km collecting feeder line+ 135 km gas collection pipeline), 1 gas metering and pigging station, wastewater treatment plant, 11.7 km station entrance roads.</td>
<td>This project</td>
<td>Resettlement Action Plan (RAP)</td>
</tr>
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<td></td>
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</tbody>
</table>
Table 1.2 Social Reports Prepared and Disclosed by Project Appraisal

This executive summary draws from the various environmental and social reports listed in the tables 1.1 and 1.2 which can be referred to for additional details.

The CTU and the pipe line from the 6GSS at Zheng 6 to the CTU are not financed by this project but are being independently financed and built by the North China Oilfield Branch of Petrochina (NCBPC). These two investments will be built whether or not this project is implemented and they do not in anyway rely on this project for their functionality. However, the reverse is required for this project. That is, this project is directly dependent upon the CTU and the pipeline from the 6GSS at Zheng 6 to the CTU for its functionality. Furthermore this project is strategically located to enhance connection to these facilities to ensure the economic viability of this project. Therefore, this project was designed to be physically linked to these investments to ensure the objectives of this project are met. As a result, as per World Bank OP4.12, these activities are considered as “linked” requiring that the Bank team preparing this project undertake a due diligence approach to examine how the environmental and social issues are being managed by the NCBPC.

The preparation of the EIA for linked 20km pipeline project from Zheng 6 Station to the Central Treatment Unit is underway. The EIA report was expected to be completed by end March 2008 and submitted to Shanxi Provincial Environmental Protection Bureau in April 2008, and Shanxi Provincial Environmental Protection Bureau is expected to complete project examination and approval by May 2008.

Whereas, in June 2007, the EIA for the CBM Central Treatment Unit was commissioned by PetroChina North China Oilfield Branch to Taiyuan University of Technology EIA Center (guo huan ping zheng yi zi No. 1313), and this EIA is already completed and Shanxi Provincial Environmental Protection Bureau issued its examining and approving opinions on September 13, 2007.

The Due Diligence Environmental Audit Report (Vol. IV) presented in Table 1.1 above reports inter alia, on the issues contained in the EIA’s for these linked project activities.
2. Detailed Project Description

Project Development Objective. The development objective of the project is to increase the production and utilization of CBM/CMM to replace coal as a fuel for thermal use and to reduce air pollutants associated with coal combustion. The project development objective will be achieved by (a) enhancing the sub sector’s policy framework and institutional capacity, and (b) supporting the exploration, production and liquefaction of CBM to increase market access.

Key Performance Indicators. The key performance indicators of the achievement of the development objective will be measured by the increased volume of CBM/CMM produced and utilized and associated reduction of key air pollutants (CO₂, SO₂ and particles) compared to the baseline in Shanxi province. The main intermediate outcomes for the proposed project are: (a) the quantity of CBM produced and LNG sold directly from the project’s investment; (b) new sub sector policies, rules and standards developed and implemented, and new methodologies to assess CBM/CMM resources and evaluate utilization options developed.

Project components

The project is comprised of an investment and a technical assistance (TA) component.

Investment Component (base cost US$178.6 million): The investment component would include: (i) the exploration and development of about 350 vertical CBM production wells with an estimated annual production capacity of 250 million Nm³; (ii) the construction of about 135 km of gas collection pipelines, three CBM gathering stations and about 15.6...
km of gas transmission pipeline to collect the CBM from each well and transport it to the LNG plant; and (iii) the construction of a LNG plant consisting of four modular, transportable liquefaction plants with individual production capacities of 50,000 tons/year for an ultimate processing capacity of 200,000 tons/year.

The project entity will not be engaged in the retail distribution and end-user segment of the market. Instead, the LNG produced will be sold to a large gas company at the plant site through a long-term wholesale contract. The buyer company will be responsible for transporting the LNG, re-gasifying it at the consumption points and retailing gas to residential, commercial and industrial users.

Technical Assistance Component (base cost US$1.96 million): The technical assistance component includes two sub-components: (i) a program to assist the project entity in developing its capacity to construct and operate the facilities efficiently and safely, and to expand business activities in the area of CBM/CMM development to achieve long-term financial sustainability; and (ii) a program to assist the key stakeholders in Shanxi province to enhance their institutional and technical capacities for policy making and implementation in order to scale up the CBM/CMM industry in Shanxi.

Therefore to summarize, the project consists of three very different activities;

- The first activity is the production of coal-bed methane (CBM) from a coal seam more than 800m below the surface.
- The second activity is the 20km pipeline transferring the CMB to the LNG plant via the CTU.
- The third activity is an LNG plant that converts the CBM into LNG, and which is then sold to a distributor (who ships the LNG by truck to his customers in nearby towns and small cities).

3. The Legal and Regulatory Framework for Safeguards Management of the Project

Environment

The Environmental Protection Law of the People’s Republic of China, the Shanxi Provincial Regulation on Environmental Protection and other state, provincial and county laws requires that this project and the linked activities financed by NCBPC, undertake an Environmental Assessment which would have to be reviewed and approved by the State Environmental Protection Agency (SEPA) and the Shanxi Environmental Protection Bureau (Shanxi EPB).

Similarly, with regards the World Bank’s safeguards policies, the activities to be funded by this project and the linked activities have all been screened against the World Bank safeguards operational policies and it has been agreed that only the following policies have been triggered by the project;

- Environmental Assessment OP4.01
• Involuntary Resettlement OP4.12

Environmental Assessment OP4.01 contains the Bank’s policy requiring projects proposed for financing to conduct environmental assessment to ensure their environmental sustainability and to improve decision making. In compliance with OP4.01, this project has been given an EA classification of “A” thereby requiring a full environmental analysis and the preparation of environmental assessment report and corresponding Environmental Management Plan.

With regards the Involuntary Resettlement OP4.12, the World Bank outlines its policy and procedures for management of and compensation to project affected households and persons who are subject to involuntary resettlement on Bank financed projects and also on activities linked to bank projects. This policy requires the preparation of the necessary Resettlement Action Plans.

OP4.12 also states the Bank’s policy on and conditions for determining activities linked to Bank financed projects.

Clause 4 of OP4.12 states that this policy applies to all components of the project that result in involuntary resettlement, regardless of the source of financing. It also applies to other activities resulting in involuntary resettlement that in the judgment of the Bank, are

(a) directly and significantly related to the Bank-assisted project,
(b) necessary to achieve its objectives as set forth in the project documents; and
(c) carried out, or planned to be carried out, contemporaneously with the project.

4. The Salient Environmental Features of the Project Area

The project area is located in Southeast Shanxi Province, China.

Shanxi Province is the largest coal producer among all provinces in China, with a coal production of 691.9 million tons in 2006, nearly one-third of the nation’s total production. Shanxi is estimated to have the largest coal bed methane (CBM) resource amounting to about 10 trillion m³. The CBM production is just around 100 million m³ in 2006 and only half of the produced CBM is being used.

The CBM production area, the transmission pipeline and the LNG Plant are all located in Quinshui County. The CBM production area which is known as the Zhengzhuang block is about 13km long from east to west and 4.4km to 6.1km wide from North to South, covering an area of about 49km².

Geology
Qinshui Basin is located in the central –southern part of Shanxi Province and is surrounded by hills formed between the Lower Proterozoic to the Paleozoic periods. The inner parts were formed between the Carboniferous to Permian and Triassic periods. Scattered parts of the central region were formed during the Jurassic period, showing a typical synclinal basin characteristic. The basin is typical of the basin structure that has taken shape during the Mesozoic period.

Climate and Weather

The project area is located in the region that has a temperate monsoon climate. The complicated topography results in a wide variation in the weather throughout the region. It is characterized by long winters and short summers; rain in hot seasons, strong monsoons, dry and windy springs with frequent droughts, summers with uneven heat and rains, warm falls with rainy days and cold winters with rain and snow. The average altitude is between 700m to 1300m, average relative humidity is 64% and extreme minimum and maximum temperatures are -18.7degrees and 37.4degrees respectively.

Hydrology

Surface water

The main surface water system consist of two rivers, namely the Qin River and the Qinshui River, both of which are part of the Qin River tributary which is part of the Yellow River system. The Qinshui River is an upstream tributary of the Qin River. The section of the Qin River in Qinshui County is about 82km long.

Ground Water

According to the geological conditions, landforms and from testing, the ground water in the region can be categorized into three types.

- The Ground water in the low mountains and hills can be formed at depths ranging from 30m to 60m below the surface.
- The Ground water in valleys – refers mainly to the phreatic water of quaternary alluvium in the valleys. It is distributed in the flood plains and terrace district in major rivers and their branches.
- Confined ground water is mainly buried in the gravel and leaf rock stratum.

Emissions of Green House Gas (GHG) and Air Quality

The rapid increase in energy production and consumption, and their primary reliance on coal has contributed to China’s severe air pollution. In particular, the combustion of bituminous coal is causing serious atmospheric pollution from air-borne particulates, emissions of sulfur dioxide (SO₂) and carbon dioxide (CO₂). Currently, China’s emissions of SO₂ and CO₂ are respectively the highest and second highest in the world.
China is projected to have the largest absolute growth in CO₂ emissions between now and the year 2020. In addition, the production of coal is estimated to result in the release of 18 billion m³ (270 million tons CO₂ equivalent) of methane into the atmosphere in 2005, about 43% of the global methane release associated with coal mining and will rise to more than 50 percent by 2020 if no serious actions are taken. China’s effort to curb emissions of GHGs is paramount to mitigating Climate Change. About half of the Chinese cities, particularly northern cities, do not meet China’s own air quality standards because of PM10 levels in excess of 100 µg/m³ – twice the World Health Organization (WHO) health standards. Ambient PM10 levels in the project area are also in excess of these standards. The main culprit of the high concentration of PM10 in the atmosphere is the direct combustion of coal by industry and households at near ground level to meet fuel and heating needs. The indoor air pollution caused by the use of coal products at households is a key cause for the large number of preventable premature deaths and respiratory diseases.

Land Use

The project area is part of the secondary shrub-grassland regions and the deciduous broad-leaf forest belt. This natural forest cover has been mostly depleted and most of the land where possible is used for plantations and the rest for agricultural farming.

5. The Significant Environmental Impacts and there Proposed Management

In this section is a very brief and concise summary of the main and significant impacts associated with this project and its linked activities, written to give the reader a broad sense of the nature of these impacts and how the project proposes to address them. For a more detailed review of all of these issues, the reader is referred to the individual EIA reports and the other project documents.

5.1 Zheng 6 Block consisting of 350 no. vertical CBM production wells, 3 Gas Gathering Station, (GGS), compressors, 150.6 km pipeline (15.6km collecting feeder line+ 135 km gas recovery pipeline), 1 gas metering and pigging station, wastewater treatment plant, 11.7 km station entrance roads and 57 km well entrance roads. (Supported by Bank – Financed Project)

The major significant environmental challenges during operation of the well fields are associated with management of the waste water produced by and collected from the wells during collection of the methane gas. To ensure the waste water does not pollute any land and/or water resources, the design proposes to install an adequately sized waste water treatment plant at a nearby location whereby the concentrated stream from the gas wells will be conveyed for temporary storage in an on-site evaporation tank. Once waste water reaches the designated water level, the tank will be transported by trucks to the waste water treatment facility. The sludge will be removed periodically from the tank and dried and sent to the approved landfill. The treated waste water will then be tested and when it
meets the local Chinese Integrated Wastewater Discharge Standard (Class I, GB8978-1996) and the Irrigation Water Quality Standard (GB5084-92), it will be discharged to the nearby Qin River, or will be used for irrigation.

During construction/drilling of these wells, in addition to the usual impacts such as noise and spoil disposal to name a few, that are normally associated with most construction activities and can be effectively mitigated through adoption of readily available measures incorporated into the civil works contracts, two additional but significant concerns that need special attention arise out of the methods used to drill these wells. These two issues are (i) management of drilling mud and (ii) the possibility of contaminating/polluting the aquifers that are passed through during drilling.

To effectively manage the drilling mud which contains chemicals used to facilitate the drilling process requires that an on-site sedimentation tank for each well be excavated prior to start of drilling. The sedimentation tank is then to be lined with a thick gauge PVC cover material. The drilling process involves re-cycling of the drilling mud to ensure efficient use of the drilling chemicals. Therefore, the design requires that the drilling mud be re-cycled through the lined sedimentation tank throughout the drilling process which will lead to the settlement of the sediments in the drilling mud to the bottom of the lined sedimentation tank as the process continues. At the end of the drilling process, the sediments at the bottom of the lined sedimentation tank will be dried out aided by an approved solidifying agent and then wrapped and sealed in the same PVC material used to line the sedimentation tank before it is buried in the excavated trench that was the sedimentation tank.

With regards preventing contamination and pollution of aquifers passed through during drilling, each well that is to be drilled will be pre-lined with steel casing tubes for their entire depth before any chemical agents are applied in the drilling process. These casing tubes remain in place during the operational life of the CBM wells.

During construction of entrance roads, these would be usual impacts such as noise, dust level, vegetation damage, spoil disposal that are normally associated with most construction activities. These impacts can be effectively mitigated through adoption of readily available measures incorporated into the civil works contracts.

5.2 The LNG Plant (Supported by Bank – Financed Project)

The operation of the LNG will effectively have to manage, (i) hazardous solid waste, (ii) waste water produced from the process of liquefaction and (iii) the air emissions from the furnace during the heating process. These are the most challenging and significant issues.

The solid wastes generated in the operation stage include spent molecular sieves and spent activated charcoal impregnated with sulfur. Containers and packages of hazardous waste will be carefully labeled as such and located at the LNG site. Also well as facilities and places associated with the collection, storage, transport and disposal of hazardous waste will contain identification as hazardous waste facilities. Hazardous waste will thus
be properly classified and separated for collection and storage. The collection, storage, transportation and disposal of incompatible or untreated hazardous waste is prohibited. Parties and companies will be licensed to engage in the collection, storage and disposal of hazardous waste. Providing or entrusting hazardous waste to units or parties not licensed to engage in the collection, storage and disposal of hazardous waste will be strictly prohibited.

Spent activated charcoal is to be returned to the manufacturer (Nanjing woods chemical industry limited). Nanjing woods chemical industry limited is qualified to purchase and handle used activated carbon (with professional recycling department and qualifications certified by the Nanjing Environment Protection Bureau). The treatment process: the spent activated charcoal will be heated in a dedicated container for de-sorption of mercury from the active carbon. Mercury and active carbon will be recovered. The treatment process will not cause secondary pollution or pollution transfer to the environment.

The spent molecular sieves (non-hazardous waste) would be collected and sent to Jincheng Solid Waste Treatment Center landfill.

The process of dealing with the waste water will be similar to that described above for the CBM wells. That is, the waste water will be treated via water treatment plant whereby the sludge will be dried and disposed of at an approved landfill and the waste water will continually be treated until it meets local classifications and standards before it is eventually discharged into nearby rivers.

With regards the emission of gases into the air, the concerns are mostly with NOx concentrated in smoke from the furnace as shown in tables 5.1 and 5.2 below,

**Table 5.1 Overview of atmospheric pollutants**

<table>
<thead>
<tr>
<th>Item</th>
<th>Volume of smoke (10⁶Nm³/a)</th>
<th>Pollutants</th>
<th>Concentration (mg/Nm³)</th>
<th>Volume (mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace 10 million K</td>
<td>12000</td>
<td>Smoke</td>
<td>40</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOₓ</td>
<td>400</td>
<td>48.0</td>
</tr>
</tbody>
</table>

**Table 5.2 Pollution source and emission parameters**

<table>
<thead>
<tr>
<th>Pollution source</th>
<th>Volume of smoke (Nm³/s)</th>
<th>Height of chimney (m)</th>
<th>Diameter of chimney (m)</th>
<th>Emission volume of pollutants (g/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace</td>
<td>4.17</td>
<td>25</td>
<td>0.4</td>
<td>Smoke: 0.166, Nox: 1.66</td>
</tr>
</tbody>
</table>

The appropriate mitigation in each case will first be applied through the engineering design process by the feasibility design consultant.
Ensuring re-use of the waste heat from the furnace for heating will in turn reduce energy consumption and lead to reduce emissions and the height of the chimney for the emission of smoke from the furnace will be increased to at least 25 m-tall to ensure compliance with local emission standards.

Construction impacts associated with construction of the LNG plant are mainly associated with erosion and stability issues with temporary roads in fairly hilly areas to access the site, noise and dust levels, and waste management issues from the construction camps. These are being adequately addressed through implementation of detailed environmental management plans.

5.3 Pipeline Project from Central Gas Treatment Station to LNG Plant (Supported by Bank – Financed Project)

This pipeline is approximately 1.434km long and will be laid underground (please confirm). The impacts will mostly be due to land acquisition, changes in land use and construction issues. These have all been taken into account during the analysis of alternatives stage undertaken as part of the EA process. Originally, the two schemes considered were;

Scheme 1: Pipeline passes between Shuiquanze and Yanggelang and has a length of 1.434km.
Scheme 2: Pipeline is to be laid from the western Jinfeng Village and has a length of 5km.

Table 5.3: Comparison on Pipeline Schemes

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme 1</th>
<th>Scheme 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>1.434km</td>
<td>5km</td>
</tr>
<tr>
<td>Temporary land occupation</td>
<td>0.57hm²</td>
<td>2.0hm²</td>
</tr>
<tr>
<td>Highway crossing</td>
<td>Crossing highway at 1 site, with a crossing length of 10m</td>
<td></td>
</tr>
<tr>
<td>River crossing</td>
<td>Crossing river at 1 site, with a crossing length of 120m</td>
<td></td>
</tr>
<tr>
<td>Scheme recommended and chosen</td>
<td>Scheme 1</td>
<td></td>
</tr>
</tbody>
</table>

In terms of pipeline length, Scheme 2 involves much longer length and much greater investment than Scheme 1; the land area occupied by Scheme 2 is 3.5 times that by Scheme 1; both schemes have the same river and highway crossing length and frequency. From the perspective of environmental protection, Scheme 1 was recommended and chosen.

5.4 The Central Treatment Unit (CTU). – A linked activity Financed by North China Oilfield Branch of PetroChina Company Ltd (NCBPC) but considered linked to this Project.
Based on the review of *EIA Statements on the Construction Project of Qinshui Basin CBM Central Treatment Plant* prepared by Taiyuan University of Technology EIA Center (guo huan ping zheng jia zi No.1313) as contained in the Environmental Due Diligence Audit Report, the major environmental impacts and their proposed management of this project component are as follows:

**Impact of Atmospheric Pollution**

The pollutants are caused by the dehydration plant during the operation period, the heating boiler room, boiler room during emergency repairing, gas discharged through use of fuel gas and the smoke discharged by the flare and venting system are a tiny amount of soot and NOX, and these emission concentrations are far below the control index and has little impact upon the atmospheric environment.

**Impact of Water Pollution**

The industrial effluent and domestic sewage produced during the operation period, after being collected, enter the integrated oil and water separating device and an underground sewage treatment facility respectively for treatment. After its quality reaches Standard Grade I pursuant to Comprehensive Effluent Discharge Standards (GB8978-1996), the treated water will be used for greening or sprinkling for dust control.

**Impact of Solid Waste**

Solid wastes mainly include waste residue from pigging, sludge from effluent treatment and domestic garbage. The waste residue from pigging will be transported to specified sites for landfill treatment; the sludge after being dried out, will be transported together with the domestic garbage to Dunshi Town for treatment together with the local domestic garbage.

**5.5 20km pipeline from Zheng 6 GSS-to-CTU - A linked activity Financed by North China Oilfield Branch of PetroChina Company Ltd (NCBPC) but considered linked to this Project.**

The EIA for this pipeline is currently under preparation and is being finalized. The review done of the draft EIA as reported in the Environmental Due Diligence Audit report confirms that any lasting significant environmental impacts of this pipe line is being avoided through careful routing as part of the analysis of alternative exercise being undertaken as part of the EA process. That being the case, the remaining significant issues will be those associated with the construction of the pipeline, the land use changes along the selected route and the resettlement issue associated with the land acquisition process. The EMP will address the construction issues, the land use changes will be minimized to the areas immediately adjacent to either side of the pipeline with the corridor being kept to a minimum and the land acquisition issues are being addressed through the resettlement action plans.

**6. Analysis of Alternatives**

The project design through the environmental assessment process has undergone a repeated and iterative process by considering various options in the engineering design to take into account the intensity of the potential adverse environmental impacts of the proposed activities, site selection and corridors of various parts of the project activities,
location of sensitive environmental areas, environmental design standards and specifications, operational efficiencies, safety and implications for costs.

These have included alternative treatment processes for the CBM produced waste water, alternative gas gathering station sites, construction methods for CBM wells, alternative LNG sites, and alternative routes for the various pipelines.

7. The Environmental Management Plan

Detailed Environmental Management Plans for all project components have been prepared which will be implemented in all stages of the project implementation, from design stage, through construction to operations and maintenance stage. The form of the EMP's reflects the requirements of World Bank Environmental Assessment OP4.01 Annex C. The matrices include detailed descriptions of the impacts and the required corresponding mitigating measures, monitoring plan with monitoring indicators, timing and institutional arrangements for implementing the mitigation measures and for monitoring. The EMP’s budget estimate of US$300,000 will be included into the project costs. These costs include the cost for monitoring and for capacity building and training measures to implement the EMPs. The cost of implementing the mitigation measures themselves are not included in the EMP costs stated above, but will be estimated by the feasibility design engineers and included in the budget for the civil works.

8. Institutional Arrangements

The EIAs have been reviewed by the Shanxi Environmental Protection Bureau and are expected to be approved in April 2008. The construction stage mitigation measures in the EMP will be implemented by the civil works contractors during construction, and will be monitored primarily by the supervising engineering consultant, the local Environmental Protection Bureau (EPB) monitoring stations and the client SECBMIH. EMP mitigation measures for all other stages will be designed on behalf of the client, SECBMIH, and monitored by the local EPB.

The Local EPB and the client have adequate in-house capacity to undertake the required monitoring as stated in the EMP's and the EMO budget includes costs for recruiting additional consultants during periods of intense activity and for access to private laboratories.

9. The Resettlement Action Plans

Project Background

The proposed Project consists of three components: (1) gas exploration and operation; (2) gas collection and transmission; and (3) a LNG plant, which are located in Qinshui County, Shanxi Province. The construction of these components would involve certain amount of permanent land acquisition and temporary land occupation. No house
demolition and relocation are expected. Following the Bank policy on involuntary resettlement, a resettlement action plan (RAP) was prepared based on detailed impact survey and compensation policies. The socio-economic survey indicated that there are no ethnic minority villages in the project areas, and the Bank Policy on Indigenous People is not triggered.

Linkage Component

The collected gas will be transported to LNG Plant through a 20km-long gas pipeline and a Central Gas Treatment Plant, which will be built by North China Branch of Petro China (NCBPC). The construction of these two components will involve permanent acquisition of 200 mu (13.3 ha) of land areas, and temporary occupation of 120 mu (8 ha) of land areas, which will affect a total of 65 households and 214 persons from 11 villages, including 22 households and 72 persons affected by permanent land acquisition. Since these two components are directly linked to the proposed Project and will be constructed at the same timeframe, they are considered as linkage project. To ensure that implementation of land acquisition for linkage project follows both national law and provincial regulations and complies with the Bank policy on involuntary resettlement, a resettlement plan with same compensation policies and rehabilitation measures has been prepared and included in the RAP. Based on current practice of NCBPC on related projects and adopted procedures and compensation policies, the task team is confident that implementation of land acquisition for linkage project will comply with the Bank policies and national laws, and basic interests of affected people will be protected.

Scope of Impact

For the proposed Project, about 671 mu or 44.7 ha of land areas would be acquired permanently and 1521 mu or 101 ha of land areas would be occupied temporarily. Among them, less than one quarter would be farmland. Such land acquisition or occupation would affect 333 households and 1,131 persons in 8 villages from Zhengzhuang Town and Duanshi Town in Qinshui County, with 107 households and 366 persons affected by permanent land acquisition. Although limited land acquisition will result in a reduction of only 0.9 percent of farmland among these villages, they will have certain impacts on those directly affected households, causing reduction of 14% of their average land holdings. Due to relatively large land holding among affected villages (3.2 mu per capita) and limited land acquisition (163 mu), the overall impacts of land acquisition would be limited.

Compensation Policies and Rehabilitation Measures

To mitigate such impacts, adequate compensations will be provided based on national laws and provincial regulations. For acquired farmland, the compensation is set at 27 times of average annual output value (AAOV) in the past three years for the acquired land or Y29,500 per mu.\(^1\) For acquired woodland and waste land, compensations are set

\(^1\) The compensation for farmland is considered as quite generous since minimum multiples required by the state are 16 times of AAOV.
at Y6,000 per mu and Y5,458 per mu respectively. Such compensation will be paid directly to affected villages or village groups. The affected people will be provided replacement farmland through reallocating village reserved lands or redistributing farmland within affected village groups, so that their land holding could be restored into levels before land acquisition. Along with land readjustment, a large portion of land compensation will be distributed equally among village members in order to improve their farming condition and increase or restore their incomes.

For temporary land occupation, the affected households will be provided with adequate compensation for the lost yield during occupation, which is set at Y1,400 per mu for farmland and Y700 per mu for non-farmland. Following construction, the project owner will be responsible to restore affected land areas into their original productive conditions, otherwise a land reclamation fee will be provided.

Cost Estimate

The total costs of land acquisition and resettlement are estimated to be Y83.79 million, of which Y73.81 million for permanent land acquisition and Y4.21 million for temporary land occupation. Among total cost, the compensations paid to the affected farmers would be Y11.84 million. The land acquisition and resettlement will be implemented in two years. The cost estimate for land acquisition includes provision of contingency set at 5% of total amount of compensation cost.

Implementation Arrangement

The resettlement implementation responsibilities belong to the project sponsor and local governments. A resettlement office has been set up within SECBMIH, which are responsible for coordinating overall resettlement planning and implementation. They will work closely with Qinshui County resettlement office located in conducting site survey, organizing consultation, developing and implementing RAP, managing and allocating the resettlement funds, signing compensation agreements with relevant villages, and being a main channel of grievance for the resettlers. In the affected townships, resettlement working teams will be set up, which will work closely with the county resettlement offices for implementing the RAP.

The proposed compensation policies and rehabilitation measures are based on extensive consultation with affected villagers; and a resettlement information booklet in local language will be distributed to affected villages prior to implementation. A well defined grievance redress mechanism will be established through the Project PMO, and an external monitoring agency would be appointed to monitor the resettlement implementation process, including implementation of land acquisition for linkage project.

10. The Safety Management Plan

The project involves the production, transmission and liquefaction of CBM and the storage and transportation of LNG, which possesses similar characteristics as
conventional natural gas, and is explosive and easy to catch fire. Efficient and Professional safety management is vital for the project during construction and operation.

Properties of CBM and LNG vapour

CBM is lighter than air and disperses rapidly in the open air. It is colorless, odorless and non toxic. CBM consists of around 98% methane with small concentrations of higher hydrocarbons, nitrogen, carbon dioxide and other trace gases. It has similar properties to conventional natural gas. Methane is an asphyxiant when it is present in sufficient quantities to displace air. When methane (CBM) is diluted in air to a concentration in the range 5-15% the mixture is flammable, and explosive if confined. CBM is classified as a category I high risk chemical product in government of China regulations.

Properties of LNG

LNG is natural gas that has been processed to remove impurities and heavy hydrocarbons and then condensed into a liquid at atmospheric pressure by cooling it to approximately minus 160 degrees Celsius. LNG occupies about 1/600th the volume of natural gas at standard temperature and pressure (STP), making it more cost efficient to transport by tanker over long distances where pipelines do not exist.

Transport requires specially designed tankers and storage requires cryogenic tanks. The primary advantage of LNG compared to Compressed Natural Gas (CNG) is that it can be stored at a relatively low pressure (0.13-1.0MPa) at about one-third the volume and one-third the weight of an equivalent CNG storage tank system. The disadvantage is the need to deal with the storage and handling of a cryogenic (-160°C) fluid during transport and storage. LNG is odorless, colorless, non-corrosive, non-combustible, non-toxic and clean. If exposed to air, it quickly vaporizes back to its gaseous state and, since it is lighter than air, will rise under normal atmospheric conditions. LNG leaves no polluting residue after vaporizing.

General explosion hazards of CBM and LNG

If exposed to air, LNG is very difficult to ignite. The gas vapor will only burn if it is between 5 percent and 15 per cent concentration in air and an ignition source is present. Should any LNG vapor be ignited, the products of combustion are carbon dioxide and water vapor which are not harmful to humans in normally ventilated conditions. Storage facilities are designed to exclude ignition sources from hazard zones and personnel are not permitted to operate any devices which could conceivably ignite gas within theses areas.

Health issues

The principal constituents of CBM, namely methane, ethane and propane are not considered to be toxic. The carbon dioxide component is potentially toxic but its low concentration and ventilation precautions obviate this as a significant hazard.
Blow-out and ignition risk during CBM production

The main safety issue during CBM exploration and production is the possibility of a blow-out during drilling. Such events occur when drilling into strata where the gas pressure exceeds the hydrostatic pressure of the mud column in the borehole or where rapid inflows of gas dilute the mud flush, reducing its density as the fluid rises up the borehole. A blow-out can release large volumes of methane at the surface which could ignite if allowed to contact an ignition source. Where a blow-out risk is deemed to exist, for instance when drilling for natural gas, blow-out preventers (BOP) are fitted which enable a well to be rapidly shut-in to contain an emission.

CBM and natural gas exploration and production drilling operations face significantly different magnitudes of risk but these are not clearly differentiated in safety regulations. While there is a regulatory requirement for CBM wells to be fitted with a BOP, in practice this is not done as CBM wells tend to be much shallower than natural gas wells and coal seams in China are generally under-pressured so the blow-out risk is negligible. Over 400 surface CBM wells were drilled in China from 1995-2004 and a similar number have been drilled in the project area in recent years. There have been no reported blow-outs at any of these wells.

Legal framework and safety management of CBM production

China has a comprehensive array of laws, regulations and rules to guide the safe design and operation of natural gas wells. Technical standards and codes governing the design and operation of CBM wells are also available. These standards and rules have been prepared in accordance with best international practices and the actual conditions in China. If they are followed strictly, they will provide good guidance and instructions for safety management of CBM well drilling and production.

Linkages of the CBM wells in this project with Coal Mines in Shanxi Province

The CBM wells in this project are not connected or linked in any way to existing coal mines in the project area as the CBM wells will be drilled into virgin coal beds that have not yet been mined. After all viable levels of methane have been exploited from the CBM wells and after the CBM wells have been closed and after this project closes, it is possible that the coal under these closed wells will be mined.

Safety Management under the Project

A comprehensive safety management plan has been developed by SECBMIH to manage the potential safety risks during the construction and operation of the project. During the design stage, qualified design institutes have been employed to carry out the feasibility study and conduct detailed design. A special chapter is dedicated to the identification, assessment and mitigation of the safety risks during project construction and operation of the project facilities. Fire and explosion hazards are minimized by prevention of CBM
and LNG vapor leaks through good design, procurement, quality construction and maintenance, comprehensive gas monitoring, ventilation to aid dispersion and removal of potential ignition sources from emission risk areas. A professional safety evaluation agency accredited by national safety authority is hired to conduct independent assessment and evaluation of whether all potential risks have been identified and adequate mitigation measures have been proposed. The government will authorize construction commencement only when the safety risks are correctly identified and adequately mitigated.

During procurement, special clause will be included in the bid specifications on the safety requirement and features of materials and equipments. Drilling will be undertaken by a qualified drilling service provider under a “Contract” with the framework for safe working procedures incorporated in the Contract. The drilling contractor is required to identify, assess and control the health and safety risk from the drilling operation. During construction, the supervising engineer will monitor whether the proposed safety measures and procedures are actually adopted and followed as part of its quality assurance. In addition, the independent safety evaluation agency will be retained to audit whether all the measures s proposed during the design stage are implemented. SECBMIH's own staff and management will also conduct site visit and inspection from time to time to ensure that standards and procedures are followed. Upon construction completion, dedicated government safety authority will inspect and test the related facilities to confirm whether the project facilities meet government safety standards for operation.

During operation, SECBMIH has developed a detailed operation plan and safety management manual and procedures. All operation staff and plant managers will receive two-month in-house training on regulations and rules of the company, operation manual of plant facilities, safety codes and rules of safety equipment. They will also receive two-month on-site training in a similar LNG plant in China or abroad. The key safety equipment and monitoring instruments will be regularly inspected and procedures submitted to regular audit. Induction and refresher training will be provided to personnel from time to time. The safety plan also includes staff and management responsibility chart for safety management as well as an emergency plan in case of any serious incident really occurs. A special team consisting of 10 persons will patrol the CBM wells and pipelines to identity possible facility damage by erosion, natural disaster or sabotage. In conclusion, the safety risks associated with the project are manageable. As long the safety standards, regulations, procedures and mitigation measures are followed, safety risks can be satisfactorily controlled.

The client, SECBMIH has agreed to also set up a Panel of Experts comprising of three members that will recruit on an ad-hoc basis additional expertise. The main terms of reference of the Panel of Experts will be to advise the client on all aspects of safety by reviewing the design, construction and operational stages and will not have any conflict of interest with their work. The panel will consist of two Chinese experts and one international expert and will be established before project effectiveness and will meet on an ad hoc basis well into the operation and maintenance stages and will produce their periodic reports which will be available to the World Bank.
11. Public Consultations and Disclosure

In accordance with the *Environmental Impact Appraisal* (State Environmental Protection Administration, February 14th, 2006, Environmental Development 2006 [No.28]) and the World Bank’s Environmental Assessment OP4.01, two public consultation rounds have been completed with the assistance of the client, SECBMIH. The first round of consultations was held on the TOR for the EIA. The second one is the consultation on the report of EIA reports.

**Table 11-1: Table of public consultation and information disclosure**

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<th>Consulted Villages</th>
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<td>Public Meetings, investigation questionnaire and participatory rapid appraisals.</td>
<td>SECBMIH, Taiyuan Design &amp; Research Institute for the coal industry</td>
<td>Some residents from Xiliang Village, Shishi Village, Yugou Village, Kongbi Village, Langbi Village, Hetou Village</td>
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<td>Village committees</td>
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**Concerns expressed during the Consultative Process.**

1. Whether the project development will promote economic development in the area and improve people living standard.

2. Whether effective efforts will be made to implement the environmental management and protection measures during the construction and operation of the Project.

3. Whether the Project will try to employ the local labor force as much as possible and improve the local public infrastructure.

4. The results of the monitoring on the environmental impact should be published regularly, in order to ensure the local residents know what the actual environmental impacts are.