Environmental Impact Assessment

Project Number: 44037
November 2012

People’s Republic of China: Shaanxi Weinan Luyang Integrated Saline Land Management Project

Prepared by the Weinan City Government for the Asian Development Bank

The environmental impact assessment is a document of the borrower. The views expressed herein do not necessarily represent those of ADB’s Board of Directors, Management, or staff, and may be preliminary in nature.
CURRENCY EQUIVALENTS
(as of 8 November 2012)

Currency unit – yuan (CNY)
CNY1.00 = $0.1601
$1.00 = CNY6.2467

ABBREVIATIONS

ADB – Asian Development Bank
CCICCD – Chinese Committee for Implementation of the Convention to Combat Desertification
CNY – Chinese Yuan
DEIA – Domestic Environmental Impact Assessment
DEIS – Domestic Environmental Impact Statement
DFR – draft feasibility report
EIA – Environmental Impact Assessment
EIS – Environmental Impact Statement
EMP – Environmental Management Plan
EPB – Environmental Protection Bureau
FFS – Farmer Field Schools
GDP – Gross Domestic Product
GEF – Global Environment Facility
IA – Implementing Agency
IEE – Initial Environmental Examination
IEM – Internal Environmental Monitor
MEP – Ministry of Environmental Protection
MOF – Ministry of Finance
NDRC – National Development and Reform Commission
NHIDRI – Northwest Hydroelectric Investigation Design and Research Institute
NWP – National Wetland Park
PAM – project administration manual
PIO – project implementation office
PIU – project implementation unit
PMO – Project Management Office
PPTA – Project Preparatory Technical Assistance
PRAIS – Performance Review and Assessment of Implementation System
PRC – People’s Republic of China
SFA – State Forestry Administration
SPS – Safeguard Policy Statement
TA – technical assistance
UNCCD – United Nations Convention to Combat Desertification
WLDC – Weinan Luyanghu Construction Development Company
WLDZ – Weinan Luyanghu Development Zone
WLMIDZMC – Weinan Luyanghu Modern Industrial Development Zone Management Commission
WMG – Weinan Municipal Government
WOCAT – World Overview of Conservation Approaches and Technologies
WEIGHTS AND MEASURES

<table>
<thead>
<tr>
<th>Unit</th>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ha</td>
<td>–</td>
<td>hectare</td>
</tr>
<tr>
<td>kg/d</td>
<td>–</td>
<td>kilogram per day</td>
</tr>
<tr>
<td>km</td>
<td>–</td>
<td>Kilometre</td>
</tr>
<tr>
<td>km²</td>
<td>–</td>
<td>square kilometre</td>
</tr>
<tr>
<td>m</td>
<td>–</td>
<td>meter</td>
</tr>
<tr>
<td>m²</td>
<td>–</td>
<td>square meter</td>
</tr>
<tr>
<td>m³</td>
<td>–</td>
<td>cubic meter</td>
</tr>
<tr>
<td>m³/d</td>
<td>–</td>
<td>cubic meters per day</td>
</tr>
<tr>
<td>m³/s</td>
<td>–</td>
<td>cubic meters per second</td>
</tr>
<tr>
<td>mg/m³</td>
<td>–</td>
<td>milligrams per cubic meter</td>
</tr>
<tr>
<td>Mg/L</td>
<td>–</td>
<td>Milligrams per Litre</td>
</tr>
<tr>
<td>mbgs</td>
<td>–</td>
<td>metres below ground surface</td>
</tr>
<tr>
<td>mm</td>
<td>–</td>
<td>millimeter</td>
</tr>
<tr>
<td>mu</td>
<td>–</td>
<td>unit of land area equal to 1/15 ha or 667 m²</td>
</tr>
</tbody>
</table>

NOTE

In the report, “$” refers to US dollars.

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.
# CONTENTS

Executive Summary 7

1. INTRODUCTION 11
   1.2 Environmental Categorization and Environmental Due Diligence 12
   1.3 Methodology and Approach 14

2. POLICY, LEGAL AND ADMINISTRATION FRAMEWORK 16
   2.1 National and Local Legal Framework 16
   2.2 Planning and Zoning Framework 18
   2.3 Technical Assessment Guidelines 21
   2.4 Environmental Protection Standards 22
   2.5 Applicable International Environmental Agreements 26

3. DESCRIPTION OF THE PROJECT 29
   3.1 Rehabilitated Drainage System and Reduced Soil Salinity 32
   3.2 Improved Flood Storage Capacity 36
   3.3 Wetlands Protection and Management 40

4. DESCRIPTION OF THE ENVIRONMENT 46
   4.1 Overview 46
   4.2 Physical Environment 46
   4.3 Ecological Environment 54
   4.4 Social-Economic Environment 58

5. Environmental Quality (Baseline Data) 61
   5.1 Soil Quality 61
   5.2 Surface Water Quality 63
   5.3 Groundwater 64
   5.4 Waterbirds 65
   5.5 Air Quality 66
   5.6 Noise Levels 66

6. ANALYSIS OF ALTERNATIVES 67
   6.1 No Project Alternative 67
   6.2 Discussion of Alternative Solutions 67

7. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES 69
   7.1 Incremental Environmental and Social Benefits 69
   7.2 Potential Adverse Impacts and Mitigation Measures Associated with Current Project Design 70
   7.3 Potential Adverse Impact and Mitigation Measures during Construction Phase 73
   7.4 Potential Adverse Impact and Mitigation Measures during Operation Phase 77
   7.5 General Mitigation Measures 81
   7.6 Biodiversity Conservation and Sustainable Natural Resource Management 81
   7.7 Cumulative Impacts 81
   7.8 Cultural Relics and Physical Culture Resources 82
   7.9 Environmental Safeguard Assurances 82

8. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION 82
   8.1 Legislative Framework for Public Consultation 82
   8.2 Public Consultation Activities 83

9. GRIEVANCE REDRESS MECHANISM 85

10. ENVIRONMENTAL MANAGEMENT PLAN 85
    10.2 Inspection, Monitoring, and Reporting 85
10.3 Mechanism for Feedback and Adjustment

11. CONCLUSIONS AND RECOMMENDATIONS

A. Objectives
B. Summary of Potential Impacts and Mitigation Measures
C. Environmental Monitoring and Inspection
D. Public Consultation
E. Responsibilities and Authorities for Implementation
F. Institutional Strengthening and Training
G. Reporting and Supervision
H. Work Plan
I. Cost Estimates for Environmental Management
J. Mechanism for Feedback and Adjustment
K. Grievance Redress Mechanism

TABLE INDEX

Table 1 Level of Environmental Assessment applied based on guideline
Table 2 Soil salinization classification indicators
Table 3 Soil Quality Standards for Class II Soils (mg/kg)
Table 4 Applicable Surface Water Quality Standards
Table 5 Water Salinity Classification
Table 6 Applicable Groundwater Quality Standards
Table 7 Irrigation Water Quality Standards
Table 8 Air Quality Standards
Table 9 Summary of Key Infrastructure Improvement Works
Table 10 Calculated Water Balance for Proposed Tianlu Lake
Table 11 Calculated Water Balance for Tianjiao Lake and Proposed Tianlu Lake
Table 12 Draft 2012 Wetlands Master Plan Functional Zones
Table 13 Climatic information from Pucheng and Fuping Weather Station
Table 14 Wetland Habitat Areas and Distribution
Table 15 Known numbers of wildlife species in the Wei River basin
Table 16 Numbers wildlife in the Project area
Table 17 Cultural sites within Fuping and Pucheng counties (but outside the Project area)
Table 18 Soil Quality Analysis Results
Table 19 Surface Water Quality Analysis Results
Table 20 Air Quality Analysis Results
Table 21 Drainage Channel Design options evaluation
Table 22 Salt pan Habitat Loss
Table 23 Calculated Water Quality for Proposed Tianlu Lake
Table 24 Calculated Water Quality for Tianjiao Lake and Proposed Tianlu Lake
Table 25 Modelled Water Quality Impact from Luoxi Drainage Discharge to Luo River

FIGURE INDEX

Figure 1 Tianjiao Lake construction progress 2011
Figure 2 Tianjiao Lake Development Plan
APPENDIX

A. Environmental Management Plan
EXECUTIVE SUMMARY

1. The Shaanxi Weinan Luyang Integrated Saline Land Management Project (‘the Project’) is classified as Environment Category A and an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) are required under the Asian Development Bank (ADB) Safeguard Policy Statement (SPS, 2009). This Project EIA presents an assessment of the potential environmental impacts, mitigation measures and design enhancement for the Project. It is based on the domestic environmental impact assessment (DEIA), prepared by the Northwest Hydroelectric Investigation Design and Research Institute (NHIDRI, May 2012), and field surveys and desktop review by the Project team. The DEIA was approved by the Shaanxi Environment Protection Department on 13 August 2012.

2. The Project area is 21,200 ha, including the proposed Luyanghu National Wetland Park (NWP) (1,070 ha). It is located northeast of Weinan City, Shaanxi Province, People’s Republic of China (PRC). The NWP comprises one existing artificial lake, Tianjiao (80 ha), a second proposed lake (130 ha; see below) and 860 ha of salt pans, ponds, reedbeds and cleared land. Approximately 113,000 people reside in the Project area. No permanent settlements occur in the NWP although residents have land use rights in and near it. The principle livelihood is agriculture. Some residents derive a seasonal income from salt harvesting in the NWP. Many residents are poverty stricken due to saline and waterlogged soils, which impede crop growth. Flooding in the past several decades has caused loss of crops and property.

3. The expected Project outcome is improved natural environment and rural livelihoods in the Luyanghu area. This will be achieved through four outputs: (i) saline soils rehabilitation, including (a) rehabilitation of Luoxi drainage system and (b) improved resilience to climate change of agro-ecosystems, (ii) flood risk management, including flood storage capacity improvement, (iii) wetland ecosystem conservation, including (a) establishment of the NWP, and (b) promotion of alternative livelihoods for local communities, and (iv) capacity development and project implementation support, including (a) institutional strengthening and (b) Project management. The Project investment of $165.2 million will be used to: (i) rehabilitate 489 km of main and branch desalination drainage channels and their associated bridges and roads, (ii) construct a second lake, Tianlu (130 ha) in the NWP and connect it with Tianjiao Lake, (iii) rehabilitate and/or improve management of the remaining 860 ha of the proposed NWP and establish 130 ha of forested shelterbelts along channels, roads and lake area, (iv) develop capacity for infrastructure, wetland management, and sustainable livelihoods, by providing training, facilities, and materials, including for tourism development, and (v) develop capacity on monitoring and evaluation procedures to support project management.

4. The Project is expected to achieve environmental benefits including (i) improved soil conditions, (ii) official designation of the NWP and implementation of the NWP master plan, (iii) improved protection of 860 ha of wetland habitats (to be included in the NWP) including at least 550 ha of important salt pan habitats for migratory waterbirds, (iv) training and improved capacity of local agencies in Shaanxi Province for wetland management and conservation of migratory waterbirds, (v) a five-year waterbird monitoring program for the Project area, and (vi) improved local livelihoods in and near the wetlands (see Project Final Report and supplementary appendices 3-8, 10), including continued salt harvesting activities by residents. Through these actions, the Project will considerably strengthen the municipal framework for wetland management in Weinan City. These benefits are timely: prior to the Project, the NWP and a draft NWP master plan was proposed by municipal agencies, but little action taken. Management of the wetlands was subsequently transferred to an economic agency with no environmental mandate or technical capacity. In addition, an extensive—but largely undefined—municipal economic development plan (2007–2025) exists for the Project area, which gives little emphasis to wetland management. The above Project measures will establish wetland management as a key component in the future development of the Project area.

5. The Project may result in some adverse environmental impacts, including: (i) loss of some important habitat for some migratory waterbird populations (see below), (ii) the possibility
of lake eutrophication, (iii) standard construction impacts, including water, soil, air and noise pollution, solid waste management, borrow and spoil, and possible effects on the wetlands and other biodiversity, and (iv) the risk of cumulative impacts resulting from future— but largely undefined— development in the Project area.

6. A project EMP has been prepared to mitigate and monitor these potential Project impacts (Appendix A). Key issues addressed by the EMP include the following.

7. Potential impacts to migratory waterbirds. Salt pans in the Project area are important seasonal habitat for migratory waterbirds. At least three species (Spotted Redshank, Black-winged Stilt, Long-billed Plover) and possibly a fourth (Kentish Plover) occur in globally significant numbers in the Project area, based on criteria of the Ramsar Convention on Wetlands. This was documented during a 3-week waterbird assessment undertaken for the Project in the migration season of September-October 2012. The assessment confirmed the findings of preliminary Project fieldwork in September 2011, when several thousand waterbirds were observed in the Project area, and an independent government survey in April 2012, when over 5,700 individuals of 27 waterbird species were observed. Waterbird migration is seasonal and occurs twice a year, and during both of the migration periods of 2012 (March-April and September-October) the largest numbers of small to medium sized waders, including the four species above, were in the salt pans proposed for construction of Tianlu Lake. The construction of this lake would cause the loss of 110 ha of salt pans (11% of the remaining salt pan habitats in the Project area). Satellite imagery indicates that construction of Tianjiao Lake in 2010–2011 (prior to the Project) caused the loss of 180 ha (18%) salt pans in the Project area; cumulatively, both lakes would cause the loss of 29% remnant salt pans (Table 22). Without mitigation, the loss of these salt pans would contribute to the continuing decline of waterbird migration sites along the East Asia-Australasia Flyway.

8. Mitigation measures to address the impacts of lake construction to migratory waterbirds were developed to achieve the SPS criteria of 'no net loss' of biodiversity. Measures address project design, lake construction, lake operation, and monitoring, and are described in the Project EMP (Appendix A). These are complemented by activities to be conducted under output 3 (wetland ecosystem conservation) of the Project, which will strengthen the municipal framework for wetland management in the Project area and help reduce potential impacts to the wetlands from future development.

- **Project design.** The Project will implement the following actions.

  - **Reduce loss of salt pan habitat through detailed lake design.** (i) Remnant salt pans in the proposed lake location which appear to be favoured by migratory waterbirds have been identified and a revised design has been developed (Figure 1 in Appendix A). Under this design, Tianlu Lake would be approximately 80 ha in size i.e. the loss of approximately 30 ha salt pans could be avoided. Although potentially significant, the final area of salt pan loss will only be estimated during detailed lake design and the need to consider topographic limitations and current land use. (ii) A transitional wetland zone will be maintained between the lake and salt pans and reed beds to the west to reduce disruption to local hydrology. (iii) The western shore of the lake will be constructed with a shallow, sloping gradient, to create shallow-water habitat. (iv) A third lake previously planned in the Project area, Tianzi, has been removed from the Project design.

  - **Construct new salt pan habitat to replace the salt pans removed by lake construction.** Prior to construction of Tianlu Lake, at least 110 ha new salt pan habitat will be constructed in the west of the Project area (see ‘area 2’ in Figure 11b, Section 3.3). This area comprises abandoned ponds and salt pans surrounded by old spoil mounds. The spoil mounds (which have no biodiversity or livelihood value) will be bulldozed and new salt pans created. Salt pan shape, depth, and seasonal water levels will emulate the existing salt pans in the Project area where salt harvesting occurs, based on the expertise of local salt farmers. Active salt harvesting in these new salt pans by local
residents will be permitted, and indeed supported, under the new wetland park (see below), to maintain the food sources and conditions which support migratory waterbirds, as well as providing a new livelihood resource for local communities. Technical input by waterbird and wetland specialists will be provided to ensure issues of waterbird food supply and roosting sites are addressed in the salt pan design, to maximize the habitat for small to medium sized waders. The involvement of these specialists, and the training of local agencies required to support subsequent management, will be funded by an ADB grant to complement the project loan.

- **Construction of Tianlu Lake.** The Project will implement the following actions.
  - **Minimize construction disturbance.** (i) Spoil from the excavation of Tianlu Lake will be disposed within the eastern portion of the lake (for islands) or immediately adjacent to its eastern shoreline, to avoid impacts to salt pan habitat located to the west. (ii) Construction of the lake will be timed to avoid, as far as possible, peak migration times in March-April and September-October. (iii) Nearby salt pan habitats will be off-limits to construction personnel and signs delimiting ‘no-go’ zones will be installed. (iv) Regulations for spoil disposal, human and vehicle access etc will be included in contractor guidelines to avoid important salt pan habitats.

- **Operation of Tianlu Lake.** The Project will implement the following actions.
  - **Include Tianlu and Tianjiao Lakes within the NWP.** Both lakes have been included in the proposed NWP. This will ensure that the lakes are subject to park regulations for both multiple use and wetland conservation.
  - **Implement seasonal regulations to protect migratory waterbirds.** If monitoring (see below) reveals that migratory waterbirds are utilizing Tianlu lake, these sites will be zoned and human activities will be regulated during the migration seasons.

- **Monitoring.** The Project will implement a five-year waterbird monitoring program from 2013–2017 (the Project duration) to monitor waterbird species richness, abundance of individuals, and the effects of Project actions, including salt pan loss and gain. The program will be implemented by the Shaanxi Animal Research Design Institute following training and capacity building supported by the ADB grant.

- **Protection and management of remaining salt pan waterbird habitat and minimizing future threats to waterbirds.** The following activities will be conducted under output 3 of the Project. They are not part of the EMP but form part of the overall actions designed to mitigate potential Project impacts to migratory waterbirds and their wetland habitats.
  - **Protection of remaining salt pan habitats.** Five hundred and fifty hectares (75%) of remaining salt pan habitat for waterbirds and 260 ha (100%) of remaining reed beds will be included in the NWP and subsequently protected and managed. Management guidelines for these salt pans will be developed in the NWP master plan and will include the continuation of local livelihoods for salt harvesting, which maintains the salt pan habitats utilized by the waterbirds.
  - **An additional 99 ha of salt pans and ponds are adjacent to the western portion of the proposed NWP and include waterbird breeding habitat (Figure 11b, Section 3.3). The inclusion of these areas in the NWP would strengthen waterbird and wetland conservation in the Project area. The potential for inclusion of these areas in the NWP will be assessed during the implementation of Project output 3.
  - **NWP and masterplan.** A NWP and master plan will be established in the Project area. A key focus of the park and plan will be to protect migratory waterbirds and their habitats.
  - **Biodiversity surveys and research.** Management activities for the NWP will include baseline biodiversity surveys to inform management planning.
  - **Training and capacity building in wetland and waterbird management.** Through the Project loan, GEF grant, and ADB grant, the Project will implement training to strengthen municipal capacity to implement and manage the NWP, manage the wetlands for
waterbirds and local livelihoods, plan and minimize the impacts of future economic development, and, contribute to improved wetland management in Shaanxi Province.

9. Lake eutrophication. Modelling indicates that concentrations of total nitrogen and phosphorus within the proposed Tianlu Lake could cause eutrophication and subsequent algal blooms, particularly after the wet season. As Tianlu Lake will be physically connected to Tianjiao Lake, algal blooms may also occur in the latter. To mitigate against these risks, an integrated nutrient management plan will be developed for the Project area, including (i) monitoring of nitrogen and phosphorus levels in the lakes and drainage channels, (ii) improved management of the use of agricultural fertilizers, (iii) enhancement of wetlands at drainage channel discharge points to support passive treatment of nutrients, and (iv) training of farmers in appropriate fertilizer application. In addition, treated wastewater from the Pucheng Wastewater Treatment Plant, which currently discharges into a drainage channel in the Project area, will be diverted to a drainage channel east of the Project area. Both channels discharge to the Luo River.

10. Cumulative impact of future development. A development plan (2007–2025) for the Project area indicates that a range of commerce, including an aviation industry, is planned. The extent and feasibility of these plans is unclear. It is recommended that future development be integrated with the environmental plans to be implemented under this Project, including the NWP master plan, integrated nutrient management plan, and actions to conserve waterbirds. For migratory waterbirds, the development of an aviation industry should include seasonal no-fly zones to reduce the risk of bird strike and impacts to human safety as well as waterbirds.

11. The mitigation measures in the Project EMP will be updated at final design stage and reviewed (and if necessary, improved) during the Project. The EMP will be implemented by an Implementing Agency and contractors, monitored and supervised by professional environmental management agencies and city environmental monitoring stations, with regular reporting to the Project Monitoring Office (PMO), Weinan Environment Protection Bureau, and ADB.
1. INTRODUCTION

1. This Project environmental impact assessment (EIA) presents an assessment of the potential environmental impacts, mitigation measures and design enhancement for the Shaanxi Weinan Luyang Integrated Saline Land Management Project (‘the Project’).

2. The report has been prepared in accordance with the requirements of the ADB Safeguard Policy Statement (SPS, 2009). It is based on a draft domestic environmental impact statement (DEIS) dated May 2012, prepared by the Northwest Hydroelectric Investigation Design and Research Institute (NHIDRI), as well as field surveys and desktop review conducted by the PPTA team. The final draft DEIA was approved by the Shaanxi Environment Protection Department on 13 August 2012.

3. The Luyanghu area is located in a basin with flat topography and poor drainage systems which are prone to flooding and highly saline soils, hindering economic development of local communities. High salinity in local soils, relating to the flat topography and poor drainage, is restricting agricultural productivity and expansion of local agriculture activities. Flooding during the rainy seasons has caused losses to local community livelihoods in the area and restricts land development. Some wetlands in the area are designated as a proposed National Wetland Park (NWP), but which has not been gazetted, and the wetlands are being degraded by agricultural encroachment and waste dumping. Ecotourism opportunities, including wetlands and salt-harvesting cultural heritage have not been developed to their full potential.

4. Luyanghu is one of the PRC’s poorest areas. The average income is one-third lower than the average income in Shaanxi Province. Approximately 113,064 people reside in the Project area. There are no permanent settlements within the NWP, although residents do have land use rights there. About 30% of rural households and 21% of rural population live below the poverty line of CNY2,500 per capita annual income. The principle livelihood is agriculture. Some residents derive a seasonal income from salt harvesting in the NWP. Many residents are poverty stricken due to saline and waterlogged soils, which impede crop growth. Periodic flooding in the past several decades has caused loss of crops and property.

5. Luyanghu is located within Weinan City municipality. The Weinan Municipal Government (WMG) is actively supporting increased economic growth in the area through the Weinan-Luyanghu Development Zone, which seeks to attract high technology industries and promote the ecotourism values of local wetlands and salt pan environments. The Weinan-Luyanghu Development Zone sits within the Guanzhong–Tianshui Economic Zone, which was approved by the State Council in 2009 to strengthen the development of the western region. In line with these regional development plans, the Project will support economic development of the Luyang lake area, improving livelihoods and enhancing land uses by improving salt drainage systems, reducing flood risks, rehabilitating local wetlands and strengthening ecotourism opportunities.

6. The Project outcome will be improved natural environment and rural livelihoods in Luyanghu area, which will be achieved through delivery of four key outputs: (i) saline soils rehabilitation, including (a) rehabilitation of Luoxi drainage system and (b) improved resilience to climate change of agro-ecosystems; (ii) flood risk management, including flood storage capacity improvement; (iii) wetland ecosystem conservation, including (a) establishment of the Luyanghu National Wetland Park, and (b) promotion of alternative livelihoods for local communities; and, (iv) capacity development and project implementation support, including (a) institutional strengthening and (b) Project management support.

7. This EIA report presents a review and assessment of (i) the Project design with respect to national policy, legal and administrative framework, (ii) a description of the Project, (iii)
description of the environment, (iv) assessment of the anticipated potential environmental impacts of the Project and mitigation measures, (v) analysis of Project alternatives, (vi) summary of the information disclosure, consultation and participation undertaken as part of the project preparation, (vii) outline of the established grievance redress mechanism, (viii) an environmental management plan including mitigation measures, required environmental monitoring and institutional arrangements, and (ix) conclusions on the environmental benefits and impacts of the proposed project design.

1.2 Environmental Categorization and Environmental Due Diligence

1.2.1 Environmental Categorization

8. The project is classified as environmental category A for the purpose of environment safeguard categorization under the ADB Safeguard Policy Statement (SPS, 2009), and classified as environment category A under the Environmental Impact Assessment Law (2003) of the People’s Republic of China (PRC).

1.2.2 Domestic Approvals

9. The draft DEIS was prepared by NHIDRI on behalf of the WMG. NHIDRI holds a Class A EIA license issued by the PRC Ministry of Environmental Protection (MEP).

10. The scope and environmental criteria for the DEIS was reviewed by the PPTA consultants and submitted to the WMG Environmental Protection Bureau for review. WMG issued approval of the scope and environmental standards to be applied in January 2012.

11. The draft DEIS report incorporating PPTA review comments was submitted to the Shaanxi Environment Protection Department (EPD) for appraisal on 5 May 2012. The Shaanxi EPD review process included a technical panel of seven senior provincial environment specialists. Comments from the technical review panel were incorporated into the draft DEIS dated 30 May 2012, which was re-submitted to the Shaanxi EPD for final approval. The final draft DEIS was approved by the Shaanxi EPD on 13 August 2012.

1.2.3 Due Diligence

12. During project preparation, due diligence was performed through technical analysis of engineering feasibility and environmental impact assessment along with other aspects of the project preparation (i.e. financial, economic resettlement planning, poverty and social impact assessment, and institutional). The purpose of the due diligence analysis was to maximize the ecological and socioeconomic benefits of the Project with the available financing and with the least adverse environmental and social impacts. Due diligence reports are presented in the Project Final Report – Supplementary Appendices 1-12.

13. For each of the project components, extensive discussions and consultations were undertaken during the project preparation to identify and assess possible positive and negative impacts of the different design alternatives, including cost-effectiveness. As part of the Project preparation phase, several design improvements were achieved.

14. Reduced area of new lake construction and increased area of protection of saline ponds. Early project designs included three lakes, Tianjiao, Tianlu and Tianzi, with a total area of over 500 ha. Following an initial assessment of the saline wetland flats in the west of the Project area, the proposed site for Tianzi was found to host important migratory bird habitat. These saline wetland flats are highly modified and used for salt harvesting, however the shallow evaporative ponds also offer habitat for native and migratory birds. It was concluded that the proposed excavation of this area, replaced by a deeper-water lake environment, had the

1Domestic Environmental Impact Assessment Report, 2012
potential to result in loss of habitats for migratory waterbirds. Based on this assessment, the proposed Tianzi Lake was removed from the project design. The salt pans and ponds of this area are now included in the area of the proposed national wetland park.

15. Drainage channel improvements options. During Project preparation, alternatives were considered for the drainage channel improvement works, with consideration for technical, economic, energy efficiency, and environmental criteria. For the environmental considerations, the primary objective was to identify options with the least adverse environmental impacts and maximum benefits. Key environmental factors used included minimizing (i) the amount of earthwork requirements (related to vegetation disturbance, soil erosion potential, and spoil disposal), (ii) requirement for household relocation, (iii) land requirements, focusing on minimizing or avoiding requirement for acquisition of agricultural land and forested land, (iv) opportunities to reduce emissions associated with construction activities, and (v) support options for use of gravity flow rather than requirement for pumping. Three key drainage channel improvement design options were evaluated comparing work amount, annual project operation cost, construction method and work schedule, water protection, EIA, energy saving and reliability.

16. DEIS review and improvement. Due diligence reviews were carried out to assess the quality and completeness of the draft DEIS report against the SPS requirements. The due diligence involved reviewing the following, providing comment and strengthening the report in updated revisions: (i) identification and analysis of alternatives to the Project, including the without-project scenario; (ii) identification and comparison of project alternatives, including alternative routes, sites and designs, (iii) review of the academic literature, especially related to protection and conservation requirements, and (iv) supplementary stakeholder consultations with key informants, local experts, and local communities. The findings from the due diligence reviews were incorporated into the draft DEIS.

17. Associated Facility - Tianjiao Lake. Tianjiao Lake (see Section 4) is an associated facility to the Project. The lake covers approximately 80 ha and will connect directly to the proposed Tianlu Lake and rehabilitated drainage channels as part of the Project. Tianjiao Lake construction commenced in 2010 and was well progressed in June 2012 (Figure 1). The flood storage potential of the Project design has been calculated based on the total flood storage capacity of both lakes combined. As such an environmental due diligence assessment was undertaken to (i) review compliance with relevant PRC laws and regulations and ADB SPS (2009) and (ii) impacts associated with the lake construction based on available information.

18. Tianjiao Lake is part of the development of the eastern part of the Weinan Luyanghu Modern Industry Development Zone, as detailed in the Detailed Planning Document dated December 2012 prepared by the Shaanxi Zhong Sheng Planning and Design Research Institute Co. Ltd.

19. An EIA was undertaken for Tianjiao Lake design and construction by the Shaanxi Hydropower Investigation Design Institute. As part of the EIA preparation, the draft EIA was submitted to the Weinan Environmental Protection Bureau on 13 January 2012 and assessed by a review panel. Comments were incorporated into the final EIA report dated April 2012. Shaanxi EPB issued environmental approval for the Tianjiao Lake project on 2 May 2012. The environmental approval was received after construction commenced.
20. The Tianjiao Lake Project area prior to development in 2000 is shown in Figure 2. As outlined in the EIA report, the area included agricultural land (100 ha) and salt pans (200 ha). Of particular importance for this Project, Tianjiao Lake construction resulted in the loss of at least 180 ha of salt pans replaced by a lake and landscaped area.

1.3 Methodology and Approach

21. This draft EIA report is based on the 30 May 2012 version of the draft DEIS and contains the following chapters: (i) executive summary; (ii) national policy, legal and administrative framework; (iii) description of the Project; (iv) description of the environment; (v) anticipated potential environmental impacts and mitigation measures; (vi) analysis of alternatives, (vi) information disclosure, consultation and participation; (vii) grievance redress mechanism; (viii) environmental management plan; and (ix) conclusion. The environmental management plan (EMP) is in Appendix A. The EMP entails an environmental monitoring program, public consultation program, responsibilities for implementation and supervision, institutional strengthening and training plan, reporting and supervision, work plan, cost estimates for environmental management, and mechanism for feedback and adjustment.

22. This report has been prepared in accordance with the ADB SPS, based on draft DEIS prepared in compliance with the PRC’s environmental assessment regulatory framework.
supported by site visits and stakeholder consultations. The draft DEIS report has been supplemented by additional surveys undertaken by the PPTA international and national environmental specialists over the period July 2011 to June 2012. Key data sources included the following:

(i) Draft Project Feasibility Study Report (June 2012), prepared by qualified domestic feasibility study consultants.

(ii) Draft DEIA report (May 2012) by NHIDRI, a domestic environmental design institute, who conducted the following baseline sampling from January-April 2012:
- site elevation and vegetation surveys at 84 locations in the Project area;
- sampling of soil salinity and nutrient levels at 40 locations in the Project area; and,
- groundwater levels at 70 points (new and existing wells) and groundwater chemistry at 42 points, in the Project area, including 8 groundwater wells currently used by the salt harvesting industry in the lower lying areas.

(iii) Supplementary monitoring data provided by the WMG environment protection bureau:
- surface water quality at 14 investigation points;
- groundwater quality at 9 investigation points;
- air quality at 4 investigation points; and
- acoustic levels at 12 monitoring points within the Project area.

(iv) A four-day waterbird survey (4-7 April 2012) by the Shaanxi Animal Research Institute.

(v) Field surveys by the PPTA team between July 2011 and June 2012 and a three-week waterbird survey from September-October 2012. The latter survey was conducted by an international waterbird specialist to determine the conservation value of the Project area for migratory waterbirds and to assess mitigation measures to address the impacts of Tianlu Lake.  

(vi) Supplementary studies by the PPTA team, based on fieldwork and desktop review, including (i) rehabilitated drainage system and reduced soil salinity technical assessment report, (ii) improved flood storage technical assessment report, (iii) improved wetlands management technical assessment report, and (iv) wetland management.

(vii) Public consultations, including (i) public information disclosure undertaken by IA in October 2011, (ii) public information disclosure undertaken by domestic EIA consultants in March 2012, (iii) public consultations undertaken by the domestic EIA consultants in March 2012 including 120 completed questionnaires, and (iv) public consultation meetings undertaken by the Project team in November 2011. The following stakeholders were consulted: Weinan bureaus of finance, environment protection, land management, statistics, and water services, Weinan Development and Reform Commission, Poverty Alleviation Office, Women’s Federation, and the townships of Jingyao, Dangmu, Yuanren, and Chenzhuang.

(viii) Published reports on topographic, geological, groundwater, surface water, soil, climate, flora, fauna, and cultural resources.

2. POLICY, LEGAL AND ADMINISTRATION FRAMEWORK

2.1 National and Local Legal Framework

23. The environmental management system in the PRC consists of a well-defined hierarchy of regulatory, administrative and technical institutions. At the national level, the People’s Congress has the authority to proclaim national environmental laws; the State Council promulgates the national environmental regulations; and the MEP issues the environmental guidelines. The provincial and local governments can also issue provincial and local environmental regulations and guidelines in accordance with the national ones. In addition, the local ordinances, national and local environmental standards and national and local five-year environmental protection plans form an important part of the legal framework.

2.1.1 National Laws and Regulations

24. The major laws that established the PRC legal and administrative framework for environmental and natural resource management includes, the Environmental Protection Law (1989), and the Environmental Impact Assessment Law (2003). Other laws, major national regulations, local laws and regulations for environmental protection pertaining to this project include the following.
   (i) PRC Law on Flood Control, 1998
   (ii) PRC Water Law, 2002
   (iii) PRC Law on Environmental Impact Assessment, 2003
   (iv) PRC Law on Environmental Pollution Prevention and Control of Solid Wastes, amended 2005
   (v) PRC Law on Air Pollution Prevention and Control, 2000
   (vi) PRC Law on Ambient Noise Pollution Prevention and Control, 1997
   (vii) PRC Law on Water Pollution Prevention and Control, 1984, amended 1996
   (viii) PRC Law on Water and Soil Conservation, 1991
   (ix) PRC Law on Environmental Protection, 1989
   (x) PRC Forest Law, 1998
   (xi) PRC Law on Urban and Rural Planning, 2008
   (xii) PRC Grasslands Law, 1985
   (xiv) Directive on Strengthening Wetland Protection and Management, 2002
   (xv) Regulation on Implementation of the PRC Law on Water and Soil Conservation, State Council, 1993

25. Flood Control Law. The provisions of Article 14 of the PRC Flood Control Law stipulates that local governments of waterlogged regions, including plains, depressions, water networks, valleys and basins, should develop waterlogging management and flood control plans, along with organizing relevant departments to take measures to improve drainage systems, develop flood-tolerant crop varieties, and manage floods, drought, and salinity.

26. The project is located in the regions subject to waterlogging and flood impacts. The project objects are aligned with the PRC Flood Control Law, in that the project aims to improve flood control and reduce waterlogging, rehabilitate drainage systems, and carry out integrated management of saline-alkali soil.

27. Water Law. Article 25 of the PRC Water Law stipulates that local governments should strengthen the leadership in works of irrigation, drainage, soil and water conservation, and promote the development of agricultural production, including areas prone to suffer from salinization and waterlogging to control and lower the groundwater level.
28. The rehabilitation of the drainage canals as part of the project is expected to lower the groundwater level, supporting increased development of agricultural activities as a result of reduced soil salinization and waterlogging. The project is considered to be broadly in line with the provisions of the PRC Water Law.

29. Environmental Impact Assessment Law. According to PRC Environmental Impact Assessment Law, it is necessary for a project, in its feasibility study stage, to carry out an environmental impact assessment. Article 16 of the PRC EIA Law (2003) stipulates that an EIA is required for capital construction projects producing environmental impacts, so as to provide a comprehensive assessment of these potential environmental impacts. On 2 September 2008, the Ministry of Environmental Protection (MEP) released the Management Guideline on EIA Categories of Construction Projects, which came into effect on 1 October 2008. According to this guideline, a project is classified into one of the following three categories:
   - Category A: Projects with significant adverse environmental impact; an Environmental Impact Statement (EIS) is required.
   - Category B: Projects with adverse environmental impacts which are of lesser degree and/or significance than those of Category A; a Tabular environmental Impact Assessment Report (TEIAR) is required.
   - Category C: Projects unlikely to have adverse environmental impact; an Environmental Impact Registration Form (EIRF) is required.

30. This project is classified as Category A and an Environmental Impact Statement (EIS) is required. The sector of the DEIS can be defined as agricultural, forest and water conservancy. The approval authority is the Shaanxi Provincial Environmental Protection Department.

2.1.2 Local laws and regulations, planning and documentation

31. Provincial legislation relevant to the environmental aspects of the project include:
   (i) Water Pollution Control Ordinance for Weihe River in Shaanxi Province (Shaanxi Provincial People’s Congress Standing Committee on August 22, 1998);
   (ii) Shaanxi Province Wildlife Conservation Ordinance (Shaanxi Provincial People’s Congress Standing Committee on July 29, 2010);
   (iii) Shaanxi Province Ecological Function Zoning (General Office of Shaanxi People’s Government on November 17, 2004);
   (iv) Shaanxi Province Wetland Regulations, June 2006 (Adopted at the 24th Session of the Standing Committee of the 10th People’s Congress of Shaanxi Province on April 2nd, 2006)
   (v) Shaanxi Province Water Function Zoning (General Office of Shaanxi People’s Government on September 22, 2004);
   (vi) Ecological Environment Protection Measures for Weihe River in Shaanxi Province (Shaanxi People’s Government Decree No. 139 on June 1, 2009);
   (vii) Shaanxi Province Implementation of Wildlife Conservation Act of the PRC (amended by Shaanxi Provincial People’s Congress Standing Committee on August 3, 2004);
   (viii) Shaanxi Province Implementation of Water Law of the PRC (Shaanxi Provincial People’s Congress Standing Committee on August 4, 2006);
   (ix) Shaanxi Province Implementation of Environmental Impact Assessment Law of the PRC (Shaanxi Provincial People’s Congress Standing Committee on December 3, 2006);
   (x) Forwarding of the “Notice on Taking Harbin Sun Island and Other 19 Wetlands as the National Wetland Park Pilots by the State Forestry Administration” of the State Forestry Administration (Shan Lin Zi [2008]750)
2.2 Planning and Zoning Framework

32. The following section outlines key planning and zoning frameworks with respect to this environmental impact assessment in the areas of wetlands management and regulation, development planning, integrated ecosystem management, and water resource planning.

33. National Wetlands Framework. From 2008-2010, PRC designated 127 pilot national wetland parks and 74 local wetland parks covering an area of 680,869 ha and 176,696 ha, respectively. The designation of wetland parks is part of the National Wetland Conservation System. A wetland ‘park’ has similar functions to nature ‘reserves’, with the difference being a wetland park is also intended to provide recreation uses for tourism and nearby residents. A total of 247 wetland parks have been designated with a total area of 1.161 million ha. More funding is expected for conservation, restoration, and sustainable use of important wetlands, infrastructure construction for wetland conservation, awareness raising and training, wetland resource survey, monitoring, research and evaluation, and expanded demonstration of wise use of wetlands. Through these efforts, wetland conservation and management is being promoted in the 12th Five-Year Plan period. Wetland regulations were adopted by the People’s Congress of Shaanxi Province on 2 April 2006. The purpose of these regulations is to enhance wetland protection, maintain the ecological functions and biological diversity of wetlands, and guarantee the sustainable utilization of wetland resources.

34. The Shaanxi Pucheng Luyanghu Lake National Wetland Park (NWP) received preliminary approval for designation as a national wetland park in 2007 by the State Forestry Administration (SFA Paper No. 234, 2007). A draft master plan was prepared, which defined the total area of the park as 14.7 km² ha (Figure 3), located within the central southern part of the Project area. The SFA preliminary approval of the park was conditional on the development and implementation of a park master plan within six years (i.e. by end of 2014). In 2008, a master plan was prepared by Xianyang City Forest Inventory and Planning Design Institute and approved by SFA. The plan categorised the NWP into five areas (Figure 3): (i) wetland conservation, (ii) new wetland, (iii) educational, (iv) recreation and tourism, and (v) wetland management and service areas. The plan included a proposal to “restore the waters of Luyanghu Lake through dredging and to reconstruct a natural water area. The proposed dredging included a stretch of 8 km length (from Dangmu Town Xilin Village in the east to Yuanren Town Wangzi Village in the west) and 500 m wide, with a total area 4 km²”.

Figure 3. Pucheng Luyanghu Lake National Wetland Park Plan-initial plan (2008). Superseded by draft 2012 master plan (Figure 11)
35. As of June 2012, the park had no history other than official gazetted as a ‘pilot NWP no. 234’ in 2007 and preparation of the draft master plan in 2008. After approval of the plan in 2008, no further action was taken to develop or establish the park. If the plan is not implemented by 2014, the park will not pass SFA accreditation assessment (Shaanxi Provincial Forestry Department pers. comm. 25 October 2011). The lack of action since 2008 reflects a combination of factors, including lack of technical capacity to implement the park and wetland management, limited budget, and a higher priority accorded to accelerating other plans for the Luyanghu area, especially economic development (Figure 4). The NWP master plan is now outdated.

36. In 2010, the WMG delegated funding, construction, and management responsibility for the pilot NWP to the Weinan Luyanghu Modern Industrial Development Zone Management Commission (WLMIDZMC). WLMIDZMC incorporated this responsibility into its overall development plan for the Luyanghu region. The WLMIDZMC is a development agency and has no specific mandate nor technical capacity for wetland management. The Project will assist the WMG in finalization and implementation of the master plan, and subsequently, official SFA approval for the park. It will also help establish collaboration between the WLMIDZMC with municipal agencies most suited to manage the park, particularly the Shaanxi Forestry Department (which oversees management of the Yellow River Nature Reserve) and technical input from other local agencies, including the Shaanxi Animal Research Design Institute. The Project’s involvement will secure these outcomes through a combination of financial and technical support through the Project loan and two associated grants (the GEF grant and a TA) and provision of relevant technical specialists to help plan and implement the master plan.

37. Government Development Strategy. Located in the east of Guanzhong Plain, Weinan City is part of the Guanzhong–Tianshui Economic Zone, which was approved by the State Council in 2009 to strengthen the development of the western region. In line with the goals of the Guanzhong–Tianshui Economic Zone, including that the gross domestic product (GDP) output reaches one-third of the western region by 2020, the WMG has prepared a long-term development plan (2007–2025) for the Luyanghu area to improve local livelihoods and environment. As there is already an established aerospace industry in the region, the development plan has been prepared to attract additional high-technology industrial investment, promote local tourism, and create job opportunities. The WMG established the Weinan Luyanghu Construction Development Company (WLCDC) to take charge of the planning and infrastructure improvement of the area and the Weinan Luyanghu Development Committee to coordinate the development efforts.

38. The Guanzhong-Tianshui Economic Zone Development Plan (2009) includes (i) implementation of flood prevention and public security engineering, and (ii) strengthening the transformation of middle-and-low-yielding farmlands with a focus on construction of irrigation and water conservation facilities. The current project design is directly aligned with these aspects of the Guanzhong - Tianshui Economic Zone Development Plan.

39. The Project area has a strategic location with the potential to connect the Guanzhong-Tianshui Economic Zone with the Shanxi, Shaanxi and Henan Yellow River Golden Triangle Region Coordinative Development Comprehensive Experimental Zone.

40. Weinan Luyanghu Lake Modern Industries Comprehensive Development Zone master plan (2007-2025). The Weinan Luyanghu Modern Industries Comprehensive Development Zone was developed in line with the Guanzhong-Tianshui Economic Zone Development Plan. The area and design of this project is set within the context of the Weinan Luyanghu Modern Industries Comprehensive Development Zone master plan (2007-2025). The development zone master plan includes three development objectives (i) commercial and industrial development including proposed hotels, residential, commercial and industrial buildings, aviation industry, manufacturing, logistics industry, (ii) residential and recreational development including residential villas and apartments, recreational parks, constructed lakes, tourism facilities and
schools, and (iii) improved agricultural infrastructure and land productivity. The development zone covers an area of 124 km$^2$ and is located in the central region of the Project area.

41. The details of the commercial and industrial development plan have not been confirmed. However the concept as depicted in Figure 4, suggests that a commercial industrial zone will be established in the north east section of the development zone. This is generally in line with the existing road infrastructure and cleared land already developed in this area. The depicted lake configuration in Figure 4 along with the plans for the western part of the development zone have been superseded by updated lake and wetland designs developed as part of this project.

**Figure 4. Weinan Luyanghu Lake Modern Industries Comprehensive Development Zone Master Plan (2007 - 2025)**

42. The development zone master plan includes a proposal to construct two sewage treatment plants within the development zone. Limited information was available on the proposed wastewater treatment plants, however it is understood they will treat water from the new commercial, industrial and residential developments and will be designed to treat effluent to Class I standards in accordance with the Integrated Wastewater Discharge Standard (GB8978-1996). Recommendations for assurances relating to wastewater treatment and other development aspects of the master plan have been provided in Section 11.

43. With regard to improved agriculture practices, the development zone master plan includes proposals to (i) implement ‘soil engineering’ practices to rehabilitate lower yielding agricultural areas, (ii) develop ‘modern’ farming practices demonstration sites including introduction of higher value crops and improved farming technologies, and (iii) improved drainage infrastructure to manage flooding during storms.

44. The project design is aligned with the agricultural sector improvements proposed in the development zone master plan, aiming to contribute directly to improved agricultural productivity, improved agricultural practices and improved flood drainage. The project design complements the commercial, industrial and residential development plans, by supporting appropriate protection and management of existing wetlands and the development of a constructed lake offering recreation areas and flood storage. There are however potential impacts of proposed development on the objectives of the project, which must be managed by coordinating the detailed project design with future plans for development. Potential negative associated impacts relating to the proposed development zone are discussed in Section 7.
45. Shaanxi Integrated Ecosystem Management (IEM) Plan to Combat Land Degradation. Shaanxi Province adopted an IEM Plan in 2008 that was developed under the PRC-GEF Land Degradation Partnership to Combat Land Degradation in Dryland Ecosystem that was formed in 2002 to support the implementation of the National Action Plan of the United Nations Convention to Combat Desertification (UNCCD) in the PRC. Shaanxi’s IEM Plan is to implement the NAP at provincial level. The Project is consistent with the key priorities of this plan and in particular the priority activities related to ‘Identifying and popularizing best practices for land reclamation to improve the productivity of the Shaanxi provincial ecosystems’, as well as its focus on transformation and recovery of desert forest and grasslands in the Yellow River basin.

46. Shaanxi Ecological Function Zoning. Shaanxi Province Ecological Function Zoning divides Shaanxi Province into three categories (i) ecological zone, (ii) ecological functional zone, and (iii) ecological functional district. In total, the province has 4 ecological zones, 10 ecological functional zones and 35 ecological functional districts.

47. The Project area includes all three zones (i) Weihe River valley agro-ecological zone (zone 1), (ii) Guanzhong Plain urban-rural integrated ecological functional zone (zone 2), and (iii) Guanzhong Plain towns and agricultural districts (zone 3). Under the zoning scheme, the following is required (i) improved water conservation (“rational use of water resources”), (ii) ensure provision of water for ecological requirements, (iii) towns and cities should enhance sewage treatment and reuse, (iv) landscaping works should be implemented to increase green coverage, (v) arable lands should be protected and modern and peri-urban agriculture should be promoted, and (vi) river management should be strengthened and flood control standards improved. The Project design has considered and adopted these requirements of the Shaanxi Province Ecological Function Zoning.

48. Shaanxi Water Function Zoning. Shaanxi Province Water Function Zoning divides the water systems of Shaanxi Province into two different divisions. The objective of the first division is to coordinate regional water use, and undertake macro solutions to the problem of water resources exploitation and protection. The first division is further classified into four categories (i) protected areas, (ii) reserves areas, (iii) development of utilization areas, and (iv) buffer areas. The second division focuses on the economic water uses and is further classified into seven categories (i) drinking water source areas, (ii) industrial water areas, (iii) agricultural water use areas, (iv) fisheries water use areas, (v) landscape and recreational water areas, (vi) transition areas, and (vii) sewage control areas.

49. According to the first division, the main stream of the Northern Luo River to the east of the Project area is part of the Yan’an, Weinan City Development and Utilization Area. Within this area the water quality objective is Class III. According to the second division, the same region belongs to the Dali County Agricultural Water Use Area, with a water quality objective of Class IV.

50. Drainage discharge from the Project area enters the Luo River to the east of the Project area, as such water quality standard should comply with Class III standards as detailed in the Surface Water Environmental Quality Standards (GB3838-2002).

2.3 Technical Assessment Guidelines

51. The following technical guidelines relate to this environmental impact assessment and outline environmental impact and quality classification levels and quantitative targets which have been incorporated in the Project environmental management plan.

(i) Interim Guideline on Public Participation in EIA, State Environmental Protection Administration, 2006

(ii) Technical Guideline on EIA, State Environmental Protection Administration, 2003.

52. Based on the project scale and existing environment, Table 1 summarizes the environmental classification based on beneficial uses applied in accordance to the above mentioned guidelines.

<table>
<thead>
<tr>
<th>Environmental Aspect</th>
<th>Beneficial Use Classification</th>
<th>Applicable Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water</td>
<td>Class III</td>
<td>HJ/T2.-3-1993</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Class III</td>
<td>HL610-2011</td>
</tr>
<tr>
<td>Flora and fauna (ecology)</td>
<td>Level II</td>
<td>HJ/T19-2011</td>
</tr>
<tr>
<td>Soil</td>
<td>No assessment category</td>
<td>NA</td>
</tr>
<tr>
<td>Acoustic Environment</td>
<td>Level II</td>
<td>HJ/T2.-2-1993</td>
</tr>
</tbody>
</table>

2.4 Environmental Protection Standards

53. The following ambient environment and pollution discharge standards have been applied to this assessment to support the study of potential impact and provide a basis for quantifiable environmental monitoring targets. The standards for specific parameters are presented in further detail in the following paragraphs. These ambient standards for soil, water, groundwater, air and noise are comparable to international standards and are suitable for reference within this report.

(i) GB3095-2012: Ambient Air Quality Standard GB3095-2012
(ii) Surface Water Environmental Quality Standard GB3838-2002;
(iii) Groundwater Quality Standards GB/T14848-93;
(iv) Sound Environment Quality Standards GB 3096-2008;
(v) Soil Environmental Quality Standard GB15618-1995;
(vi) Atmospheric Pollutants Emission Standard GB16297-1996;
(vii) Urban Sewage Treatment Plant Pollutants Emission Standards GB 18918-2002;
(viii) Sewage Discharge Standard GB8978-1996;
(ix) Yellow River Basin (Shaanxi Section) Wastewater Discharge Standard DB61/224-2011;
(x) Construction Site Noise Limits GB12523-90 ;
(xi) Irrigation Water Quality Standards GB5084-92;
(xii) Municipal Wastewater Reclamation and Irrigation Water Quality GB20922-2007;
(xiii) Municipal Wastewater Reclamation and Landscape Environmental Water Quality GB/T18921-2002;
(xiv) Flood Control Standard GB50201-94;
(xv) Urban Regional Environmental Noise Area Dividing Technical Specification GB/T15190-94.

2.4.1 Ambient Environmental Quality Standards

54. Soil Salinity. The soil salinity classification is based on the PRC Guideline for saline lands. Table 2 provides a summary of the classification scale from non-salinized to saline soil
based on this classification. Soil salinity can be reported in several ways; in the PRC the standard is as a % of the soil volume. Outside the PRC, soil salinity is commonly reported as mg/kg, ppm or dS/M using a standardised electrical conductivity (EC) method.

Table 2. Soil salinization classification indicators

<table>
<thead>
<tr>
<th>Soil salinity (%)</th>
<th>Non-salinized soil</th>
<th>Mild-salinized soil</th>
<th>Moderate-salinized soil</th>
<th>Severe-salinized of the soil</th>
<th>Saline soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.1</td>
<td>0.1-0.2</td>
<td>0.2-0.4</td>
<td>0.4-0.6</td>
<td>&gt; 0.6</td>
<td></td>
</tr>
</tbody>
</table>

55. Soil quality. Soils in the Project area belong to the classification of saline-alkali dry land soil, for which the Level II standard is applicable under the *Soil Environmental Quality Standards* (GB15618-1995). The standard provides soil quality parameters based on soil pH (Table 3).

Table 3. Soil Quality Standards for Class II Soils (mg/kg)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>pH&lt;6.5</th>
<th>pH 6.5-7.5</th>
<th>pH&gt;7.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>0.30</td>
<td>0.30</td>
<td>0.60</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.30</td>
<td>0.50</td>
<td>1.0</td>
</tr>
<tr>
<td>Arsenic</td>
<td>40</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Copper</td>
<td>50</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Lead</td>
<td>250</td>
<td>300</td>
<td>350</td>
</tr>
<tr>
<td>Chromium</td>
<td>150</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td>Zinc</td>
<td>200</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Nickel</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>DDT</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
</tbody>
</table>

56. Surface water. The section of the Luo River within the Project area belongs to the Development and Utilization Area of Yan’an and Weinan City which defines the water functional zoning and water quality objectives as Class III under the *Surface Water Environmental Quality Standards* (GB3838-2002). Surface water within modified drainage systems including the drainage canals, Tianjiao Lake and the proposed Tianlu Lake are required to meet Class IV water quality standards. The water quality targets for Class III and Class IV surface waters are outlined in Table 4.

Table 4. Applicable Surface Water Quality Standards

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water temperature (°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human-induced environmental temperature changes should be limited to a mean weekly maximum rise ≤1°C and decline of ≤2°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>6-9</td>
<td>6-9</td>
</tr>
<tr>
<td>Dissolved oxygen (≥), mg/L</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Permanganate Index (≤), mg/L</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD) (≤), mg/L</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand for 5 days (BOD5) (≥), mg/L</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Parameter</td>
<td>Class IV Standard</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>6~9</td>
<td></td>
</tr>
<tr>
<td>Total hardness (as CaCO3)</td>
<td>5 mg/L</td>
<td></td>
</tr>
<tr>
<td>Sulphate</td>
<td>6 mg/L</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>20 mg/L</td>
<td></td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>4 mg/L</td>
<td></td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>1.0 mg/L</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Class IV Standard</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Volatile phenols (as phenol)</td>
<td>&lt;0.2 (lakes and reservoirs 0.05) mg/L</td>
<td></td>
</tr>
<tr>
<td>Permanganate index</td>
<td>1.0 mg/L</td>
<td></td>
</tr>
<tr>
<td>Nitrate (as N)</td>
<td>1.0 mg/L</td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>0.0001 mg/L</td>
<td></td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.005 mg/L</td>
<td></td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>0.05 mg/L</td>
<td></td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.05 mg/L</td>
<td></td>
</tr>
<tr>
<td>Chromium (hexavalent) (Cr6+)</td>
<td>0.005 mg/L</td>
<td></td>
</tr>
<tr>
<td>Total coliforms (per L)</td>
<td>0.05 mg/L</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>0.2 mg/L</td>
<td></td>
</tr>
<tr>
<td>Total hardness (as CaCO$_3$)</td>
<td>10,000 mg/L</td>
<td></td>
</tr>
</tbody>
</table>

59. Irrigation water. Agriculture within the Project area is classified based on the soil salinity and annual rainfall as saline-alkali dry land farming. Based on the *Irrigation Water Quality Standards* (GB5084-2005), irrigation water for this type of farming must comply with the standards listed in Table 7.

### Table 7. Irrigation Water Quality Standards

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard (GB5084-2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (no unit)</td>
<td>5.5~8.5</td>
</tr>
<tr>
<td>Total salinity</td>
<td>&lt;2,000 mg/L</td>
</tr>
<tr>
<td>Volatile phenols</td>
<td>1 mg/L</td>
</tr>
<tr>
<td>Fluoride</td>
<td>3 mg/L</td>
</tr>
<tr>
<td>Total arsenic</td>
<td>0.1 mg/L</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>0.1 mg/L</td>
</tr>
<tr>
<td>Chloride</td>
<td>350 mg/L</td>
</tr>
</tbody>
</table>

60. Air quality. The Project area is primarily developed for rural land uses, for which Level II air quality standards (Table 8) are applicable under the *Ambient Air Quality Standard* (GB3095-2012).

### Table 8. Air Quality Standards

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard (GB3095-2012) (mg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSP</td>
<td>0.30</td>
</tr>
<tr>
<td>PM10</td>
<td>0.15</td>
</tr>
<tr>
<td>NO$_2$</td>
<td>0.12</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>0.15</td>
</tr>
</tbody>
</table>

61. Noise standards. Based on the *Sound Environmental Quality Standards* (GB 3096-2008) the applicable ambient noise criteria ranges between Class II for residential areas to Class IV for industrial areas and transportation corridors. As a general rule, the project will adopt a target of Class II as the applicable noise limit for all works, as summarised in Table 9.

### Table 9. Standard limits of main ambient noise assessment factors

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Day time (dB)</th>
<th>Night time (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class II acoustic environment</td>
<td>60</td>
<td>50</td>
</tr>
</tbody>
</table>
The maximum sound level

Burst noises in all kinds of acoustic environment functional zones at night, the range of the maximum sound level exceeding the environmental noise limits shall not be higher than 15dB (A)

2.4.1 Pollution Discharge Standards

62. Wastewater Discharge. In accordance with the highest water environment function requirements of the Project area, wastewater discharge shall meet the Level I Standard applicable under the Yellow River Basin (Shaanxi section) Wastewater Discharge Standard (DB61/224-2011). For water quality parameters not included in this standard, the Level I Standard under the Sewage Comprehensive Discharge Standard (GB8978-1996) has been applied (Table 10).

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Integrated Standard for Sewage Discharge (mg/L)</th>
<th>Integrated Standard for Sewage Discharge in Shaanxi section of the Yellow River Basin (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids (SS)</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Biochemical Oxygen Demand</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Chemical Oxygen Demand</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Petroleum</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ammonia nitrogen</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

2.5 Applicable International Environmental Agreements

63. In addition to the legal framework within the PRC there are numerous international conventions, treaties and agreements to which the PRC is a signatory and which are also relevant to environmental conservation. These are described below.

64. The Ramsar Convention on Wetlands (Ramsar). The PRC is a signatory to Ramsar. This obliges the PRC to protect or make wise use of all wetlands, but especially those listed as Ramsar sites. "Wise use" of wetlands is defined as "their sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem". The primary concern of the convention is the welfare of wetlands and the waterfowl dependent on them. Article 1 of the convention defines wetlands as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters. The salt pans, streams, ponds, marshes, and reedbeds of the Project area, most of which are artificial and/or highly modified, qualify as wetlands under this definition. A wetland may qualify as a wetland of international importance if it (i) supports vulnerable, endangered, or critically endangered species or threatened ecological communities (criterion 2), (ii) supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions (criterion 4), and/or (iii) it regularly supports 20,000 or more waterbirds (criterion 5) (see: http://www.ramsar.org/cda/en/ramsar-about-faqs-what-are-criteria/main/ramsar/1-36-37%5E7726_4000_0__).
65. The wetlands in the Project area, particularly salt pans, support large seasonal populations of migratory waterbirds, including at least three species (possibly four) whose seasonal numbers meet or exceed the thresholds for global significance as defined by the Ramsar Convention (Section 5.4). This makes the Project area potentially eligible for Ramsar status. The Pucheng Luyanghu wetlands are not a Ramsar site nor are listed on the PRC priority list of wetlands.

66. Multi-lateral agreements. Various agreements have been reached between the PRC and other countries to protect and manage migratory waterbirds, including the following.

- Sino-Japanese Agreement on the Protection of Migratory Birds (1981), which protects birds from sale, over harvest, and habitat destruction.
- Sino-Australian Agreement for the Protection of Migratory Birds and their Environment (1 September 1988), which protects birds from sale, over harvest, and habitat destruction.

2.5.1 Coordination with Other Initiatives

67. The Project will become an integral part of the PRC-GEF Land Degradation Partnership in Dryland Ecosystems. It will consult and coordinate its activities with the provincial and national technical experts who have been involved in the Partnership. Notably these include the experts of the Shaanxi Provincial Project Coordination Office (PPCO) and the Provincial Project Management Office (PPMO). Moreover, the project will cooperate with the Integrated Ecosystem Management Data Center, that has been established in the Province. The Data Center has established monitoring procedures for land degradation in the province and has built up an important database of relevant information which is crucial for the proposed project.

68. Best practices for land degradation control in dryland areas of the PRC, such as the World Bank-financed project on salinization control by hidden pipe drain and its lessons\(^3\), will be capitalized on to ensure the success of the investment project. The Project will also benefit from lessons learnt from all seven projects under the PRC-GEF Partnership on Land Degradation in Dryland Ecosystems, its best practice publications and monitoring and assessment framework.

69. The Project will also develop close links with the FAO/UNEP/GEF project on Land Degradation Assessment in Drylands (LDAD) and its partner program World Overview of Conservation Approaches and Technologies (WOCAT) that is being institutionalized in the PRC, to identify suitable best practices for rehabilitation of saline soils.

70. In addition, synergies will be developed with the government-funded Desertification Prevention Programs that include Plain Farmland Shelterbelt System Program, Taihang Mountain Afforestation Program, and National Program for Prevention and Control of Desertification, including shelterbelt forests in the middle and lower reaches of the Yangtze and Yellow rivers.

2.5.2 ADB Guidelines and Policies

71. The SPS provides the basis for this EIA. The policy promotes international good practice as reflected in internationally recognized standards such as the World Bank Group’s Environmental, Health and Safety Guidelines.

---

72. All projects funded by ADB must comply with the SPS. The purpose of the environmental safeguards is to establish an environmental review process to ensure that projects undertaken as part of programs funded under ADB loans are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and are not likely to cause environmental, health, or safety hazards.

73. The SPS requires a number of additional environmental considerations to those generally undertaken in accordance with PRC Law, including (i) project environmental risks and respective mitigation measures and project assurances; (ii) project level environmental grievance redress mechanism (GRM) including documentation in the EMP; (iii) definition of the Project area of influence; (iv) physical cultural resources damage prevention analysis; (v) climate change mitigation and adaptation; (vi) biodiversity conservation and natural resources management requirements; and (vii) ensuring that the EMP includes an implementation schedule and measurable performance indicators. These requirements, which are usually not covered in PRC EIAs, have been considered in the development of the DEIS report to the EIA institutes’ best knowledge and capacity. All SPS requirements are covered in this EIA.
3. DESCRIPTION OF THE PROJECT

74. The Project area covers 21,200 ha (Figure 5, herein the ‘Project area’) and is located northeast of Weinan City, Shaanxi Province, mid-western PRC. The Project aims to improve land productivity and uses in Luyanghu area, and support the Luyanghu Development Zone Master plan (2007-2025) of attracting high-technology industrial investment, promoting tourism and creating job opportunities. The project impact will be sustained economic growth in Guanzhong–Tianshui Economic Zone.

75. The Project area is defined by the extent of the Luoxi drainage system infrastructure, and represents an area characterized by shallow groundwater at less than 2 metres below ground surface (mbgs) annual average. The Project area extends across Pucheng and Fuping counties, and is set within the Luoxi irrigation scheme covering 41,800 ha. The Project area and Luoxi irrigation scheme do not cover the full watershed area, which extends further north and has a total area of 1,207 km².

76. The Project will support WMG plans to develop the Luyang lake area, improving livelihoods and enhancing land uses by improving salt drainage systems, reducing flood risks, rehabilitating local wetlands and strengthening tourism opportunities. The total investment of the Project is estimated to be $165.2 million, including $100 million project co-financing from ADB, and the remaining in counterpart funds from government.

77. Investment will be used to: (i) rehabilitate 489 km of existing main and branch desalination drainage channels and improve associated bridges and roads along the canals; (ii) construct Tianlu Lake (130 ha), connecting to the adjacent Tianjiao Lake (80 ha) and wetlands to the west; and, (iii) rehabilitate and/or improve management of the remaining 860 ha within the Luyanghu NWP (total size 1,070 ha, including the two lakes). In addition, approximately 130 ha of forested shelterbelts will be established along the channels, roads and lake area; (iv) develop capacity for infrastructure and wetland management, and sustainable livelihoods in poor rural areas by providing training and establishing training facilities and materials and support development of tourism activities, and (iv) develop capacity on monitoring and evaluation procedures to support project management. Table 9 provides a summary of the key infrastructure improvement work components under the Project.

78. A $2 million GEF grant will provide technical assistance during Project implementation for: (i) improved agricultural management, through introduction of at least 10 innovative sustainable land and water management practices to improve agricultural management on saline lands, (ii) improved resilience to climate change of agro-ecosystems and reduced flood risk to local people, through the testing of at least two innovative and replicable practices in wetland rehabilitation and two practices for establishment of forested shelterbelts, in the drainage basin surrounding the lakes and salt pans, (iii) improved wetland management and rural livelihoods, including the integration of ecosystem services valuation into the park master plan, and pilot projects for community ecotourism, to provide a basis for local income-generation, and (iv) establish a comprehensive land management and monitoring framework, involving the agriculture, forestry, water resource, and rangeland sectors.
Notes: (i) the figure shows the proposed boundary of the Luyanghu National Wetland Park as of July 2012; (ii) green lines are irrigation canals in the Project area and part of the Luoxi Irrigation Scheme, indicated for information only; they are not part of the Project.
79. The Project outcome will be improved natural environment and rural livelihoods in the Luyanghu area, which will be achieved through the delivery of four key outputs (i) rehabilitated drainage system and reduced soil salinity, (ii) improved flood storage capacity in Luyanghu, (iii) improved wetland management and rural livelihoods in poor rural area, and (iv) supported project management.

80. The Project will be implemented over 5 years and is expected to commence in 2013. The WMG will be the executing agency (EA). A Project leading group of multi-agencies will be established, consisting of various government agencies such as Weinan Finance Bureau, Weinan Development and Reform Commission, Weinan Environmental Protection Bureau, Weinan Land Management Bureau, Weinan Water Services Bureau. The Project Management Office (PMO) set up by WMG will be a permanent office responsible for coordination among various agencies and a contact point with ADB.

81. The Project will be delivered by the WLMIDZMC, the Implementing Agency (IA). The WLCDC will establish a Project Implementation Office (PIO) and will provide guidance and support to the Project implementation unit including procurement management, disbursement, reporting and liaison with various government agencies.

Table 9. Summary of Key Infrastructure Improvement Works

<table>
<thead>
<tr>
<th>Drainage channel improvements</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation, dredging and repair of the main channel</td>
<td>21</td>
</tr>
<tr>
<td>Excavation, dredging and repairs to 3 branch channels</td>
<td>30</td>
</tr>
<tr>
<td>Excavation, dredging and repairs to 25 secondary branch channels</td>
<td>70</td>
</tr>
<tr>
<td>Excavation, dredging and repairs to 316 field drainage ditches (on farm)</td>
<td>369</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structures</th>
<th>Main channel</th>
<th>2ndary channel</th>
<th>On farm land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridges for vehicles</td>
<td>13</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>Bridges over irrigation channels</td>
<td>71</td>
<td>163</td>
<td>138</td>
</tr>
<tr>
<td>Channel confluence</td>
<td>25</td>
<td>70</td>
<td>246</td>
</tr>
<tr>
<td>Pipes</td>
<td>20</td>
<td>48</td>
<td>-</td>
</tr>
<tr>
<td>Pits</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Culvert</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pipe covers</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Constructed lake, protected wetlands and associated infrastructure</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tianlu</td>
<td>130</td>
</tr>
<tr>
<td>Wetlands</td>
<td>860</td>
</tr>
<tr>
<td>Emergency access (flood) roads</td>
<td>35.6 km</td>
</tr>
<tr>
<td>Shelterbelts</td>
<td>130</td>
</tr>
</tbody>
</table>
3.1 Rehabilitated Drainage System and Reduced Soil Salinity

82. The Project is set within a rural agricultural region dominated by irrigated agricultural land uses. The irrigation is part of the Luoxi Irrigation Scheme diverting water from the Luo and Yellow Rivers. Crops include wheat, maize, soybean, grape, peanuts, cotton, and fruit4.

83. As a result of poor soil drainage, high groundwater levels and high evaporation rates, soils within the Project area are moderately to highly saline, with soil salinity levels in the top 0.2 m classified as moderately salinized through most of the Project area5. Moderately salinized soil is focused in what has been termed the Luyanghu Depression6, which defines the Project Area and is characterized as the area of land with groundwater less than 2 mbgs (meters below ground surface), and covering an area of 21,200 ha.

84. High soil salinity results in reduced agricultural productivity of the land, estimated to reduce crop productivity by up to 50%7. While wheat, cotton, soybean are considered salt tolerant crops8, and maize, grape, peanuts and fruit trees less so, productivity of all crops is impacted to different degrees by increasing soil salinity. To improve agricultural productivity and increase local farmer incomes, the Project aims to increase salinity removal from the soil by improving drainage and lowering groundwater levels. Reduction in the level of soil salinity through improved drainage and groundwater table control is expected to provide direct benefits to the local farmers.

3.1.1 Existing Saline Soil Drainage System

85. In the 1970s, the PRC government commissioned the development of a system of drainage canals to draw down the groundwater level and improve salinity drainage from the soils within the Project area, known as the Luoxi drainage system. The Luoxi drainage system was constructed in 1974 and included over 380 km of main channels, branch channels, secondary branch channels, and field ditches within the Luyanghu Depression.

86. The drainage system remains operational today, with the key structures including four main channels: (i) the West Main Channel draining from the west through the wetland area into Tianlu Lake on the west side; (ii) the East Main Channel from the east into Tianjiao Lake on the east side; (iii) the Middle Main Channel draining from the north, in between the West Main and the East Main, in Tianjiao Lake where the two lakes join; (iv) the Central Main Channel, which is the exit channel from Tianjiao Lake through the exit control gates. This is the only exit channel of the drainage system. The following photos show the existing condition of the West, East, Middle and Central Channel.

---

4 Domestic Environmental Impact Assessment, 2012
5 PRC Guideline on Saline and Alkaline lands, 1997
6 Domestic Environmental Impact Assessment, 2012
7 PPTA Final Report Supplementary Appendix: Saline Soil and Agricultural Productivity, 2012
The main and branch channels extend to over 10 m depth in parts of the Project area allowing shallow groundwater to drain into the unsealed channel walls, resulting in reduced groundwater level and increased soil salinity drainage.
88. The original desalination system design was poorly constructed, particularly with regard to the gradient of the main channels which were too gentle\(^9\) and with respect to secondary branch channels and field ditches, partly due to insufficient investment.

89. The insufficient gradient of the main channels, especially in the lower sections, have led to sediment accumulation which has clogged the system and restricted drainage. In addition, lack of maintenance of the drainage system has also allowed accumulation of sediments, erosion and collapse of channel walls, blockages due to vegetation establishment, and disappearance of some secondary branch channels and field ditches. As a result the current drainage system is ineffective in reducing soil salinity levels and keeping groundwater levels at depth. Records show that the groundwater level in some parts of the Project area has been gradually rising since the 1980s and soil salinity has been increasing\(^10\). For example, depth to groundwater near the Town of Dangmu has risen from 8.94 m below ground surface (mbgs) in 1980 to 3.12 mbgs in 2012, and from 16.13 mbgs to 8.05 mbgs near Longchi Village over the same period.

90. The DEIS (2012) report notes that this has not only resulted in increasing soil salinity and decreasing agricultural productivity of large areas of agricultural land, rising groundwater has also resulted in housing foundation collapse and rising dampness in building floors making some existing houses uninhabitable. The DEIS (2012) reports 11,719 housing collapses, 18,478 block wall collapses, and 2,823 relocations within the Project area since 1992\(^11\), however supporting evidence for these claims could not be obtained as part of this assessment.

3.1.2 Proposed Channel Rehabilitation Works

91. The Project will include rehabilitation and expansion of the existing drainage channel system and construction of new field drainage ditches. The layout of the rehabilitated channels will be consistent with the layout of the original channels, with improvements to gradient, depth, drainage capacity, connectivity, and associated building structures. The proposed rehabilitation works have been designed based on hydraulic assessment and modelling of the drainage system undertaken by the local design institute, as outlined in the Feasibility Design Report\(^12\), with consideration for the soil salinity drainage, flood management, and wetlands conservation objectives of the Project. The Project does not include construction of new main channels or branch channels. The flow within the main channels will be controlled with 7 sluice gates, which will regulate flow volumes and allow management of the water level within the wetland and lakes. The location of the sluice gates and their functionality is detailed in the PPTA Final Report Technical Due Diligence Report 1: Rehabilitation drainage system and reduced soil salinity (2012).

92. Channel rehabilitation. The proposed channel rehabilitation works cover all four levels of channels, including rehabilitation of 21 km main channel, 30 km branch channel, 70 km secondary branch channel and 369 km of field ditches. Rehabilitation works will include excavation of in-filled material in existing channels, widening and contouring channel walls, and deepening channel bases. Field ditches between 1,000-1,500 m in length and spaced at 100-500 m will be constructed on existing agricultural areas without change to the existing farming. The field ditches will enhance the salinity drainage directly from cropping areas.

\(^9\) Feasibility Study Report, 2012
\(^10\) Domestic Environmental Impact Assessment, 2012
\(^11\) Domestic Environmental Impact Statement, 2012
\(^12\) Feasibility Study Report, 2012
93. Drainage channel excavation works will be undertaken with machinery and trucks to haul the material to disposal sites. It is estimated that approximately 2.5 million m$^3$ of spoil will be generated, which will be deposited to 8 locations within the Project area as clean fill.

94. Built infrastructure. The channel rehabilitation works will include the rehabilitation of the following associated infrastructure: (i) 407 main road and secondary (‘production’) road bridges passing over the main and branch channels. The bridge design adopted will be a simple slab supported bridge; (ii) 15 culverts, including rehabilitation of the west main canal intersection culverts under the Xi-Yan railway and the Xi-Han railway both over 50 m in length, 3 box culverts and 10 pipe culverts. Culvert rehabilitation work will include excavating fill material from the base of the culvert and reinforcing concrete and masonry structures; (iii) rehabilitation of 29 existing aqueducts required due to aging infrastructure in need of repair and replacement; (iv) replacement and rehabilitation of 183 confluences, including 32 confluences at the junctions of main channels and branch channels, and 141 confluence at the junctions of branch channels and secondary branch channels; (v) construction of 7 controlling sluice gates along the main channels which will control water level and flow volumes; and (vi) construction of 5 management offices.

3.1.3 Pilot Saline Soils Rehabilitation Best Practice Sites

95. Ten pilot sites will be used to introduce and test at least 10 innovative best practices in rehabilitation of saline soils on around 10 ha of land each, using biological measures, such as planting of ‘green manure’ (a type of cover crop grown to add nutrients and organic matter to the soil), cover crops, improved crop rotations, introduction of more salt tolerant crops, as well as agroforestry and water saving irrigation practices. Identification of these practices will be aided by global knowledge platforms, such as World Overview of Conservation Approaches and Technologies (WOCAT), and the UNCCD Performance Review and Assessment of Implementation System (PRAIS) module on Best Practices.

96. To increase adoption and uptake of good saline land management practices, Farmer Field Schools (FFS) will be established where experienced farmers take the lead in training other farmers. This will allow for the assessment of the environmental and socio-economic benefits, as well as replication and upscaling potential for further investment in the selected approaches and technologies. This, in turn, will maximize the impact of the investment component of the Project and ensure that promotion of saline land management on rehabilitated land will lead to increase in provision of ecosystem services due to improved vegetation cover, improved storage of carbon in soils and vegetation, and improved irrigation flows. These anticipated benefits are subject to detailed planning, still to be undertaken.

3.1.4 Improved rural livelihoods and inclusive growth

97. Rural households in the Project area are lagging behind in terms of access to social services and income, and particularly to opportunities for improving their livelihoods and living standards. The project will improve agricultural infrastructure and services related to agricultural production, thus providing the households with better and more secure income. Improved access to capacity development, training, and services such as extension will improve overall empowerment of the households and gender equity. Primary stakeholders will include rural households benefiting from saline soil improvement, flood control and overall environment improvement, and those households affected by land acquisition and resettlement. A total of 1,590 people (372 households) will lose their land use rights as a result of the Project, and will be compensated in accordance with the approved resettlement plan, and land acquisition will
involve 172 ha (2,588 mu) (Project Final Report – Supplementary Appendix 10). Secondary stakeholders include village committees and government units at township level and above, particularly the Luyanghu management committee. The proposed Project contains improved rural livelihoods, improved farmer incomes and improved agricultural productivity. The total incremental production increase as a result of soil salinity reduction over the life of the Project is estimated to be 102–398 million kg i.e. an increase in revenue of $32.4–126.3 million (CNY204–796 million) based on the 2012 average market price of Weinan municipality of $317 per metric tonne of wheat (Project Final Report – Appendix 5). Improved rural livelihoods and improved farmer income will be achieved by the end of project implementation to ensure reduction in poverty and improvements in livelihoods. The Project will also contribute to ADB’s overall vision of an Asia region free of poverty, and contribute to achievements under its strategy 2020 through inclusive growth.

98. The Project will not impact the few remaining residents in the Project area which conduct seasonal salt-harvesting. Under the proposed NWP, existing salt harvesting activities by residents will be permitted, avoiding the loss of this seasonal income for these residents. Salt harvesting has been identified as a key cultural value for ecotourism (Project Final Report – Supplementary Appendices 3 and 8), and this provides an additional possibility of income for such residents.

99. Women will benefit in various ways: Agricultural production in PRC is supposedly increasingly carried out by women, a fact that increases the workload on them. Improved arable land will increase the available income and thus improve the living standard of the women, and reduce the need for out-migration, thus potentially decreasing their workload: (i) the drainage system improvement will, among others, improve agricultural production and increase income and give them access to nonfarm activities; (ii) as ensured through the gender action plan (GAP), project implementation will improve women’s access to information and provide more opportunities for participating in public affairs; and taking part in project planning, implementation, and monitoring and evaluation, women will be entrusted with power and will develop a sense of ownership; (iii) a series of trainings will be provided to women and their concerns fed into the training schedules and curricula; and (iv) with more specialized industries, including tourism development, more opportunities will be offered for women to choose work; and their work independence will increase. Training and capacity development will provide women with new knowledge; and more importantly, with new channels for getting access to knowledge. The GAP includes features to (i) improve participation of women in project decision making, (ii) improve participation of women in associations created and/or strengthened under the project, (iii) ensure that women benefit from employment opportunities, and (iv) women benefit from capacities and skills development opportunities under the project. These features are aligned with the different project outputs.

3.2 Improved Flood Storage Capacity

100. A total watershed area of 1,122 km² drains through the Project area, discharging to the Luo River. Due to poor drainage and limited flood storage, the Project area is prone to soil water logging and flooding during the wet season (July–September). In particular, heavy rainfall events during August 2003 resulted in flooding of the lower areas within the Project area inundating an area of 270 ha with 0.5 to 2 m of flood waters. The August 2003 flood apparently resulted in loss of 19,036 houses, impacting 1,485 families in the area, and negatively affected almost

---

13 Feasibility Study Report, 2012
20,000 ha of cropped land. The direct economic loss was reported as more than CNY200 million. However, supporting information was not made available to confirm the extent of the flood impact.

101. To improve flood drainage and storage the Project will implement drainage improvement works outlined in the section above and the construction of Tianlu Lake to provide additional flood storage for flood control.

102. In accordance with the PRC Standards of Flood Control (GB50201 - 94), the additional flood storage and improved drainage has been designed for a 10-year flood event (the national flood standard for agricultural land). Additional flood protection has been allowed for the proposed Weinan-Luyanghu Development Zone, and includes increased drainage channel capacity in the area of the proposed industrial zone, designed for the 50 year flood event (following the national standard for commercial / industrial area flood protection).

3.2.1 Proposed Tianlu Lake Construction

103. The Project will include construction of a new lake, Tianlu, of 130 ha size and located in the low-lying Neifutan area in the Luyanghu depression. The lake will be connected with Tianjiao Lake, constructed in 2010–2011 prior to the Project (Figure 5). The combined area of both lakes will be 210 ha, with a total storage capacity of 5.4–10.8 million m³ in flood events, allowing a total free board of 3.3 m and additional flood storage capacity of 4.3 million m³. Tianjiao Lake covers an area of 80 ha and has a maximum depth of 7 m. It includes two islands with one connected by a land walking bridge, 1:5 sloping shores, and landscaped surrounding areas for recreational use. The lake currently receives surface water runoff, irrigation drainage, groundwater discharge and discharge of treated effluent from the Pucheng County Sewage Treatment Plant located 20 km to the north, which currently discharges 15,000 m³/day. Although the treated effluent from the treatment plant is reported to be in compliance with its discharge permit (Section 2.4.1), it is proposed that the treated effluent will be diverted prior to construction of Tianlu Lake, and will not be used to recharge the lake or wetlands.

**Figure 9. Aerial Photo of Tianjiao Lake construction in 2011**

Source: Google Earth (2012)
Construction of Tianlu Lake will involve the excavation of 130 ha of moderately saline agricultural land (20 ha) and wetlands (110 ha) including salt pans (Table 22). Figure 10 shows the proposed extent of Tianlu Lake excavation and current land uses. Land acquisition will be required, and local land owners and residents will be compensated in accordance with the Project resettlement plan and livelihood restoration measures.

Figure 10. Aerial Photo of Area of Proposed Tianlu Lake in 2011

Salt pans within the Project area provide important habitat for migratory waterbirds (Section 5.4). The total area of existing salt pans within the Project area is approximately 660 ha (Table 14). After the construction of Tianjiao Lake (which reduced the area of salt pans from 1,020 ha to 840 ha, a decline of 18%; Table 22), Tianlu Lake will result in the loss of another 110 ha [11%] of the remaining salt pans in the Luyanghu NWP. It is recommended that the lake design ensure that an equivalent area of shallow water brackish environment is provided to partially off-set the removal of the salt pan habitat. Additional off-site ecological offsets are proposed in Section 7.2 for the impact to the existing wetland habitat.

The proposed lake construction methods include dredging and excavation. Some areas of the lake are proposed to extend to 5 – 7 m in depth, contributing to the salinity drainage and flood control functions of the lake. Initial estimates suggest that excavation will result in approximately 7.9 million m$^3$ of spoil material. It is proposed that spoil will be directly reused on site for construction of an island(s) within the centre of the lake.

Design plans for Tianlu Lake have not been finalised and were not available during this EIA. Mitigation measures to address impacts to waterbird habitats have been developed and are included in the Project EMP (Appendix A) and include: (i) detailed lake design to reduce area of salt pans to be lost, based on the findings of the waterbird survey; (ii) a transitional zone between the western boundary of the lake and reed beds and salt pans to the west; (iii) disposal of spoil from lake excavation to areas east and north-east of the lake, away from remaining salt pan habitat; and (iv) the design of shallow-water areas, and shallow sloping banks, as waterbird
habitat in the lake (but given the anticipated recreational use of the lake it is likely the lake will have little value for waterbirds compared with the original salt pans).

108. Lake Water Balance. The Project design included consideration for the water balance of Tianjiao and proposed Tianlu lake. The water balance was determined based on (i) assessment of recharge from groundwater flow considering the entire watershed area, (ii) Luoxi drainage system, surface water runoff including the entire watershed area, and (iii) the Pucheng Sewage Treatment Plant, against the rate of evaporation and water loss due to leakages. The water balance was modelled for the seasonal change including higher recharge and evaporation during the wet season for each lake. Table 10 and 11 show the water balance determined for the proposed Tianlu Lake and both lakes combined for the months of May, August and December.

Table 10. Calculated Water Balance for Proposed Tianlu Lake

<table>
<thead>
<tr>
<th></th>
<th>May (m$^3$/d)</th>
<th>August (m$^3$/d)</th>
<th>Dec (m$^3$/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater Recharge</td>
<td>379</td>
<td>344</td>
<td>379</td>
</tr>
<tr>
<td>Luoxi drainage system</td>
<td>-</td>
<td>-</td>
<td>88,844</td>
</tr>
<tr>
<td>Surface runoff</td>
<td>64,833</td>
<td>126,254</td>
<td>6,742</td>
</tr>
<tr>
<td>Pucheng Sewage Treatment Plant</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total recharge</td>
<td>65,212</td>
<td>215,442</td>
<td>63,145</td>
</tr>
<tr>
<td>Total evaporation and leakage loss</td>
<td>(7,932)</td>
<td>(7,369)</td>
<td>(1,784)</td>
</tr>
<tr>
<td>Water Balance</td>
<td>57,280</td>
<td>208,073</td>
<td>61,361</td>
</tr>
</tbody>
</table>

Table 11. Calculated Water Balance for Tianjiao Lake and Proposed Tianlu Lake

<table>
<thead>
<tr>
<th></th>
<th>May (m$^3$/d)</th>
<th>August (m$^3$/d)</th>
<th>Dec (m$^3$/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater Recharge</td>
<td>723</td>
<td>723</td>
<td>723</td>
</tr>
<tr>
<td>Luoxi drainage system</td>
<td>-</td>
<td>192,201</td>
<td>121,200</td>
</tr>
<tr>
<td>Surface runoff</td>
<td>197,537</td>
<td>481,240</td>
<td>75,947</td>
</tr>
<tr>
<td>Pucheng Sewage Treatment Plant*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total recharge</td>
<td>198,260</td>
<td>674,164</td>
<td>197,870</td>
</tr>
<tr>
<td>Total evaporation and leakage loss</td>
<td>(15,143)</td>
<td>(14,069)</td>
<td>(3,406)</td>
</tr>
<tr>
<td>Water Balance</td>
<td>183,117</td>
<td>660,095</td>
<td>194,464</td>
</tr>
</tbody>
</table>


Note: * Pucheng Sewage Treatment Plant currently discharges 15,000 m$^3$/d to Tianjiao Lake, however the updated design for the proposed Tianlu Lake and Tianjiao Lake does not include discharge from the sewerage treatment plant, which will be diverted.

109. The water balance shows that (i) groundwater recharge remains constant over the seasons, (ii) recharge from the Luoxi drainage system is expected to be zero in May, increasing to a peak in the wet season, and remaining relatively high in December as the system continues to drain water from the wet and irrigation seasons, (iii) surface run off draining the watershed area of 1,207 km$^2$ is the main recharge for the lakes, and (iv) overall the recharge from all three sources is greater than the loss through evaporation and leakages, allowing the water level

---

within the lakes to be controlled by the amount of discharge released from the sluice gate on the southern side of Tianjiao Lake. The water balance calculation shows that recharge volumes are sufficient to maintain the water levels with the combined Tianjiao and Tianlu Lakes during the dry season\textsuperscript{15}.

### 3.2.2 Emergency Evacuation Roads

110. The project includes construction of 18.6 km of new emergency access and flood evacuation roads. The roads will be built surrounding the lakes with one central road through the middle of the two lakes including a bridge, and designed for multipurpose including emergency evacuation. The road will also be suitable for recreational needs, allowing people to walk and cycle around the lakes. The road design includes asphalt surface, compact clay pavement, concrete guttering and pedestrian foot paths, totalling 8 m wide, with a design life of 5 years. Roads will meet Class IV design standards and will be raised above flood levels.

111. It has been recommended that the detailed road design adopt the use of culverts and coarse gravel at the base of the road to improve permeability.

### 3.3 Wetlands Protection and Management

112. Wetlands within the Project area provide important ecological habitat (Section 4.2.3). However they have been degraded by agricultural encroachment, uncontrolled dumping of municipal waste, some local salt harvesting industry practices, and establishment of local roads. The Luyanghu National Wetland Park master plan (2008), approved as a pilot by SFA, established an initial plan for wetlands conservation of an area of 14.7 km\textsuperscript{2} including a 4 km\textsuperscript{2} constructed lake. However, by 2012 no progress had been made to develop the rehabilitation and conservation management within the 2008 plan (see Section 2.2).

113. The Project will include the following measures to improve wetland ecosystem health and conservation management: (i) finalization and implementation of the NWP master plan (Section 3.3.1), (ii) zoning of land within the NWP, and regulations in the NWP master plan, to support appropriate habitat management for the benefit of wetland biodiversity and sustainable local livelihoods, (iii) rehabilitation of degraded wetland areas, and (iv) support improved understanding and management of wetlands.

### 3.3.1 Wetland Protection and Rehabilitation

114. In February 2012, as part of the Project design phase, the Luyanghu NWP draft master plan (2008) was revised and updated by Qingdao University, in a document entitled ‘Draft Shaanxi Weinan Luyanghu Wetland Protection and Utilization Master plan’. The plan defines the revised area for the park (1,070 ha) and five functional zones (Figure 11). This document was used as the basis for discussions between the WMG, PPTA team and Qingdao University for park planning. The document does not fully address management of biodiversity, salt pans, and some other issues. As a result, a revised draft plan with additional recommendations was prepared by the PPTA team. This is described in the PPTA Final Report – Supplementary Appendix 9. During output 3 of the project, both draft plans will be used as the basis for participatory planning with residents and other stakeholders, to produce a single plan for official endorsement.

\textsuperscript{15} Domestic Environmental Impact Assessment Report, 2012
Figure 11a. Revised extent (2012) of the proposed Luyanghu National Wetland Park and functional zones

Note: For Key, refer to Table 12 identification numbers. Source: Draft NWP master plan, 2012.

Figure 11b. Proposed detailed boundary and zones for the western portion of Luyanghu National Wetland Park (areas 1 and 2), and two additional sites (areas 3 and 4) which could be included in the park.

Notes. This preliminary zonation for the western portion of the proposed Luyanghu National Wetland Park was based on waterbird surveys in September-October 2012. See Table 12 for functional zones. Area 1: habitat – salt pans, area – c.300 ha. Area 2: habitat – salt pans, area – c.120 ha. Area 3: possible extension to the park; area – c.62 ha. Area 4: possible extension to the park; habitat – active and abandoned salt pans; area – c.37 ha. Exact areas to be calculated during finalization of the NWP plan.

115. The proposed functions in the 2012 master plan by Qingdao University are similar to those described in the 2008 master plan as outlined in the following Table 12.
### Table 12. Draft 2012 Wetlands Master Plan Functional Zones

<table>
<thead>
<tr>
<th>Functional zone</th>
<th>Wetland types</th>
<th>Area (ha)</th>
<th>Proposed use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Conservation</td>
<td>Reed beds and salt pans</td>
<td>590</td>
<td>Regulated activities and access. Support ecological surveys/data collection.</td>
</tr>
<tr>
<td>2 Restoration</td>
<td>Salt pans</td>
<td>240</td>
<td>Restore the sodium sulphate harvesting ponds to natural wetlands</td>
</tr>
<tr>
<td>3 Public Education and Tourism</td>
<td>Salt pans</td>
<td>20</td>
<td>Ecotourism, showcase wetland ecology, public education on wetland functions</td>
</tr>
<tr>
<td>4 Recreation</td>
<td>Tianjiao Lake and proposed Tianlu Lake</td>
<td>210</td>
<td>Recreation and tourism, including boating and fishing</td>
</tr>
<tr>
<td>5 Management and Service</td>
<td>Naizi Village, Dangmu Township, eastern part of NWP</td>
<td>10</td>
<td>Management offices and tourism centre</td>
</tr>
</tbody>
</table>

116. The updated master plan (2012) by Qingdao University covers an area of 1,070 ha, whereas the 2008 master plan covers an area of 1,470 ha. The land area discrepancy is due to exclusion of 400 ha in the center of wetlands park along the canal connecting the western (Luobotan) and eastern (Neifutan) wetland areas. This area is cultivated farmland characterized by moderately salinized soils and does not include existing wetlands. It has been excluded from the plan due to no existing wetlands and to reduce the extent of resettlement associated with land acquisition of the national wetland park areas. The change in land area requires review and approval from SFA, which is being sought by the WMG. The area of 1,070 ha includes the two artificial lakes, Tianlu (130 ha) and Tianjiao (80 ha).

117. During PPTA studies, including a waterbird survey in September-October 2012, an additional 99 ha of active and/or abandoned salt pans was identified, which could be included in the NWP (Figure 11b). This would increase the total size of the NWP to approximately 1,169 ha (an increase of 8.5%). The 99 ha comprises two areas, one of 62 ha and one of 37 ha, both adjacent to the western portion of the proposed NWP (areas ‘3’ and ‘4’ in Figure 11b). The potential to include these two additional areas in the NWP will be assessed during output 3 of the Project.

118. During the project, the master plan will be developed in consultation with local communities residing in or adjacent to the wetlands. The plan will be implemented in a participatory manner and provide the basis for development of income generating activities to support sustainable livelihoods and protect wetland ecosystem services. Opportunities for establishing an eco-compensation mechanism for wetland protection will also be assessed. The Project will introduce and test at least two innovative and replicable best practices in wetland rehabilitation. Wetlands will be protected by testing of: (i) options for improved salt pan management; and (ii) opportunities for alternative livelihoods in wetlands, including community-based ecotourism.

119. Establishment of demonstration activities will a process of: (i) review of current land use, species/habitat knowledge as well as land-use rights in the NWP; supplement knowledge gaps with field surveys and village interviews; (ii) preparation of a short rapid assessment report.
indicating the confirmed or likely presence of key species (degree of certainty) with geographical information as to where in the NWP the key species persist and where they do not, a brief threats assessment on key species and their habitats and recommendations for their management; (iii) finalisation of the draft master plan (2012); and (iv) Identification of 2 possible demonstration areas for sustainable wetland management involving local communities.

120. Activities related to the eco-compensation mechanism will include: (i) review of legal and policy framework for long-term sustainable management of the NWP; (ii) review of eco-compensation models relevant to the Project area; (iii) review the draft NWP master plan, and recommendations for management by the PPTA team (PPTA Final Report – Supplementary Appendix 9) to identify possible eco-compensation mechanisms for the Luyanghu wetlands; and, (iv) preparation of a draft financing plan for implementation of the NWP master plan.

121. Improved management of the Luyanghu wetlands will enhance typical wetland functions, such as water quality improvement, flood storage, local climate moderation and provision of human foods.

122. The Project will support acquisition of 200 ha of land within the Luyanghu NWP, including land for construction of Tianlu Lake. Land acquisition and resettlement will be undertaken, managed and compensated in accordance with the Project resettlement plan.

123. Documenting the biodiversity of the Luyanghu wetlands. Little information exists on the biodiversity and natural resources of the Luyanghu wetlands. A considerable amount of new information on migratory waterbirds has been collected through the Project, but there is much scope for further surveys. Further baseline data will strengthen the development and management of the LNWP. The Project will ensure that further biodiversity surveys are included in the activities to be conducted during development of the NWP, and will include for the following groups, as well as the establishment of monitoring stations to record seasonal water levels and salinity concentrations in the wetlands; and, waterbird monitoring. Personnel and agencies to undertake these studies will be identified during Project implementation in discussion with the PMO, EPB, forestry bureau, and Shaanxi Animal Research Design Institute, and will probably include these agencies as well as local academic institutions.

- **Flora.** Surveys will describe the vascular flora and vegetation communities of the Luyanghu wetlands. This information will assist in developing rehabilitation plans.

- **Invertebrates** - salt pan invertebrate fauna, shellfish, dragonflies, damselflies. The salt pan invertebrate fauna will provide an index of forage availability to migratory waterbirds. Dragonflies and damselflies are bio-indicators of water quality.

- **Fish.** Fish numbers, body sizes, and species richness are important indicators of ecosystem health, including water quality, and conservation effectiveness.

- **Amphibians and reptiles.** Almost no data is available on these groups for the Project area.

- **Mammals.** Mammals are poorly known at the NWP and surveys will be needed to confirm presence of some species. Mammal surveys often involve trapping (rodents and other small mammals) but some data can be collected by general observation and/or camera-trapping. Mammals listed on the NWP are active throughout the year so there is no seasonal requirement for sampling.
124. Rehabilitation works. A wetland rehabilitation plan will be prepared under the draft NWP master plan as part of the project EMP. This will focus on three broad habitats: the reedbeds, saltpans, and shores of Tianlu and Tianjiao Lakes. Reedbed rehabilitation will include (i) identification of the existing land tenure and use (if any) of the reedbeds by local communities, through community meetings; (ii) participatory delineation with local residents and other stakeholders of the reedbed areas; (iii) the development of regulations for inclusion in the NWP master plan which (a) enable continued local use of the reedbeds for local livelihoods, so long as these are sustainable and regulated and (b) halt any current commercial development in the reedbeds and prohibit any future development; (iv) development of a plan, prepared with local participation, to restore patches of degraded habitats in the reedbeds. This may include removal, filling, re-contouring of old/abandoned drainage and irrigation channels, constructed bunds, and dykes. For the saltpan habitats, existing solid waste, abandoned power supply poles and wires, and demolition and removal of most buildings, will be implemented. For Tianlu and Tianjiao Lakes, lakeshore vegetation and reed beds will be established.

125. The Project will include pilot tests of at least two innovative and replicable best practices in wetland rehabilitation, identified through global knowledge platforms, such as WOCAT and UNCCD/ PRAIS and the active input of an international wetland ecologist.

126. Hydrological connection with drainage system and buffer zone. The Project design allows the Luoxi drainage system to continue to drain into the wetlands, ensuring the wetlands will remain hydrologically connected with the regional water system. Drainage runoff passing through the wetlands also provides a benefit of passive water treatment as described below. The drainage channel rehabilitation works will include a buffer zone around the wetlands, in which the channel depth will gradually be reduced over a distance of between 0.5 to 4 km to the equivalent level of the existing groundwater. This design will mitigate the risk of adverse impacts to hydrology of the wetlands as a result of drawing down groundwater level to 1.8 mbgs within agricultural areas. The total area of the buffer zone is estimated at 2,542 ha.

127. Passive wetland water treatment. The project will support enhancement of the wetlands natural water quality treatment functions. Wetland systems commonly provide passive water treatment through a variety of complex natural chemical, physical and biological processes, including sedimentation, precipitation, adsorption, assimilation from the plants and microbiological activity. Case studies have shown wetlands have the potential to purify water by removing chemical oxygen demand (COD) up to 80%, NH3-N in the range of 40-96%, total nitrogen (TN) in the range of 64-98%, and total phosphate (TP) in the range of 47-97%. Phragmites wetland reed species, which are the most common within the Project area, are known to be effective in reduction of nutrients. The Project will enhance the wetlands nutrient reduction functions by promoting poly-culture Phragmites wetland models, which include use of Phragmites australis, Typha angustata, and Zizania latifolia with stem density ratio in the order of 8:1:5:1, which has been shown to be the most effective in nutrient reduction. Before any

---

16 World Bank, 2010, Sanitation, Hygiene and Wastewater Resource Guide
rehabilitation is implemented, a restoration plan will be prepared, which identifies the most suitable species.

128. Wetland Management Training. The Project will include a full time national wetlands specialist within the Project Implementation Office (PIO) and support of an International Wetlands Specialist to support a wetlands management training project. The training program will focus on wetland and saline land management, including training of officials on wetland ecosystem functions and management. This component will build capacity, through a training program, of local officials and villagers in wetland and saline soil management to improve ecosystem functioning and rural livelihoods. Staff of at least two nearby wetland reserves will be included in the training.

3.3.2 Forested shelterbelts

129. Forested shelterbelts are proposed to be established adjacent to the new roads. Their purpose is to reduce soil erosion and improve amenity. The forested shelterbelts will be up to 30 m wide and cover an area of 130 ha. The species will include a combination of (i) locally adapted tree species including *Fraxinus*, Black locust *Broussonetia papyrifera*, Pagoda tree *Koelreuteria paniculata*, *Rhus typhina*, *Pyrus betulaefolia*, and (ii) locally adapted small shrubs including *Tamarix chinensis*, *Ligustrum vicaryi*, *Cornus alba* and *Sorbaria sorbifolia*. The Project will support pilot testing of at least two ‘innovative and replicable best practices’ for the establishment of shelter belts in the Luyanghu area. A ‘Greenway System’ will be established to provide wind protection to crops and soils and increase visual amenity along roads and walking paths. These will also lead to increased carbon sequestration below and above ground.

3.3.3 Salt Harvesting

130. The Project area has a long history of salt harvesting. This has apparently declined in recent decades, but it continues to provide some residents with a seasonal income (PPTA Final Report – Poverty and Social Assessment Report, 2012). Salt harvesting occurs in approximately 200 ha, all within the proposed NWP. To protect this cultural heritage and maintain a diversity of local incomes, under the NWP master plan the Project will promote tourism opportunities associated with the history of salt harvesting in the area. The Project will provide training support for salt harvesting in coordination with the implementation of the NWP, to focus on environmental sustainable practices in salt harvesting and supporting improved socio-economic aspects of the salt harvesting industry.

3.3.4 Ecotourism

131. Under the Weinan Luyanghu Modern Industrial Development Zone master plan (2007-2025), the WGC intends to promote tourism in the Project area. Tourism values include salt harvesting history and proximity to Xi’an City. Under the Project, opportunities for ecotourism will be assessed and which may be included in the NWP master plan are ecological walk-ways, bird watching hides, and tourist zones in Lutanguyun, Jiatancangyan and Xiangtimaibu. The Project will support the establishment of an ‘ecotourism incubator’ to develop a network of competitive ecotourism and agri-tourism (e.g. homestay, organic produce) business. PPTA studies also identified the potential for a ‘salt eco-museum’, a wetland ecological visitor centre, and creation of a greenway system (PPTA Final Report – Supplementary Appendix 8).
4. DESCRIPTION OF THE ENVIRONMENT

4.1 Overview

132. The Project covers an area of 21,200 ha (Figure 5) and is located northeast of Weinan City, Shaanxi Province, mid-western PRC. The Project area is defined by the extent of the Luoxi drainage system infrastructure, and represents an area characterized by shallow groundwater at less than 2 mbgs annual average. The Project area extends across Pucheng and Fuping counties, and is set within the Luoxi irrigation scheme covering 41,800 ha. The Project area and Luoxi irrigation scheme do not cover the full watershed area, which extends further north and has a total area of 1,207 km$^2$. The watershed is part of the Wei River Basin, which covers 135,000 km$^2$.

133. The Project area is located in a region with a long history of irrigation and as a result is highly modified by human activity. The land uses includes approximately agricultural land, planted forest, planted and natural low-lying shrub land, 800 ha of existing wetland vegetation, and 80 ha of constructed lake, Tianjiao. Infrastructure within or adjacent to the Project area includes the Xiyu Expressway in the north, and the Weipu Expressway and Weiqing highway in the east of the Project area. The Xiyan and Xihan railway lines pass through the Project area.

134. The following section provides a description of the physical, ecological and social environment within the Project area, and the subsection Section 5 provide quantitative baseline data from field monitoring and published information.

4.2 Physical Environment

4.2.1 Topography and Geomorphology

135. The Project area is located in a topographic region known as the Guanzhong Plain, a regional alluvial plain including the Wei, Jing and Luo Rivers. The Guanzhong Plain is characterized by deep fertile soils and rich agricultural production. Bordering the Guanzhong Plain is the Qinling Mountain Range to the south and Weibei Terrace Region to the north. The elevation within the Project area ranges from 370 m to 650 m above sea level, sloping towards a low point within the wetland area and ultimately to Tianjiao Lake, the lowest point within the Project area. The landforms within the Project area can be divided into three broad types (i) piedmont alluvial plains, (ii) loess tableland, and (iii) valley terraces.

136. Piedmont alluvial plains. The Piedmont alluvial plains exist within the north part of the Project area (Mei Yuan and Puotou region), with an elevation between 470 m and 650 m, sloping to the south at between 1° to 5°, and are characterized by alluvial sedimentary deposits.

137. Loess tableland. The Loess tableland exists within the central and southern part of the Project area (Yuanren and Liugu regions of the south and Pucheng, Xingzhen and Wangliao regions of the central area). The tableland elevation is between 400 m and 570 m, composed of loess and paleosol soils, typically moderately salinized. The Loess tableland includes the Lupotan Depression which is manifest as low-lying in the central southern part of the Project area hosting wetlands, salt pans and Tianjiao Lake. The Lupotan Depression has an elevation of between 370 m and 410 m.

---

20 Domestic Environmental Impact Statement, 2012
Valley terraces. The Wei River and Luo River Valley Terrace geomorphology (‘valley terraces’) exist within parts of the south and east of the Project area. The valley terraces are characterized by thick river flood plain deposits including sandy loam, silt, sand and pebble layers.

Figure 12. (a, b) Piedmont alluvial plains, (b) Loess Tableland, (c) Valley Terraces

4.2.2 Geology

The Project area is located within the eastern section of the Wei River fault zone, part of the Qinling tectonic system. The Wei River fault zone is over 45 km long and formed during the Cretaceous period (65-145 million years ago). The fault zone remains active and earthquakes have been recorded as recently as the 300 years ago. Geothermal hot springs exist in the surrounding areas, but not within the Project area, associated with the existence of the fault zone.

Lake sediments of Quaternary and Pleistocene age within the Project area show the historic presence of a lake during this period, greater than 11,000 years ago, known as the Sanmen Lake. The lake was in-filled over time with sediments eroded from surrounding topography. Tectonic activity during the Holocene Period resulted in the subsidence and eventual disappearance of Sanmen Lake.
Near surface geology within the Project area comprises deep, greater than 100 m below ground surface (mbs), sedimentary strata including sand stone and silt stone underlying unconsolidated clays, silts, sands, and gravels deposited in lacustrine (lake), pluvial (rain/runoff) and alluvial (river) environments.

4.2.3 Climate

The Wei Basin is within a warm to mild temperate climatic zone. Average annual precipitation is 516 mm, evaporation 1,652 mm, and temperature $13.3^\circ$C, as shown in Table 13 along with other key climatic data for Pucheng and Fuping.

| Table 13. Climatic information from Pucheng and Fuping Weather Station (1976-2010) |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec    | Yr    |
| Average Temp ($^\circ$C)        | -1.2   | 2      | 7.7    | 14.4   | 19.9   | 25.2   | 26.7   | 25.5   | 19.8   | 13.8   | 6.3    | -0.2   | 13.3  |
| Max Temp ($^\circ$C)            | 17.1   | 22.5   | 27.3   | 33.5   | 40.1   | 41.8   | 41     | 39.9   | 38.4   | 32.5   | 25.4   | 16.2   | 41.8  |
| Min Temp ($^\circ$C)            | -16.7  | -14    | -9.6   | -5.3   | 0.7    | 10.6   | 15.3   | 13     | 3.3    | -3.7   | -10    | -16    | -16.7 |
| Average precipitation (mm)      | 5.3    | 10.1   | 19     | 31     | 51.6   | 55.9   | 102.6  | 100.9  | 73.3   | 47.5   | 14.3   | 4.9    | 516   |
| Average evaporation (mm)        | 47.9   | 72.4   | 112.5  | 164.2  | 210.6  | 254.7  | 233.1  | 207.4  | 139.3  | 103.3  | 63.3   | 44     | 1,652 |
| Average Relative humidity       | 56     | 55     | 60     | 61     | 62     | 58     | 70     | 72     | 73     | 70     | 68     | 60     | 64    |
| Average sunshine hours          | 173    | 154    | 169    | 191    | 22     | 228    | 232    | 231    | 170    | 167    | 160    | 173    | 2277  |
| Average wide speed              | 2.3    | 2.7    | 2.9    | 2.9    | 2.7    | 2.7    | 2.7    | 2.7    | 2.4    | 2.3    | 2.3    | 2.2    | 2.6   |
| Maximum wind speed              | 16     | 17     | 18     | 21     | 20     | 18     | 17     | 15     | 15     | 17     | 16     | 19     | 21    |

Source: Domestic Environmental Impact Assessment Report, 2012

There is a large deficit in average annual rainfall versus evaporation, which is partly responsible for the high evaporative salt concentrations in soil within the Project area. The wet season occurs during July to September, as shown in Figure 13. Rain events during the wet season are commonly short and intense, resulting in rapid increases in runoff volumes resulting in soil water logging and flooding.
Surface water. The Project area exists within the Wei river basin which covers 135,000 km². The Wei River originates on the Loess Plateau of northern Gansu province and ends at the Wei confluence with the Yellow river. The Luo river, the second largest tributary of the Wei River Basin, joins the Wei river at a confluence southeast of the Project area.

Surface water from the Project area drains directly into the Luo River approximately 10 km to the east from the main channel (Figure 14), at which point the Luo River is approximately 50 m wide, with characteristically heavy suspended sediment loads and poor water quality. The average salinity of the Luo River is 800 mg/L to 1,100 mg/L.

The broader watershed drains southeast into the Project area including Tianjiao lake, discharging to the Luo river via the main channel. Surface water entering the Project area from the upper watershed is controlled by the Luoxi drainage system, primarily entering the Project area through the north and west main channels. The size of the watershed draining into the Project area and poor drainage within Project area are two key factors which have resulted in the higher flood risk within the area. In addition the annual flow volumes of the Luo River are characteristically uneven, rising and falling rapidly in response to rainfall events, making it prone to flooding during the wet season. Large flood plains with thick flood sediment deposits are common along the Luo river (Figure 14).

Climate change. Analysis of climate records in Shaanxi province reveals that temperatures are rising, especially in winter, with warmer winters more noticeable in the north and centre (e.g. the Guanzhong plain), average annual precipitation has decreased, and the incidence of extreme weather events has increased, including record high summer temperatures, droughts, floods and waterlogging.

---

21 Weinan Environmental Protection Department monitoring data, 2012
Figure 14. Luo River

![Image of Luo River]

Source: Domestic Environmental Impact Assessment Report, 2012

Notes: (right) Downstream of Luohe River at the entrance of general ditch main, (left) Segment of Luohe River near Dongli Village, Dali County.

148. The Project area receives additional water for agricultural irrigation from the Luohui Luoxi Irrigation System, which pumps water from the Yellow River.

Figure 15. Central Irrigation Canal (left), Tianjiao Lake (right)

![Image of Central Irrigation Canal and Tianjiao Lake]

Source: Domestic Environmental Impact Assessment Report, 2012

149. Tianjiao Lake covering 80 ha and 910 ha of wetlands is located in the center of the Project area, and are the only surface water bodies within the Project area. Tianjiao Lake is the lowest point in the Project area and receives surface water runoff from the watershed, drainage from the Luoxi irrigation system and groundwater discharge. The lake area is historically prone to flooding, which the storage capacity of the lake is designed to mitigate.

150. Wetlands cover approximately 910 ha in the Project area and occur in the lowest sections of the Luyanghu Depression, within the pilot national wetlands park area. The wetlands receive water from surface water runoff from the watershed, drainage from the Luoxi irrigation system and groundwater discharge. No water level monitoring information was available for the wetlands. The description provided here is based on site observations during the PPTA
assessment period (July 2011 to June 2012). The wetlands are of three basic types (i) salt pans (shallow), (ii) salt pans (deep water and ponds), and (iii) reed beds. The NWP also includes areas of agricultural land, which are referred to as other uses. The total area of each type of wetland is summarised in Table 14 and each type is described below.

<table>
<thead>
<tr>
<th>Table 14. Wetland Habitat Areas and Distribution (2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Salt pan (shallow)</td>
</tr>
<tr>
<td>Salt pan (deep) + pond</td>
</tr>
<tr>
<td>Reedbed</td>
</tr>
<tr>
<td>Lake (artificial) ^1</td>
</tr>
<tr>
<td>Other ^2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

1^Tianjiao Lake (under construction). 2^Cleared, agricultural, residential land, forested, and/or infrastructure. 3^The proposed Tianlu Lake will replace 130 ha of mostly shallow salt pan habitats (see Table 22). LWNP=Luyanghu National Wetland Park. Source: estimated from Google Earth satellite imagery (2011).

151. Salt pans (shallow water). Shallow (<0.1 m water depth) artificial salt pans are used in the wetland area for the production of hydrous sodium sulphate (Glauber’s salt). The ponds are segregated by small earth bunds, and water depth within the ponds is regulated at about 0.1 m by a series of graduated discharge points. Within the active salt pans, saline groundwater (salinity >10,000 mg/L) is pumped to the surface from shallow surface water aquifers under the salt pans using small diesel pumps. Groundwater pumped to the surface is allowed to drain and evaporate from the bunded areas. Excess water that is not evaporated drains to the main channel eventually entering Tianjiao Lake. The salt evaporate is manually harvested and sold as a product. Salt pans exist in the Neifutan (east) and Luobutan (western) wetland areas. These shallow wetland habitats support different habitat (shallow water salt pans) and different waterbirds (small and medium sized waders) compared with salt pans in the west of the Project area (deeper water salt pans and ponds, used more by waterfowl - ducks, geese, large waders) (Section 4.3.2).

**Figure 16. Evaporative salt ready for harvest (right), Salt pans (left)**

[Image of evaporative salt and salt pans]

Source: Domestic Environmental Impact Assessment Report, 2012
152. Salt pans (deep water and ponds). Abandoned salt pans exist primarily in the western area of the proposed NWP, known as Luobutan (Figures 17 and 18). These salt pans are deeper ranging up to approximately 0.5 m water depth, larger, and more isolated, than those in the eastern portion of the area. The salt pans resemble an interconnected pond system, however are clearly the result of past salt harvesting activities. The abandoned salt pans do not receive water from artificial pumping of groundwater, and are susceptible to periods of dry weather which may cause water depths to change. They support migratory ducks, rails, herons, egrets, cormorants, and grebes, whereas the eastern salt pans are more shallow and support migratory shorebirds such as plovers, lapwings, curlews, sandpipers. The proposed construction of Tianlu Lake will only impact the eastern salt pans.

Figure 17. Deeper water salt pans in Luobutan

![Deeper water salt pans in Luobutan](source: D.Todd photo, 2012)

Figure 18. Deeper water salt pans and ponds in Luobutan

![Deeper water salt pans and ponds in Luobutan](source: Google Earth, 2012)

153. Reed beds. Reed beds exist at the lowest areas of the Project area, at approximately 369 m elevation. The water level within the reed beds varies and was not determined accurately, but is estimated to be in the order of 1 m depth based on visual observations. There is a large area of reed beds within the central part of the pilot Luyanghu national wetlands park.
as shown in Figure 15, which will be rehabilitated as part of the Project (see para. 130). These reeds beds are dominated by mono-culture of *Phragmites communis* reed species (Figure 16, further described in Section 4.3.1) and show evidence of dumping of general waste in some areas (Figure 16).

**Figure 19. Aerial view of central reed beds 2011**

![Aerial view of central reed beds 2011](source: Google Earth, 2012)

**Figure 20. Phragmites communis reeds (left), Illegal waste dump in reed beds (right)**

![Phragmites communis reeds and waste dump](source: D.Todd photo, 2012)

### 4.2.4 Groundwater

154. Groundwater within the Luoxi Irrigation scheme ranges in depth from 50 mbgs in the north to <1 mbgs in the wetlands and Tianjiao Lake. Within the Project Area (21,200 ha) depth to groundwater is on average ≤2 mbgs. Groundwater flow direction is variable but in general flows towards the southeast. Groundwater salinity is >10,000 mg/L in some places. High salinity of groundwater renders it is mostly unsuitable for irrigation or drinking purposes. Saline groundwater is extracted in the salt pans for salt harvesting.
4.3 Ecological Environment

Flora and fauna recorded within the Project area are summarised in Table 15. The diversity of the Project area is considered to be depleted due to environmental degradation as a result of human activities.

Table 15. Known numbers of wildlife species in the Wei River basin

<table>
<thead>
<tr>
<th>Species Group</th>
<th>Numbers of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Orders</td>
</tr>
<tr>
<td>Total vascular plants</td>
<td>19</td>
</tr>
<tr>
<td>Fish</td>
<td>2</td>
</tr>
<tr>
<td>Amphibians</td>
<td>1</td>
</tr>
<tr>
<td>Reptiles</td>
<td>1</td>
</tr>
<tr>
<td>Birds</td>
<td>14</td>
</tr>
<tr>
<td>Mammals</td>
<td>4</td>
</tr>
<tr>
<td>Total vertebrates</td>
<td>22</td>
</tr>
</tbody>
</table>


4.3.1 Flora

The flora within the Project area belongs broadly to the Guanzhong Plains region characterised by deciduous broad leaf forests. The region has a long history of agricultural development and natural forest cover has largely been removed to provide for crop land. Few
isolated patches of natural forest remain in steeper valleys and areas not suitable for cultivation. In these areas species include Hawthorn, Walnut, White pear, Pyrus betulaefolia, and small shrubs (Sophora davidii, wild Jujube, Rosa davurica, Vitex, Elaeagnus pungens, Sea Buckthorn). In cultivated areas, the main introduced tree species includes Ailanthus, elm, Paulownia, Chinese scholar tree, Robinia pseudoacacia and poplar. Fruit tree crops include apple, walnut, apricot, persimmon, pomegranate, peach, pear, and jujube. A large proportion of the region is cultivated for primarily crops wheat, corn, beans, buckwheat and cotton with smaller areas of grape, peanut, cotton and tobacco.

157. The NWP master plan (2008) lists 34 species of vascular plants, occurring within the Wei River Basin. Extensive loss and alteration of wetland habitats for agriculture in the area has resulted in loss of large areas of natural habitat. By comparison, at least 287 flora species have been documented in the Shaanxi Yellow River Nature Reserve. The species inventory in the master plan (2008) list is incomplete and further surveys are recommended to properly characterise the vegetation communities of the NWP and project area. Native flora in the Project area includes shrubs, grasses, and wetland reed beds, as follows.

(i) Shrub species native to the Project area include woody Phanerophytes, Hippophae rhamnoides and Elaeagnus pungens. These are scattered on riversides, roadsides and farm paths in the Project area.
(ii) Grass species native to the Project area include Phragmites australis, Suaeda salsa and Artemisia scoparia communities on the sides of drainage ditches and abandoned farmlands. Where soil salinity is <0.3%, other species include Artemisia capillaris, Setaria and Pennisetum.
(iii) Reed beds. Wetland flora is dominated by Phragmites communis, widely distributed in drainage depressions and wetlands. These communities are sensitive to soil moisture content, preferring submerged soil, and die back in the dry season. Salt tolerant grasses Suaeda salsa and Artemisia scoparia exist in the wetlands. The reeds provide habitat for some birds (e.g. herons, egrets) and cover for many wildlife species. Reed beds in the Project area are threatened by expansion of farmlands.

**Figure 22. Project area Vegetation Types**

Source: Domestic Environmental Impact Assessment Report, 2012
158. Species of Conservation Concern. None of the 34 species of vascular plants listed in the Luyanghu NWP master plan (2008) are listed as conservation concern in the Red Data Book of the PRC or the Shaanxi Province Priority Lists. The flora inventory for the park is not complete. A baseline flora survey will be conducted as part of output 3 to inform revision and finalization of the master plan.

159. Cultivated flora within the Project area includes wheat, corn, soybean, supplemented by cash crops such as grape, peanut, and cotton. Most of these crops are harvested twice a year. There is also a small amount of tobacco cultivation. Fruit tree crops include apple, walnut, apricot, persimmon, pomegranate, peach, pear, and jujube. Forested shelter belts exist through the Project area established to improve soil stability, reduce impacts of wind erosion and improve amenity. The primary shelterbelt species include Chinese Scholar and *Robinia pseudoacacia*, commonly planted in rows along drainage lines, roads, and at the boundary of agricultural land. The trees grow to between 10 m to 16 m in height.

### 4.3.2 Fauna

160. The following section presents a summary of fauna within the Project area, based on information reported in PPTA Final Report, Supplementary Appendix 2, Wetland and Biodiversity Management Thematic Study.

161. At least 111 species of terrestrial vertebrates have been recorded in the Project area, based on survey data of wildlife in Luyanghu Lake area and field surveys conducted as part of this assessment (Table 15). A full list of Fauna species recorded in the Project area is presented in the PPTA supplementary report on waterbird impact assessment. Birds account for most of the reported vertebrate species, partly because they have been studied in greater detail than other classes of fauna within the Project area. Aquatic fauna within the Project area includes six species of fish including carp, crucian carp, and catfish, along with species of freshwater crabs and water clams. Surveys of fauna are incomplete for the Project area and it is likely that species numbers are greater than the 111 reported.

#### Table 16. Numbers of reported wildlife in the Project area and the lower Wei river basin

<table>
<thead>
<tr>
<th>Species Group</th>
<th>Orders</th>
<th>Families</th>
<th>Genera</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PA</td>
<td>WR</td>
<td>PA</td>
<td>WR</td>
</tr>
<tr>
<td>Fish¹</td>
<td>2</td>
<td>nd</td>
<td>3</td>
<td>nd</td>
</tr>
<tr>
<td>Amphibians²</td>
<td>1</td>
<td>nd</td>
<td>2</td>
<td>nd</td>
</tr>
<tr>
<td>Reptiles³</td>
<td>3</td>
<td>nd</td>
<td>3</td>
<td>nd</td>
</tr>
<tr>
<td>Birds¹</td>
<td>15</td>
<td>15</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Mammals³</td>
<td>4</td>
<td>nd</td>
<td>7</td>
<td>nd</td>
</tr>
<tr>
<td>Total vertebrates</td>
<td>25</td>
<td>nd</td>
<td>50</td>
<td>nd</td>
</tr>
</tbody>
</table>


162. Species of Conservation Concern. Species of conservation concern include those listed in the PRC Red Data Book, protected nationally or in Shaanxi Province, or listed as globally threatened in the Red List of IUCN World Conservation Union. The Project area supports 24
species and the Wei River basin supports 31 species of conservation concern (PPTA Supplementary Appendix 9 – draft wetland management plan).

163. The Project area has records of three globally threatened fauna species, Chinese Softshell turtle *Pelodiscus sinensis* (Vulnerable), Great Bustard *Otis tarda* (Vulnerable) and Saker Falcon *Falco cherrug* (Vulnerable).

164. The Chinese Softshell inhabits rivers and associated wetlands, and is native to PRC. Wild populations are under pressure from hunting and collecting. The 2008 NWP master plan lists the species as occurring in the Project area, but no data is available to substantiate this record. The high salinity of the wetlands suggests the Project area is not optimal habitat for the species. Most remaining wetland habitat in the Project area will be designated within the NWP, ensuring any remnant turtle populations are protected. A baseline survey for amphibians and reptiles, to be conducted for output 3 of the Project, will further assess the local status of this species.

165. The Great Bustard is a migratory bird species and is a winter resident of the Wei River basin. Although it is mentioned as occurring in the Wei River floodplain and/or the Project Area it appears very unlikely that the species currently occurs within the Project Area. Qingdao University has confirmed to the PMO that inclusion of the species in the park list was an error (Mr. Hou, pers. comm. 7 October 2012).

166. Saker Falcon was recorded in the Project Area in October 2011 (one individual; T. Dahmer pers. obs.), March 2012 (two individuals; T. Dahmer and M. Bezuijen pers. obs.) and September 2012 (one individual; D.S. Melville pers. obs.). The Chinese population is currently estimated at 3,000–7,000 pairs (BirdLife International 2012c), thus the few birds recorded account for less than 1% of the national population. The Project area is within the known winter range of the species, but birds will only be present if there is sufficient food. The Saker Falcons recorded in the Project area may be passage migrants or wintering birds. On the basis of current knowledge the site cannot be considered to be internationally important for Saker Falcon.

167. The Project area provides habitat to at least 87 recorded species of birds, with large population numbers occurring within the wetlands areas. The bird species include (i) migratory birds frequenting the Project area during spring and autumn, including the Black Stork, Great Bustard, Upland and Common Buzzard, Long-eared owl, Hen Harrier, Grey Crane, Great Egret, and the Bean Goose, (ii) summer resident bird species including the Kestrel, Merlin, Ruddy Shelduck, and Mallard, and (iii) year long resident birds including the Little owl and Heron. Incidental observations by the PPTA team from 2011-2012, and a specialist waterbird survey conducted in September-October 2012, confirmed the importance of salt pans in the Project area for migratory waterbirds. See Sections 5.4 and 7.2 for further details.
Salt pans within the Project area provide a large, virtually uninterrupted landscape of shallow water foraging habitat. A key feature is the physical mosaic of salt pans, each providing a shoreline with invertebrate prey. A second key feature is the temporal mosaic of management schedules of the individual salt pans and/or managers. The varied conditions of salt pans, depending on their individual stage of management for salt production, provide a variety of foraging habitats that are exploited by migratory birds according to individual species requirements. At any point in time, some salt pans are dry, some are flooded, some support vegetation on their bunds, some are barren, some are deeper, some more shallow. Each of these conditions determines the value of the individual salt pan to migratory birds. It is important to note that the current management of the salt pans by their operators does not appear to be having an adverse impact on the ecological value of the salt pans to migratory waterbirds.

**4.3.3 Further Monitoring**

A comprehensive biodiversity study of the Luyanghu Lake area will be conducted as part of the Project. Based on the assessment undertaken as part of the EIA, it is believed that this site has high biodiversity value as: (i) it is on the route of the central flyway of migratory birds in PRC, and (ii) can provide excellent staging, breeding and wintering habitats for water birds.

The wetland complex has high value for scientific research as (i) it is located in a densely populated region, (ii) it includes a diverse range of natural features, and (iii) has also been altered by human activities such as excavation of salt and sodium sulphate ponds, fishing, and agriculture.

A rapid biodiversity inventory of the Project area will be conducted prior to Project construction as outlined in the EMP (Appendix A) to better understand these values, including for flora, fish, amphibians, reptiles, birds, and mammals. It will be carried out over a period of at least one year and will cover all four seasons (spring, summer, autumn, and winter). Species will be identified and numbers estimated by systematic sampling. Sampling methods will be selected to enable continued use during longer-term monitoring as part of the Project implementation of selected indicator species.

**4.4 Social-Economic Environment**

Approximately 113,064 people reside in the Project area. Rural households are lagging behind in terms of access to social services and income, and particularly to opportunities for
improving their livelihoods and living standards. In 2010, the per capita net income of rural households was 4,372 CNY, while the annual per capita disposable income of urban households was 15,918 CNY, which is 3.64 times higher than the per capita net income of rural households. Almost no ethnic minority people reside in the Project area. Project interviews conducted of 147 households found that all interviewees were Han except two, of Zhuang ethnic nationality. No permanent residents occur within the boundary of the proposed NWP, although local residents do have land use rights within the area.

173. In the project sites, about 90% land, 94% of the total households and 96% of the total people in the project sites are located in Pucheng County. Therefore, the situation of Pucheng County is an important indicator of the project situation.

174. The Project will improve agricultural infrastructure and services related to agricultural production, thus providing the households with better and more secure income. Improved access to capacity development, training, and services such as extension will improve overall empowerment of the households.

175. Primary stakeholders will include rural households benefiting from saline soil improvement, flood control and overall environment improvement, and those households affected by land acquisition and resettlement. Secondary stakeholders include village committees; and government units at township level and above, particularly the Luyanghu management committee.

4.4.1 Cultural Heritage

176. Weinan City area has a long and rich cultural history. The area is considered to be the ‘root and source’ of Chinese culture. As a protectorate of fourteen dynasties, Weinan was an important strategic military and cultural centre. It was the birthplace of many important figures from Chinese history including Emperor Di Ku known as the virtuous ruler, Cangjie the inventor of Chinese characters, Du Kang inventor of liquor and patron saint of brewing in PRC and Japan, Sima Qian grand scribe of the Han Dynasty and Yang Jian Emperor of the Sui Dynasty. As a result of this history there are many sites of both archeological and intangible cultural importance distributed throughout the prefecture. Table 17 summarise the cultural sites within Fuping and Pucheng counties. None are located within the Project area.

<table>
<thead>
<tr>
<th>Cultural Site</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pucheng Scenic spot</td>
<td>More than 100 sites in Pucheng town including: pagodas, monasteries, Taoism temples, Tang Pagoda in Southern Temple, Song pagoda in Northern temple, Culture temple, Wang Ding’s memorial hall, Qing dynasty examination yard</td>
</tr>
<tr>
<td>Yao Shan</td>
<td>The Goddess’ temple (Tang Dynasty), the temples of Dragon, Mountain God and Fair Lady were consecutively built on the mountain</td>
</tr>
<tr>
<td>Qiao Mausoleum</td>
<td>Tomb of Tang Dynasty Emperor Ruizong, located at Fengshan Mountain.</td>
</tr>
<tr>
<td>Tai Mausoleum</td>
<td>Tailing Mausoleum of Emperor Xuanzong (Tang Dynasty), Jinsu Mountain 15 kilometers northeast of Pucheng</td>
</tr>
<tr>
<td>Zhangjishan Scenic Spot</td>
<td>Located in Gaoyang Township of Pucheng County.</td>
</tr>
</tbody>
</table>
Heixia Valley scenery spot
Longshouba Dam built in West Han period. Formed lake with various scenic attractions. Various recreation areas developed.

Pinglu Miao Hot Spring
Holiday village, located in the Valley of Luohe River. Jin dynasty pagoda, Haiyuan Temple of Wentang Pagoda and remains of Qing Dynasty Great Wall.

Yongfeng Cemetery
Cemetery for casualties of Revolutionary Martyrs from the November 1948 offensive by the Northwest Field Army.

Ceramic Art Village
Fule International Ceramic Art Museum, hotel and orchards. The museum displays ceramics from around the globe and has hosted international pottery conferences.

Jinsushan
Located 30 km northeast of Jinsu county town; altitude 1,241 m. Geological attraction

Wang Jian Tomb
Military leader of third century, born in Dongxiang. One of 32 historical figures who appear as characters in the special game Romance of the Three Kingdoms XI Koei's.

Yong & Cheng Mausoleums
Burial places of Wen Emperor (North Wei Dynasty) and Tuwen Tai (Wendi Emperor) respectively

177. Agriculture plays a large role in the areas economy and has been cited as an area both for further technological development and as a tourism resource. The area is locally known as "Shaanxi Granary" and "Shaanxi Cotton Warehouse" and is a major producer of maize, wheat and other grains, cotton, oilseed, fruit, livestock and poultry products. Weinan Prefecture produces 80% of the Province's cotton and up to one quarter of the annual apple and grain production. Production of forest produce Walnut (Juglans spp.), Sweet chestnut (Castanea sativa), Jujube (Ziziphus zizyphus), and Persimmon (Diospyros spp.). Currently a number of towns are promoted for their agricultural crop specialties.

178. Salt harvesting industry. The salt pans at Luyanghu are a working cultural landscape going back at least to the Ming Dynasty and are still harvested in the traditional way. Up until 60 years ago the Chinese salt monopoly was the largest and oldest monopoly in the world, with its history going back 2,500 years and its influence and power stretching across the world. During revision and finalization of the NWP master plan (Project output 3), the potential for a salt harvesting demonstration centre, to showcase the cultural history of the salt harvesting industry, will be assessed. The salt harvesting industry within the Project area retains some of this cultural heritage, which will be maintained and promoted as part of the Project.
5. ENVIRONMENTAL QUALITY (BASELINE DATA)

179. The following section provides a summary of environmental quality baseline data collected by (i) NHIDRI (domestic EIA institute) as part of the preparation of the DEIS 2012, (ii) the Shaanxi EPB as part of regular environmental monitoring, and (iii) the Project team as part of the preparation of this EIA report. Sampling by NHIDRI was conducted in February 2012 and focused on surface water quality, groundwater, air quality, and ambient noise levels, and was described in the DEIS 2012 (in Chinese language). The raw data are available on request.

5.1 Soil Quality

5.1.1 Soil Salinity

180. Soils in the Project area are highly saline, due to a combination of natural and human-induced factors which cause accelerated salt accumulation at the soil surface. These include the Project area’s low topography, location in a small closed basin (where underground runoff and salt have limited discharge), high groundwater table and evaporation rates, progressive clearance of natural wetland habitats over the past several centuries or more, and increasing agricultural demands (Project Final Report–Supplementary Appendix 4). Soil salinity concentrations were assessed at 40 locations within and adjacent to the Project area at 0 – 0.2 m depth. The sample locations were spread relatively evenly over the Project area in a grid base pattern. The results show that soil salinity ranges from 0.075 % to 0.23 %. Figure 24 shows the soil salinity concentration contours for the Project area. Soil salinity is highest in the lowest lying areas including around Tianjiao Lake and the site of the proposed Tianlu Lake, and in the wetland area in the western part of the Project area. Soil within the Project area generally showed soil salinity concentrations greater than 0.1 %. Soil salinity concentrations closely follow the pattern of groundwater salinity, described in Section 5.3, which also is highest within the Project area.

Figure 24. Surface Soil Salinity Concentrations
Six test pit locations were developed to test vertical change in soil salinity concentrations. The results show that soil salinity increases rapidly with depth (Figure 25). This is likely to reflect the influence of high salinity groundwater within the subsurface. The results also suggest that leaching of salts is occurring in the surface soils as a result of rainfall and irrigation infiltration.

![Figure 25. Soil Salinity Concentrations at depth](image)

5.1.2 Soil Contamination

Soil analysis for potential inorganic (metals) and a pesticide, dichlorodiphenyltrichloroethane (DDT) was undertaken on soil samples from 8 locations within the area of proposed drainage rehabilitation and lake excavation. Soil samples were assessed against the PRC Soil Environmental Quality Standard and PRC Soil Environmental Quality Monitoring Standard. The results, as presented in Table 17, show that soil quality was within the standard for agricultural soil for all samples. This suggests that soil to be excavated for the construction of the proposed Tianlu Lake is unlikely to be contaminated. However, further soil quality testing for metals and pesticides is recommended for soil excavation sites which have a history of storage or use of hazardous materials.

<table>
<thead>
<tr>
<th>ID</th>
<th>Geographic location</th>
<th>pH</th>
<th>Cd</th>
<th>Cr6+</th>
<th>Hg</th>
<th>As</th>
<th>Pb</th>
<th>Cu</th>
<th>Zn</th>
<th>Ni</th>
<th>BHC</th>
<th>DDT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agricultural Soil Standard</td>
<td>250</td>
<td>25</td>
<td>350</td>
<td>100</td>
<td>300</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LT01</td>
<td>Zhongbailu Village</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>57.1</td>
<td>ND</td>
<td>6.37</td>
<td>22.8</td>
<td>53.1</td>
<td>67</td>
<td>38.5</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>LT02</td>
<td>Mingdi Village</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>55.1</td>
<td>ND</td>
<td>6.09</td>
<td>20.4</td>
<td>34.1</td>
<td>72.4</td>
<td>36.9</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>LT03</td>
<td>Dangmu Town</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>57.5</td>
<td>ND</td>
<td>5.75</td>
<td>21.8</td>
<td>35.2</td>
<td>82.5</td>
<td>27.7</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>LT04</td>
<td>Dongxinglong</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>47.7</td>
<td>ND</td>
<td>4.66</td>
<td>17.9</td>
<td>24.9</td>
<td>48.1</td>
<td>25.4</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>LT05</td>
<td>Xujiazhuang</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>64.9</td>
<td>ND</td>
<td>5.66</td>
<td>24</td>
<td>46.7</td>
<td>81.9</td>
<td>49.8</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>LT06</td>
<td>Xizhang Village</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>67.9</td>
<td>ND</td>
<td>4.59</td>
<td>23.6</td>
<td>32.8</td>
<td>93.3</td>
<td>38.9</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>LT07</td>
<td>Nanping Village</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>61.9</td>
<td>ND</td>
<td>4.2</td>
<td>31.5</td>
<td>31.2</td>
<td>40.6</td>
<td>36.7</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>LT08</td>
<td>Xiawang Village</td>
<td>&gt;7.5</td>
<td>ND</td>
<td>58.6</td>
<td>ND</td>
<td>4.11</td>
<td>22.1</td>
<td>31.4</td>
<td>60.7</td>
<td>38.4</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>
5.2 Surface Water Quality

183. Water entering the wetlands and Tianjiao Lake is largely from irrigation channels, rainfall, groundwater and treated effluent from the Pucheng Sewage Treatment Plant. Baseline monitoring for the DEIS (2012) involved sampling at 14 locations, in the Luoxi Drainage System, Tianjiao Lake, and Luo River upstream and downstream of the discharge point of the Project area. The results show that surface water quality exceeds the relevant standards for several parameters (Table 19). Water quality diverted from the Yellow River is high in dissolved oxygen (DO), biological oxygen demand (BOD) and total nitrogen (TN). Water draining from the ‘main channel’ in the Project area is high in nutrients, DO and BOD, along with elevated levels of total petroleum hydrocarbons (TPH). Water in the Wei River is high in Total Coliforms, suggesting pollution from poorly treated sewage effluent. Water in Tianjiao Lake has high TN, indicating high nutrient levels; samples from the western portion of the lake have notably higher BOD and COD than in the eastern portion.

184. Sampling of treated effluent from the Pucheng Sewage Treatment Plant indicates that it complies with Class IV water standards for COD (24.65 mg/L), NH3-N (0.678mg/L), TN (1.088mg/L) and TP (0.040 mg/L) (DEIS 2012). Water quality from the treatment plant meets Standard B of the PRC Urban Sewage Treatment Plant Emission Standards (GB18918-2002) but does not meet national standards for re-use as urban landscape water nor agriculture. The treatment plant currently discharges 15,000 m³/day of treated effluent to the Project area.

185. Water quality exceeding national standards for organic matter, ammonia, TN, TP and Total Coliforms is probably due to pollution from treated effluent, while high levels of TN in channels and lakes may be due to the high content of nitrogen in groundwater; for all variables, pollution from agricultural nonpoint sources is probably also a contributing factor.

186. Levels of organic matter, ammonia and TN recorded 500 m upstream of the Luo River main ditch exceed national standards, indicating the water coming from upstream of the Luo River is polluted. Levels of organic matter, ammonia nitrogen, total nitrogen, petroleum and fecal coliform 1,000 m downstream of the confluence of the Luo River main ditch partially exceed the relevant standards (Table 19).

Table 19. Surface Water Quality Analysis Results (mg/L except for pH)

<table>
<thead>
<tr>
<th>ID</th>
<th>Monitoring points</th>
<th>pH</th>
<th>DO</th>
<th>COD</th>
<th>BOD</th>
<th>TP</th>
<th>TN</th>
<th>TPH</th>
<th>F.col</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigation Standards</td>
<td>6~9</td>
<td>3</td>
<td>30</td>
<td>6</td>
<td>0.3</td>
<td>1.5</td>
<td>0.5</td>
<td>20,000</td>
</tr>
<tr>
<td>1</td>
<td>Irrigation water diverted from the north Yellow River canal</td>
<td>7.2</td>
<td>7.7</td>
<td>39.7</td>
<td>13.8</td>
<td>0.09</td>
<td>3.77</td>
<td>0.43</td>
<td>7,300</td>
</tr>
<tr>
<td>2</td>
<td>Irrigation water diverted from the north Yellow River canal</td>
<td>7.3</td>
<td>10</td>
<td>42.7</td>
<td>14.5</td>
<td>0.1</td>
<td>3.53</td>
<td>0.38</td>
<td>9,933</td>
</tr>
<tr>
<td>3</td>
<td>Losey two branch canals</td>
<td>7.44</td>
<td>10.6</td>
<td>32.8</td>
<td>11</td>
<td>0.15</td>
<td>3.23</td>
<td>1.27</td>
<td>11,667</td>
</tr>
<tr>
<td>4</td>
<td>Drainage main channel</td>
<td>7.61</td>
<td>6</td>
<td>42.1</td>
<td>14</td>
<td>0.15</td>
<td>18.3</td>
<td>1.32</td>
<td>13,667</td>
</tr>
<tr>
<td>5</td>
<td>Drainage main channel</td>
<td>7.74</td>
<td>9.6</td>
<td>22.3</td>
<td>7.1</td>
<td>0.16</td>
<td>4.8</td>
<td>0.06</td>
<td>12,000</td>
</tr>
<tr>
<td></td>
<td>River Ecosystem Standards</td>
<td>6~9</td>
<td>5</td>
<td>20</td>
<td>4</td>
<td>0.2</td>
<td>1</td>
<td>0.05</td>
<td>10,000</td>
</tr>
<tr>
<td>6</td>
<td>Luohe River</td>
<td>7.73</td>
<td>8.8</td>
<td>32</td>
<td>10.6</td>
<td>0.15</td>
<td>4.04</td>
<td>0.49</td>
<td>7,933</td>
</tr>
<tr>
<td>7</td>
<td>Luohe River</td>
<td>7.86</td>
<td>9.1</td>
<td>34.3</td>
<td>11.7</td>
<td>0.15</td>
<td>3.83</td>
<td>0.45</td>
<td>9,267</td>
</tr>
<tr>
<td>8</td>
<td>Luohe River</td>
<td>7.92</td>
<td>10.2</td>
<td>35.8</td>
<td>11.9</td>
<td>0.15</td>
<td>4.48</td>
<td>0.46</td>
<td>9,800</td>
</tr>
<tr>
<td>9</td>
<td>Luohe River</td>
<td>7.93</td>
<td>9.7</td>
<td>44.5</td>
<td>16.3</td>
<td>0.18</td>
<td>6.16</td>
<td>ND</td>
<td>13,667</td>
</tr>
</tbody>
</table>
187. Surface water within the Project area also contains high levels of SO$_4$, Cl, Na, and which commonly occur as Na$_2$SO$_4$ and other salts.

5.3 Groundwater

188. Groundwater quality and depth was sampled at 9 locations in the Project area. Water quality monitoring is conducted in accordance with the provisions of PRC Quality Standard for Groundwater, PRC Technical Specifications for Environmental Monitoring of Groundwater and PRC Standards for Irrigation Water Quality consisting with the characteristics of the Project. Results show that groundwater has a characteristic chemistry dominated by SO$_4$Cl-Na, with salinity concentrations range from $<1,000$ to $>10,000$ mg/L (Figure 26). Groundwater salinity concentrations increase towards the central low-lying wetland areas. In these areas the groundwater chemistry is dominated by SO$_4$-Na and ClSO$_4$-Na type waters. Salinity concentrations range from $20,000$–$40,000$ mg/L, and is classified as highly saline. Groundwater pH is generally neutral, ranging between 5 and 8.

![Figure 26. Groundwater Salinity Concentrations](image)

189. Monitoring results from 9 sampling locations shows that depth to groundwater ranges from near surface ($<0.1$ mbgs) in the wetlands to $>50$ mbgs in northern parts of the Project area. Records from 1999–2011 for groundwater depth show that groundwater levels have varied over time (Figure 27). Shallow groundwater ($<8$ mbgs) shows a slight increase in water level since 1999, whereas deeper groundwater levels show a general decline over the same period.
Shallow groundwater also demonstrates seasonal influence with increasing groundwater levels during the wet season.

Figure 27. Groundwater depth from 1999 to 2011

5.4 Waterbirds

190. As of October 2012, 138 bird species had been recorded in the Project area, of which at least 39 are waterbirds (ducks and waders), based on species lists in the 2008 NWP Master plan and Project fieldwork between October 2011 and October 2012. Sixty-five bird species are listed in the 2008 NWP master plan; the remaining species were largely added during Project fieldwork, suggesting additional species will be probably be recorded in the future. Another 24 vertebrate fauna species (mammals, amphibians, reptiles, fish) and least 34 flora species have been recorded in the Project area (largely based lists in the NWP master plan). Siberian Weasel Mustela sibirica was the only mammal recorded at the NWP during 2011-2012. At least one previously recorded species, Red Fox Vulpes vulpes, is protected in Shaanxi Province but is said to have disappeared from the NWP.

191. A three-week survey of the Project area was undertaken by an international waterbird specialist from September-October 2012 as part of Project fieldwork. The survey confirmed that the Project area supports at least three waterbird species (Spotted Redshank, Black-winged Stilt, Long-billed Plover) and possibly a fourth (Kentish Plover) which occur in globally significant numbers, based on criteria of the Ramsar Convention on Wetlands. The survey confirmed previous incidental observations by the Project team from 16-28 October 2011 (T. Dahmer) and 10-11 March 2012 (T. Dahmer and M. Bezuijen), when over 2,000 individuals of 25 waterbird species were recorded. In all observations, the highest numbers of waterbirds observed were in the salt pans proposed to be removed for Tianlu Lake. The fact that the Luyanghu wetlands are an artificial habitat with water always available through pumping makes it particularly important as it is a site which can be relied upon by birds.

192. At the recommendation of the Project, an independent government survey for waterbirds was conducted. Under contract to WLMIDZMC, the Shaanxi Animal Research Institute
conducted a four-day survey (4-7 April 2012) in the Project area, and recorded over 5,700 individuals of 27 waterbird species. The highest numbers of individuals (>1,600) were in the Neifu Tan salt pans, the proposed location of Tianlu Lake.

193. The salt pans in the east of the Project area (the site of Tianlu Lake) appear to support different habitat (shallow-water salt pans) and different waterbirds (small- and medium-sized waders) compared with salt pans in the west of the Project area (deeper salt pans and ponds, used more by waterfowl - ducks, geese, large waders).

194. Two species, Great Bustard and Saker Falcon, are listed as globally threatened by IUCN-World Conservation Union. The Project area is not considered suitable habitat for the Great Bustard and the source data for the record are unclear. Three Saker Falcons have been observed in the Project area, and it is possible they visit the area seasonally in small numbers: the Project area is not considered significant for either species and they are not assessed further.

5.5 Air Quality

195. Air quality monitoring was undertaken at four locations within the Project area, including Donglu Village, Jiangji Village, Fujia Village and Fanjia Village (Table 19). The monitoring was conducted over a 7 day continuous period. All air quality monitoring results were within the applicable standard.

<table>
<thead>
<tr>
<th></th>
<th>Average of seven days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TSP</td>
</tr>
<tr>
<td>Class II Air Quality Standard</td>
<td>0.3</td>
</tr>
<tr>
<td>Donglu Village</td>
<td>0.143</td>
</tr>
<tr>
<td>Jiangji Village</td>
<td>0.241</td>
</tr>
<tr>
<td>Fujia Village</td>
<td>0.178</td>
</tr>
<tr>
<td>Fanjia Village</td>
<td>0.141</td>
</tr>
</tbody>
</table>

5.6 Noise Levels

196. The Project area belongs mostly to a class II and partly to a class I function zone of ambient noise standard for an urban area (GB3096-93). Areas adjacent to the road (50 m from the ROW for class I and 35 m from the ROW for class II) are classified as class IV. For sensitive receptors, the noise level standard of 60 decibels [dB(A)] in daytime and 50 dB(A) in night-time is applied. In most cases, the noise level can meet the standard value, according to the local EPB environmental quality reports. To provide baseline noise values, 12 monitoring points were set to monitor at least 20 minutes continual equivalent grade A sound level in the day and night in the area of influence. In nine points, the environmental noise values at different time intervals did not exceed the Class II standard of noise limits. Noise values for Wangzi Village near the railway exceeded the standard as trains passed by. Noise values for Chijia Village, located next to County Road X313 and Provincial Road S201 (with large traffic flow), exceeded the standards at night. Noise values for Nanshe Village, near Weipu Highway, slightly exceeded standards at night.
6. ANALYSIS OF ALTERNATIVES

6.1 No Project Alternative

197. The no-project scenario would see: (i) ongoing incremental loss and degradation of wetland habitats, especially salt pans, which are not currently recognized as sites of ecological importance, (ii) continued problems of saline and waterlogged soils, low crop yields, and poverty, (iii) continued flood risk to local lives, property, and hindrance to economic development, (iv) little or no improvement in the management of the wetland ecosystem services, (v) possible de-regulation of the proposed NWP, and subsequent conversion to other land uses, and (vi) missed opportunity to promote alternative livelihoods, such as ecotourism and protection of some salt-harvesting heritage. For the migratory waterbirds that utilise the salt pans in the east of the Project area, the no-project scenario would avoid the loss of an important local site in the regional network of wetlands used by these species. However, given the increasing economic and human population demands in and around the Project area, this would almost certainly be a temporary respite, while future developments might not offer the same opportunities for good management that the current Project does.

6.2 Discussion of Alternative Solutions

198. Several design alternatives were considered as part of the Project preparation phase to achieve the Project outputs of improved flood storage and reduced soil salinity. The key alternative design aspects considered related to alternative flood management options and drainage channel construction options.

6.2.1 Alternative flood management design

199. Two alternative flood management designs were considered as part of the project preparation (i) construction of two lakes Tianlu and Tianzi, or (ii) construction of one additional lake, Tianlu. The initial constructed lake design included two lakes Tianlu and Tianzi, in addition to the existing Tianjiao, with a total area of approximately 500 ha. It was proposed that the three lakes be connected by canal system, finally discharging to the Luo River. Following an assessment of the saline wetland flats in the west of the Project area, the proposed site for Tianzi was noted to host important wetlands and habitat for some migratory birds. It was concluded that the proposed excavation and dredging of this area and replacement with a deep lake environment would result in loss of important habitats for waterbirds and wetland habitats. Based on this assessment, Tianzi lake construction was removed from the project design. Through Project planning, most (75%) of remaining salt pans have subsequently been incorporated in the proposed NWP.

6.2.2 Drainage channel improvements options

200. During the Project preparation various alternatives were considered for the drainage channel improvement works, with consideration for technical, economic, energy efficiency and environmental criteria. In terms of environmental consideration, the primary objective was to identify and adopt options with the least adverse environmental impacts and maximum environmental benefits. Key environmental factors used included minimizing (i) the amount of earthwork requirements (related to vegetation disturbance, soil erosion potential, and spoil disposal), (ii) requirement for household relocation, (iii) land requirements, focusing on minimizing or avoiding requirement for acquisition of agricultural land and forested land, (iv) opportunities to reduce emission associated with construction activities, and (v) support options for use of gravity flow rather than requirement for pumping.
Three key drainage channel improvement design options were evaluated on this basis, as shown in Table 20, comparing work amount, annual project operation cost, construction method and work schedule, water protection, EIA, energy saving, and reliability.

Table 21. Drainage Channel Design options evaluation

<table>
<thead>
<tr>
<th>Item</th>
<th>Program I</th>
<th>Program II</th>
<th>Program III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil earth works m³</td>
<td>572,620</td>
<td>841,620</td>
<td>2,710,590</td>
</tr>
<tr>
<td>Silt earth works / dredging m³</td>
<td>143,155</td>
<td>213,300</td>
<td>135,000</td>
</tr>
<tr>
<td>Mortar and stone work with M5.0 cement m³</td>
<td>64,740</td>
<td>65,040</td>
<td>44,763</td>
</tr>
<tr>
<td>Permanent cover area mu</td>
<td>280</td>
<td>230</td>
<td>681</td>
</tr>
<tr>
<td>Artificially amended slope m²</td>
<td>478,074</td>
<td>613,200</td>
<td>341,641</td>
</tr>
<tr>
<td>Annual operation cost CNY</td>
<td>5.05 million</td>
<td>4.25 million</td>
<td>4.25 million</td>
</tr>
<tr>
<td>Construction method and schedule</td>
<td>Short section of sands to pass, less difficult construction method and short schedule of works</td>
<td>Short section of drift sands to pass, less difficult construction method, medium work schedule.</td>
<td>Long section of drift sands to pass, difficult in terms of construction, large work load and long work schedule</td>
</tr>
<tr>
<td>Water protection, EIA and energy saving</td>
<td>Simple water protection measures, low potential impact on environment, in need of pumping water, high annual cost, relatively poor energy saving</td>
<td>Common water protection measure, moderate potential impact on environment, all automatic flow and good energy saving</td>
<td>Biggest amount of rejected material, un-advantageous to water and soil protection, high potential impact on environment, all automatic flow and good energy saving</td>
</tr>
<tr>
<td>Security and reliability of operation</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

Based on a comprehensive evaluation, Program II was recommended as the best option from drainage channel improvement works. Potential negative environmental impacts associated with Program II are discussed in the following section, along with suitable mitigation measures.
7. **ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES**

203. The potential environmental impacts and benefits of the proposed activities have been assessed in line with ADB’s SPS, including assessment of the possible benefits and impacts with regard to (i) biodiversity conservation and sustainable natural resource management; (ii) pollution prevention and abatement; and (iii) health and safety, and physical cultural resources.

7.1 **Incremental Environmental and Social Benefits**

7.1.1 **Protection and rehabilitation of the Luobutan wetlands and reed beds**

204. The Project will result in the protection and rehabilitation of 860 ha of lands in the NWP including the salt pans in the Luobutan area and wetland reed beds. The Project will support the revision and implementation of the NWP master plan. Environmental benefits of the Project will include (i) establishment of legal protection for the wetlands and a framework for management, (ii) reduced wetland degradation caused by unsustainable agriculture, waste dumping, incremental development, and other human activities, (iii) the protection and management of important habitat for migratory waterbirds, and (iv) increased passive nutrient removal due to improved management and rehabilitation of reed beds.

7.1.2 **Improved Climate Change Resilience**

205. The Project will reduce the vulnerability of local communities to climate change through enhanced provision of regulating ecosystem services, such as water and temperature regulation and soil retention, which will improve the resilience of ecosystems to climate change.

7.1.3 **Improved drainage, resulting in improved soil quality and increased land productivity**

206. The rehabilitation of the Luoxi salinization drainage system will reduce soil salinity over approximately 1,820 ha of existing moderately salinized agricultural land. Anticipated environmental benefits associated with the improved drainage include (i) improved soil quality with the potential to increase agricultural harvest and support greater diversity of crops, (ii) improved coverage of planted forested areas and shelter belts outside the existing wetland area, and (iii) improved opportunity for a greater diversity of flora. As a result of reduced soil salinity there will be improved socio-economic conditions for local farmers, including an addition of 4,000 ha of agricultural land which will reach the classification of high-productivity, with a unit output increase of 50%. Local farmer’s annual income has the potential to increase by CNY935, with the potential to raise in the order of 30,000 farmers out of poverty.

7.1.4 **Reduced flooding and improved land development**

207. Increases in the flood storage capacity provided by Tianlu Lake, rehabilitation of wetlands and improved flood drainage resulting from the rehabilitation and improvements in the Luoxi Drainage System will reduce the risk of flooding events within the Project area, providing economic and social benefits. These include reduced cost of flood damage to homes, infrastructure and crops and improved opportunities for land development for tourism.

---

23 Draft Shaanxi Weinan Luyanghu Wetland Protection and Utilization Master plan prepared by Qingdao University, February 2012

24 Baseline survey is included in the EMP to document the pre-development flora biodiversity

commercial and industrial uses, in accordance with the Luyanghu Industrial Development Zone Plan (2007 – 2025).

7.1.5 Improved capacity for environmental management

208. Through a training program on skills development related to sustainable wetland and saline soil management, including marketing skills, the Project will support local officials and villagers capacity development to sustain ecosystem services provided by the Luyanghu area. Community-based ecotourism activities will be piloted, as the Project site lends itself to the development of ecotourism that combines cultural and environmental experiences with underlying conservation and educational benefits, such as the salt pan landscape that is both an important habitat for biodiversity and an important cultural and historical heritage. An Incubator for small rural enterprises will be established to support the development of alternative livelihoods, including development of a network of competitive ecotourism and small agri-businesses.

7.2 Potential Adverse Impacts and Mitigation Measures Associated with Current Project Design

7.2.1 Loss of salt pan habitat

209. Development of Tianlu Lake will result in the loss of 110 ha salt pan habitats (Table 22), to be replaced by a single, large, and relatively deep (2-7 m) lake with landscaped banks. The existing salt pans provide shallow water foraging and roosting habitats for migratory birds, and are important as they enable migrating individuals to rest and replenish reserves of fat metabolized during long-distance flights between breeding and wintering grounds. In addition, the shallow-water habitats of the salt pans in the east of the Project area (the site of the proposed Tianlu Lake) provide different habitats from the deeper salt-pans and ponds in the west of the Project area. The former seems to support larger numbers of small- and medium-sized migratory waders, while the latter seems to support more waterfowl (ducks, geese). Artificial lakes in the PRC which are deep, landscaped, and also utilized for human recreation, support homogenous habitats with little habitat diversity. They generally have low conservation value for waterbirds, and support lower numbers of species, and fewer individuals, than a wetland which supports a mosaic of shallow- and deep-water zones and diversity of microhabitats.

210. Migratory birds are highly mobile and travel long distances on migration. Loss of feeding and roosting habitats along migration flyways may cause increased stress, fatigue, overcrowding, competition and disease transmission at remaining sites, and higher rates of mortality. There has been a dramatic loss of wetlands throughout the PRC and globally. The Project waterbird survey revealed there were previously at least two salt pan areas within a few hundred kilometres of the Project area, but only the salt pans of the Project area appear to remain. The Yellow River Nature Reserve, 60 km from the Project area, is an important site for some waterbirds, but supports different habitats.
Table 22. Cumulative changes in habitat in Project area due to construction of Tianjiao Lake and the proposed Tianlu Lake

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt pan+pond (total)</td>
<td>1,020 (4.8)</td>
<td>-180 (18)</td>
<td>-110 (11)</td>
<td>-290 (29)</td>
<td>730 (72)</td>
<td>550 (54)</td>
</tr>
<tr>
<td>Salt pan-shallow</td>
<td>640 (3.0)</td>
<td>-180 (28)</td>
<td>-80 (13)</td>
<td>-260 (41)</td>
<td>380 (59)</td>
<td>260 (41)</td>
</tr>
<tr>
<td>Salt pan-deep; pond</td>
<td>380 (1.8)</td>
<td>0</td>
<td>-30 (8)</td>
<td>-30 (8)</td>
<td>350 (92)</td>
<td>290 (76)</td>
</tr>
<tr>
<td>Reedbed</td>
<td>260 (1.2)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>260 (100)</td>
<td>260 (100)</td>
</tr>
<tr>
<td>Lake (artificial)</td>
<td>0</td>
<td>+280</td>
<td>+130</td>
<td>+410</td>
<td>n/a</td>
<td>210 (51)</td>
</tr>
<tr>
<td>Other¹</td>
<td>19,920 (94)</td>
<td>+100 (3)</td>
<td>-20 (0.7)</td>
<td>0</td>
<td>20,000 (103)</td>
<td>50 (2)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21,200 (100)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1,070</strong></td>
<td></td>
</tr>
</tbody>
</table>

¹Cleared, agricultural, and/or residential land. Ha=hectare; LWNP=Luyanghu National Wetland Park; TJ=Tianjiao Lake; TL=Tianlu Lake. Source: aerial photograph of Project area (2000); Google Earth satellite imagery (2011).

211. The construction of Tianlu Lake will result in the loss of 110 ha (11%) of salt pan habitats which support large global numbers of at least three, possibly four migratory waterbird species (Section 5.4). In addition to these species, the salt pans support an entire assemblage of migratory waterbirds (up to 27 species recorded; Section 5.4). The cumulative loss of salt pan habitats due to Tianjiao and Tianlu Lakes and associated landscaping is estimated to be 290 ha (29%) (Table 22). Without mitigation, the loss of this habitat may cause increased pressure on the remaining salt pans, increased competition for food resources, and a decline in populations of the some waterbird species. It would also cause an incremental impact to the integrity of the East Asia-Australasia Flyway.

212. Mitigation measures to address the impacts of lake construction to migratory waterbirds were developed to achieve the SPS criteria of ‘no net loss’ of biodiversity. Measures address project design, lake construction, lake operation, and monitoring, and are described in the Project EMP (Appendix A). These are complemented by activities to be conducted under output 3 (wetland ecosystem conservation) of the Project, which will strengthen the municipal framework for wetland management in the Project area and help reduce potential impacts to the wetlands from future development.

- **Project design.** The Project will implement the following actions.
  - **Reduce loss of salt pan habitat through detailed lake design.** (i) Remnant salt pans in the proposed lake location which appear to be favoured by migratory waterbirds have been identified and a revised design has been developed (Figure 1 in Appendix A). Under this design, Tianlu Lake would be approximately 80 ha in size i.e. the loss of approximately 30 ha salt pans could be avoided. Although potentially significant, the final area of salt pan loss will only be estimated during detailed lake design and the need to consider topographic limitations and current land use. (ii) A transitional wetland zone will
be maintained between the lake and salt pans and reedbeds to the west. (iii) The western shore of the lake will be constructed with a shallow, sloping gradient, to create shallow-water habitat. (iv) A third lake which was previously planned in the Project area has been removed from the Project design.

- **Construct new salt pan habitat to replace the salt pans removed by lake construction.** Prior to construction of Tianlu Lake, at least 110 ha new salt pan habitat will be constructed in the west of the Project area (see ‘area 2’ in Figure 11b, Section 3.3). This area comprises abandoned ponds and salt pans surrounded by old spoil mounds. The spoil mounds (which have no biodiversity or livelihood value) will be bulldozed and new salt pans created. Salt pan shape, depth, and seasonal water levels will emulate the existing salt pans in the Project area where salt harvesting occurs, and will be based on the expertise of local salt farmers. Active salt harvesting in these new salt pans by local residents will be permitted, and indeed supported, under the new wetland park (see below), to maintain the food sources and conditions which support migratory waterbirds. Technical input by waterbird and wetland specialists will be provided to ensure issues of waterbird food supply and roosting sites are addressed in the salt pan design, to maximize the habitat for small to medium sized waders. The involvement of these specialists, and the training of local agencies required to support subsequent management, will be funded by an ADB grant which will complement the project loan.

- **Construction of Tianlu Lake.** The Project will implement the following actions.
  - **Minimize construction disturbance.** (i) Spoil from the excavation of Tianlu Lake will be disposed in the eastern portion of the lake and/or adjacent to the eastern shoreline, to avoid impacts to salt pans to the west. (ii) Construction of the lake will be timed to avoid, as far as possible, peak migration times in March-April and September-October. (iii) Nearby salt pan habitats will be off-limits to construction personnel and signs delimiting ‘no-go’ zones will be installed. (iv) Regulations for spoil disposal, human and vehicle access etc will be included in contractor guidelines to avoid waterbird habitats.

- **Operation of Tianlu Lake.** The Project will implement the following actions.
  - **Include Tianlu and Tianjiao Lakes within the NWP.** Both lakes have been included in the proposed NWP. This will ensure that the lakes are subject to park regulations for both multiple use and wetland conservation.
  - **Implement seasonal regulations to protect migratory waterbirds.** If monitoring (see below) reveals that migratory waterbirds are utilizing the lake, sites of habitat use will be zoned and human activities will be regulated during the migration seasons.

- **Monitoring.** The Project will implement a five-year waterbird monitoring program from 2013–2017 (the Project duration) to monitor waterbird species richness, abundance of individuals, and the effects of Project actions, including salt pan loss and gain. The program will be implemented by the Shaanxi Animal Research Design Institute following training in capacity building.

- **Protection and management of remaining salt pan waterbird habitat and minimizing future threats to waterbirds.** The following activities will be conducted under output 3 of the Project. They are not part of the EMP but form part of the overall actions designed to mitigate potential Project impacts to migratory waterbirds and their wetland habitats.
  - **Protection of remaining saltpan habitats.** Five hundred and fifty hectares (75%) of remaining salt pan habitat for waterbirds and 260 ha (100%) of remaining reed beds will
be included in the NWP and subsequently protected and managed. Management guidelines for these salt pans will be developed in the NWP master plan and will include the continuation of local livelihoods for salt harvesting, which directly maintain the salt pan habitats utilized by the waterbirds.

- An additional 99 ha of salt pans and ponds are adjacent to the western portion of the proposed NWP and include waterbird breeding habitat (Figure 11b, Section 3.3). The inclusion of these areas in the NWP would strengthen waterbird and wetland conservation in the Project area. The potential for inclusion of these areas in the NWP will be assessed during the implementation of Project output 3.

- **NWP and master plan.** A NWP and master plan will be established in the Project area. A key focus of the park and plan will be to protect migratory waterbirds and their habitats.

- **Biodiversity surveys and research.** Management activities for the NWP will include baseline biodiversity surveys to inform management planning.

- **Training and capacity building in wetland and waterbird management.** Through the Project loan, GEF grant, and ADB grant, the Project will implement training to strengthen municipal capacity to implement and manage the NWP, manage the wetlands for waterbirds and local livelihoods, plan and minimize the impacts of future economic development, and, contribute to improved wetland management in Shaanxi Province.

### 7.3 Potential Adverse Impact and Mitigation Measures during Construction Phase

213. Potential adverse impacts of the Project construction phase include (i) increased siltation of surface water bodies due to lake and channel sediment excavation, (ii) re-use and/or disposal of spoil from excavation works, (iii) impacts on air quality from dust and emissions from vehicles, (iv) noise impacts from excavation machinery and transport, and (v) soil waste impacts from construction camp, general waste and construction solid waste. Construction-phase impacts are likely to be localized and will occur over a relatively short period of time.

#### 7.3.1 Siltation, soil erosion and mitigation measures

214. Dredging and excavation for construction of Tianlu Lake and channels will cause disturbance of sediment and soil and short-term increases in concentrations of suspended substances (SS) in water bodies, especially around the excavation sites. To mitigate this potential impact, the contractor will be required to have sound environmental management programs, including a sediment control plan which outlines sediment control measures including sediment nets and booms, covering and bunding around stockpiles, and use of water diversion trenches as appropriate. Water quality in the adjacent surface water bodies will be monitored during construction for suspended solids to confirm the result of the impact assessment and effectiveness of mitigation measures adopted. Mitigation measures in the EMP include:

(i) Implement erosion protection measures including terraces and silt barriers.

(ii) Stabilize excavation slopes, embankments, and other erosion-prone working areas during excavation works.

(iii) Stabilize all earthwork areas within 30 days after earthworks have ceased.

(iv) Divert drainage around excavation areas during channel/lake earthworks.

(v) Undertake excavation in sections, to minimize the area of active excavation at any time.

(vi) Provide temporary detention ponds or containment to control silt runoff.

(vii) Construct intercepting ditches / drains to prevent runoff entering construction sites, and divert runoff from sites to existing drainage.

(viii) Strip and stockpile topsoil, cover or seed temporary soil stockpiles.

(ix) Limit construction and material handling during periods of rains and high winds.

(x) Properly slope or re-vegetate disturbed surfaces.
(xi) Appropriately set up temporary construction camps and storage areas to minimize the land area required and impact on soil erosion.

(xii) Where drainage channels directly drain into the NWP, additional siltation barriers will be applied within 100 m prior to interception with the wetlands.

(xiii) The wetlands will be monitored weekly during the construction phase at the intersection point of each drainage channel.

(xiv) If evidence of sediment runoff entering wetlands is recorded, construction works will be halted and corrective action (improved siltation protection measures) will be implemented.

### 7.3.2 Spoil from construction activities and mitigation measures

215. It has been estimated that approximately 10 million m$^3$ of spoil will be produced by the drainage rehabilitation and lake construction works. Spoil materials will include soil, lake sediments, silt, unconsolidated clays, and sands of lacustrine and alluvial origins. Soil analysis for potential inorganics (metals) and a pesticide, dichlorodiphenyltrichloroethane (DDT) was undertaken on soil samples from 8 locations in the area of proposed drainage rehabilitation and lake excavation. Samples were assessed against the PRC Soil Environmental Quality Standard and PRC Soil Environmental Quality Monitoring Standard. The results (Table 18), show that soil quality was within the standard for agricultural soil. This suggests that soil to be excavated for construction of Tianlu Lake is unlikely to be contaminated. However, further soil quality testing for metals and pesticides is recommended for soil excavation sites which have a history of storage or use of hazardous materials.

216. Spoil from Tianlu Lake construction, estimated to be almost 8 million m$^3$, will be reused on site to develop constructed islands within the lake areas. The design of the islands has not been confirmed. Considering the spoil will not be transported or stockpiled off site, the potential environmental impacts are considered to be limited to those identified for sediment dredging above, primarily relating to the potential for increased water course sedimentation.

217. Spoil produced during the rehabilitation of drainage channels is estimated to be around 2.5 million m$^3$. Eight spoil disposal sites will be identified as part of the construction planning process. To mitigate the potential for siltation of water courses and agricultural land from spoil disposal sites, the following principles for the siting and layout of spoil disposal areas will be employed: (i) siting to minimize transportation and the need for temporary storage; (ii) siting to avoid potential flood areas or flood way; (iii) sites to be small, and have no encroachment on cultivated land or forestland; (iv) sites to be concave land, gullies or gentle slopes; (v) sites to be located . Specific mitigation measures in the EMP include:

(i) Manage the spoil disposal sites in accordance with approved plan by the Weinan EPB

(ii) Rehabilitate and restore the spoil disposal sites in accordance with approved plan

(iii) Conduct regular internal supervision and periodic external monitoring (licensed soil erosion institute) of the spoil disposal sites

(iv) Conduct project completion audit to confirm that the spoil disposal sites were rehabilitated in accordance with the approved rehabilitation plan and government regulations

(v) Hold contractors liable in case of non-compliance

218. The final height and shape of each disposal area will be determined by survey during the detailed design phase and will be based upon the resting stability of local spoil material and the surrounding topography.

---

7.3.3 Spoil from construction activities and mitigation measures

219. Potential soil, groundwater and surface water impacts associated with release of construction related pollution to the environment will be managed and mitigated as follows:

(i) Ensure that prior to lake construction, wastewater entering the Project area along the north-south canal, from the Pucheng Wastewater Treatment Plant, is permanently diverted to a drainage channel east of the Project area. Both channels discharge to the Luo River.

(ii) Follow national standards to control fuel, oil and other substances

(iii) Collect wastewater from construction works in sedimentation tanks, retention ponds, and filter tanks to remove silts and oil

(iv) Equip all areas where construction equipment is being washed with water collection basins and sediment traps

(v) Station fuel storage, maintenance shop and vehicle cleaning areas at least 300m away from the nearest water body

(vi) Place storage facilities for fuels, oil, and other hazardous materials within secured areas on impermeable surfaces, and provide bunds and cleanup installations

(vii) Follow proper protocol for transferring fuel and the standard of JT 3145-88 (Transportation, Loading and Unloading of Dangerous or Harmful Goods)

(viii) Locate labor camps at least 500 m from ecologically sensitive receivers

(ix) Install eco-toilets and septic treatment and disposal systems at construction camps along with proper maintenance protocols

(x) Water quality parameters (for pollutants including SS, TP, TN, oil, and grease) in the drainage channels and the wetland park will be monitored during construction in accordance with the EMP monitoring program to assess effectiveness of adopted mitigation measures

(xi) The discharge of construction wastewater to the wetland area will be strictly prohibited. Instead, wastewater will be discharged after pre-treatment to the municipal sewer and treated in the Pucheng Wastewater Treatment Plant

(xii) Work camp will not be located within wetland areas

(xiii) Station fuel storage, maintenance shop and vehicle cleaning areas at least 1 km away from the boundary of the NWP

(xiv) Implement awareness building and training program for construction workers. Construction workers will be ordered not to enter any non-work area

7.3.4 Noise nuisance and mitigation measures

220. During construction, noise will mainly come from construction machines such as excavators, scrapers, tractors, dump trucks, cars, the belt of gravel yard transport and screening, washing and piling of construction material. The noise of construction machine is generally between 80 ~ 110 dB, while the vehicle noise intensity is generally about 90 dB. As some of the construction areas are adjacent to villages, where the noise will have some adverse effects on nearby residents.

221. In the construction area, the noise should be controlled according to the Standard of Measurement Method for Noise from Construction Site (GB12523–90). In the Project affected areas, the noise should be controlled according to the Standard of Environmental Noise of Urban Areas (GB3096–93). For urban and rural areas impacted by construction, the implementation of Category 2 environmental standard (60/50 dB day/night) and Category 4 (70/55 dB day/night) are required (Table 9).

222. The mitigation measures include; (i) noise source control; select the low-noise technology and equipment; equipment (components) with large vibration should be equipped
with vibration dampers; (ii) strengthen equipment repair and maintenance, so that construction machinery is maintained in good working condition; and (iii) make reasonable arrangements for construction time. For construction areas near residential zones, construction activity with high noise will be avoided from 22:00 to 06:00 h. When vehicles pass noise sensitive areas, speed should be controlled to no more than 35km/h and use of whistle/horn is prohibited.

7.3.5 Dust generation and mitigation measures

223. Potential sources of dust during construction activities include (i) dust generated from earth excavation, loading, hauling, and unloading; (ii) dust generated by the movement of vehicles and heavy machinery on unpaved access and haul roads; and (iii) dust from aggregate preparation, concrete-mixing, and haulage activities. To limit dust generation during construction, water trucks will be used to wet the construction roads, according to a daily schedule and taking into consideration weather conditions. When construction takes place during dry and windy days, water will be sprayed on earth piles and exposed surfaces to suppress dust. Aggregate preparation, storage areas and concrete-mixing will be located more than 300 m from the nearest residential area, downwind of the prevailing wind. Dust suppression equipment will be installed for concrete-batching.

7.3.6 Mitigation of potential impacts on Flora during construction

(i) Prior to construction in specific sites, clearly delineate existing vegetation which will not be cleared, and if necessary provide temporary fencing. Ensure that all contractors are aware of these no-clearance zones and do not enter them.

(ii) In compliance with the PRC’s forestry law: (i) document the specific areas of trees and other vegetation which are cleared; (ii) undertake compensatory planting of an equivalent or larger area elsewhere in the Project area.

(iii) For replanting activities which are to compensate for clearance by construction of existing wetland habitats, only native plant species of local provenance will be used for replanting.

(iv) Restoration and replanting will focus on areas of cleared/bare land, especially slopes prone to erosion, to simultaneously strengthen flood control, reduce soil erosion, and benefit local biodiversity.

7.3.7 Mitigation of potential impacts on Fauna during construction

(i) Take special precautions during construction for the protection of fauna, i.e., protect sites where small animals, reptiles, and birds of common species live such as trees, along the boundary of channels, and at the boundary to NWP.

(ii) In the event that mammals, birds, amphibians or reptiles are observed trapped within construction structures, such as new drainage channels or temporary pits, carefully catch these individuals and immediately release them in the reedbeds west of the proposed Tianlu Lake. Do not keep them in captivity.

(iii) In the event that any injured animals are found during construction, immediately report this to WFB and WEPB, who will decide whether the individual should be immediately euthanized or rehabilitated. Injured animals will only be held in captivity for the purpose of rehabilitation, and will be released into the reedbeds west of the proposed Tianlu Lake on recovery. Prior to release, the animal will be checked by a qualified veterinarian for disease. Injured or captive animals which are found to be diseased will be euthanized.

(iv) Report all records of biodiversity to the WFB and WEPB.
7.3.8 Pollution Prevention and Abatement

224. Wastewater from construction camps. Pollution relating to wastewater discharge from construction camps will be managed by use of portable sanitary systems. The wastewater will be collected, transported off site and disposed of to the domestic sewerage system.

225. General waste from construction camps. The project will promote best practice waste management focusing on minimisation, reuse, and recycling, including minimisation of solid waste generation through appropriate materials procurement and use of multi-compartment collection bins to promote recycling of construction materials.

226. Waste oil from machinery. During the construction phase, some of the machines take diesel as fuel and the vehicle washing and maintenance waste water has suspended solids and oil. If oily waste water is discharged directly into water bodies, an oil film will form on the water surface, resulting in reduced dissolved oxygen in the water body, which affects water quality. The random disposal of oily waste water also reduces soil fertility and causes a change in the soil structure. Thus, oily waste water cannot be discharged until it reaches the required treatment standard. A simple oil-water separation facility will be used to collect the oily waste water and treat it until the discharge standard is met.

227. Greenhouse gas emissions. Potential sources of greenhouse gas emissions from project works include machinery and vehicle exhaust, and inundation of existing vegetation resulting in the decay and release of carbon dioxide. Proper maintenance of vehicles and diesel equipment, and avoidance of unnecessary running of vehicle and equipment engines will reduce emissions. No vehicle that emits black smoke will be allowed to operate on-site. According to past similar water resource construction works, greenhouse gas emissions from vehicles and machinery are likely to be low.

7.4 Potential Adverse Impact and Mitigation Measures during Operation Phase

7.4.1 Lake Eutrophication

228. Lake eutrophication is an ecosystem response to increased nutrient levels within the water body, including nitrates and phosphates, which results in increased algal growth\(^{27}\). Depending on the degree of eutrophication, the water quality can be degraded, including reduced water clarity, reduced level of light, and decreased levels of oxygen which can have a negative consequence on the freshwater flora and recreational uses of the lake. The process of eutrophication can occur naturally. However, it is commonly related to human-induced addition of excess nutrients from runoff of excess fertilizer from agricultural land and discharge of partially treated sewage to water bodies\(^{28}\). The concentrations of nitrogen and phosphorus determines the trophic state of the lake. Nitrogen concentrations in the range of 0.3 – 1.5 mg/L and phosphorous concentrations in the range of 0.02 – 0.06 mg/L are associated with eutrophic conditions in lakes\(^{29,30}\). Due to the large area of agricultural land use within the Project area, there is a potential for lake eutrophication to occur.


\(^{29}\) Massachusetts Water Watch Partnership, [www.umass.edu/tei/mwwp](http://www.umass.edu/tei/mwwp)

\(^{30}\) International Lake Environment Committee, 1989, Lake Management Report
229. Expected lake water quality was modelled based on the Technical Guidelines for Environmental Impact - Surface Water Environment HJ/T2.3-93, which included the following key assumptions\textsuperscript{31} (i) the lakes are well mixed and water quality is uniform throughout\textsuperscript{32}, (ii) the average depth of the lake is 2 m, (iii) concentrations of salinity and nutrients entering and discharging from the lake are based on monitoring results for December 2011, and (iv) flow rates detailed Section 5 have been adopted. These assumptions provide for a simplistic model, which is considered suitable for concept design phase assessment. Tables 23 and 24 show the calculated water quality for the proposed Tianlu Lake, and both lakes together. Average measurements are necessary because they are not physically separate, but will be joined by a channel, although they are referred to and named by the WMG as separate lakes.

### Table 23. Calculated Water Quality for Proposed Tianlu Lake

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Class IV water standard\textsuperscript{4}</th>
<th>May (mg/L)</th>
<th>August (mg/L)</th>
<th>Dec (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td></td>
<td>98</td>
<td>3,946</td>
<td>8,417</td>
</tr>
<tr>
<td>COD</td>
<td>30</td>
<td>27</td>
<td>32</td>
<td>38</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N</td>
<td>1.5</td>
<td>1.1</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>1.5</td>
<td>1.7</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>0.1</td>
<td>0.02</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Table 24. Calculated Water Quality for Tianjiao Lake and Proposed Tianlu Lake

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Class IV water standard\textsuperscript{4}</th>
<th>May (mg/L)</th>
<th>August (mg/L)</th>
<th>Dec (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td></td>
<td>251</td>
<td>3,847</td>
<td>7,669</td>
</tr>
<tr>
<td>COD</td>
<td>30</td>
<td>27</td>
<td>32</td>
<td>37</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N</td>
<td>1.5</td>
<td>1.0</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>1.5</td>
<td>1.6</td>
<td>2.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>0.1</td>
<td>0.03</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

230. The expected water quality for the proposed Tianlu Lake and two lakes combined is broadly the same. The key trends include (i) forecast high salinity in August and December months due to high inflow of water from the Luoxi drainage system, and (ii) increase in total nitrogen and total phosphorus in August and December months due to increase agricultural runoff draining from the Luoxi drainage system. The concentration for total nitrogen during December is within the range where eutrophication can occur, and the concentration for total phosphorus during August and December are within the range where eutrophication can occur. Based on the results of modelling it is likely that some level of eutrophication will occur within the constructed lakes due to high nutrient levels, particularly in the months following the wet season. Eutrophication may lead to algal blooms.

231. Mitigation through Integrated Nutrient Management. To mitigate against the risk of lake eutrophication, an integrated nutrient management plan will be developed for the Project area,

\textsuperscript{31} Domestic Environmental Impact Assessment Report, 2012
\textsuperscript{32} The assumption of well mixed lake applied to the model is a simplified assumption, in practice the lake will not be uniform throughout. However, this simpliciation is acceptable for concept design stage. More detailed modelling is recommended as part of an overall nutrient management plan.
and is included in the Project EMP (Appendix A). This plan will include (i) improved monitoring, management and application of agricultural fertilizer use within the drainage area, (ii) improved regulation of fertilizer volumes used per ha, (iii) use of constructed wetlands at drainage channel discharge points aimed at reducing nutrient levels, and (iv) training and capacity building for local farmers in appropriate fertilizer application. Ongoing monitoring of total nitrogen and phosphorus levels in lake and drainage waters is also required as part of the Project EMP.

7.4.2 Salinity discharge to the Luo River

232. There are no water quality discharge standards to the Luo River for salinity, however the Surface Water Environmental Quality Standards (GB3838-2002) outlines limits for other parameters (see Section 2.4).

233. Two-dimensional steady-state and well-mixed water body models\textsuperscript{33} were used to determine the water quality discharge to the Luo River from the Luoxi drainage system following the construction of the proposed Tianlu Lake and drainage rehabilitation works in accordance with the Environmental Impact Assessment Technical Guidelines - surface water environment HJ/T2.3-93. The model was based on the following key assumptions and parameters: (i) main channel and Luo River physical dimension outlined in the FSR, 2012, (ii) water quality for Tianjiao and Tianlu Lakes (Tables 23 and 24), (iii) main channel flow rate from August and December 2011 of 7.97 m\textsuperscript{3}/s and 2.63 m\textsuperscript{3}/s (respectively) as determined in the FSR, 2012, (iv) water quality of the Luo River as presented Section 5.2 of this report, (v) hydrological parameters of the Luo River for August and December including average flow of 54.51 m\textsuperscript{3}/s and 14.02 m\textsuperscript{3}/s (respectively) as determined in the FSR, 2012, and (vi) the average annual flow of the Wei River of 273 m\textsuperscript{3}/s as determined in the FSR, 2012.

234. December represents the highest concentrations of salinity, COD and total nitrogen discharging from the Luoxi drainage system and have been shown here to assess the potential change in water quality of the Luo River. The modelling forecasts that water quality discharging from the main channel to the Luo River will include salinity concentrations up to around 6,000 mg/L, along with other parameters listed in Table 25. The concentrations are slightly different from those listed for the lake water quality due to attenuation and additional water inflows to the main channel enroute to the Luo River.

<p>| Table 25. Modeled Water Quality Impact from Luoxi Drainage Discharge to Luo River |
|-----------------------------------|-----------------------------------|-----------------------------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>Main channel discharge point (modeled)</th>
<th>Luo River upstream of discharge point (actual)</th>
<th>Luo River 1 km* downstream of discharge point (modeled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td>5.991 mg/L</td>
<td>1.100 mg/L</td>
<td>2.058 mg/L</td>
</tr>
<tr>
<td>COD</td>
<td>34.8 mg/L</td>
<td>44.5 mg/L</td>
<td>41.5 mg/L</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>6.4 mg/L</td>
<td>4.5 mg/L</td>
<td>5.2 mg/L</td>
</tr>
</tbody>
</table>

* 1 km downstream represents the maximum concentration zone, following which dilution is modelled to reduce the concentrations, prior to the Luo River entering the Wei River approximately 7 km downstream from the discharge point.

235. The model shows that discharge from the Luoxi drainage system to Luo River is likely to increase salinity concentrations, decrease COD concentrations, and increase total nitrogen.

\textsuperscript{33} Domestic Environmental Impact Assessment Report, 2012
concentrations in the Luo River. The main area of altered salinity is likely to be immediately downstream of the junction with Luoxi drainage system. It is expected that an increase from 1,100 mg/L to 2,058 mg/L will not result in significant negative impacts to fresh water ecology of the Luo River: the Luo River joins the Wei River 7 km downstream of the discharge point of the Luoxi drainage system, providing increased dilution and mixing which is likely to reduce salinity by 1,000 mg/L to negligible levels. Water quality monitoring at the discharge point of the drainage system into the Luo River is required in the EMP to confirm the modelling results during the course of the Project implementation.

7.4.3 Proposed Luyanghu industrial development zone associated impacts

236. The Project is set within the context of the Weinan Luyanghu Lake Modern Industries Comprehensive Development Zone master plan (2007-2025). The development plan includes proposed hotels, recreation parks, residential, commercial and industrial buildings (including general aviation industry), schools, and agricultural land uses. All development to date has focused on a 1,500 ha area in the eastern portion of the Project area. As of July 2012, one lake, Tianjiao, has been constructed with associated landscaping and a network of sealed roads. No further information is currently available on the extent of planned implementation of the development plan.

237. The surrounding planned industrial development has the potential to have an associated impact on the environment within the Project area. In particular, (i) wastewater discharge and urban run-off from new areas of development including industrial facilities is an important consideration for the water quality of the constructed lakes and wetlands, (ii) land use development adjacent to wetland areas without consideration for suitable buffer zone or interconnected vegetated corridors has the potential to impact the fauna within the wetlands as a result of noise and air pollution, and isolating the wetlands from surrounding forested areas, and (iii) development of aviation industry within the development zone, which may impact migratory birds and create hazards to human safety due to birdstrike.

238. Project design and environmental considerations must be integrated with the proposed Luyanghu industrial development zone plan. Consideration must be given to the location of proposed residential areas, increased industrial uses and increased development of the aviation industry, with respect to the wetland and lake environments and water bird protection. An overlay of the Project design onto the Luyanghu industrial development zone plan should be developed, including clear location of the wetland areas with respect to the development plan. The risk of birdstrike, both for migratory waterbirds and human safety, will need to be considered in the development of any aviation industry in or near the Project area.

239. Wastewater treatment planning associated with the proposed Luyanghu industrial development zone should ideally be undertaken in accordance with an integrated nutrient management plan for the entire watershed, although this is beyond the Project scope. It is recommended that assurances be sought that any further development will include suitable wastewater treatment facilities to treat municipal and industrial wastewater, in accordance with permitted wastewater effluent discharge limits protective of the wetlands and lake environments. The permitted effluent discharge standards must be monitored closely, to protect against increased pollution levels within the wetlands and lakes. The need for integration of the Project and its environmental and social planning into future development plans is considered in the Project assurances (Section 11).
7.5 General Mitigation Measures

240. In the preparation of the EIA report and feasibility study report, and during the ensuing preliminary design phase, the following mitigation measures have been and must be undertaken:

- Attempts have been made to locate drainage rehabilitation works and new channel works to minimize potential adverse impacts on the environment and surrounding communities.
- The Project is located and designed to minimize resettlement impacts.
- Adequate technical design and scheduling of construction activities for the components will provide for safety, sanitation, and environmental protection in compliance with government regulations and international practices.
- All components have undergone the EIA process under the PRC laws and regulations. The EIA report was prepared by qualified EIA institutes, reviewed by expert panels, and approved by the Local Environmental Protection authority or the respective municipal environmental protection bureaus.
- Appropriate environmental mitigation and monitoring measures are included in the environmental management plan (EMP). The proposed environmental mitigation measures will form part of the design documents for the components, and be included in the contracts for procurement of goods and services. All contractors and subcontractors will be required to comply with the EMP.
- The environmental monitoring program is also incorporated into the overall project design to ensure that environmental impacts are closely monitored and the construction and operating activities are closely supervised against the approved EMP.

7.6 Biodiversity Conservation and Sustainable Natural Resource Management

7.6.1 Important Habitats

241. Salt pans in the Project area are important habitat for waterbirds. At least three, possibly four, waterbird species occur in number that meet or exceed the thresholds of global importance for these species as defined by the Ramsar Convention. Salt pans in the west will mostly be protected as part of the NWP. Salt pans in the east will be partly replaced by construction of Tianlu Lake (Table 22). These eastern salt pans may support the largest numbers of migratory waders, and this is where the greatest potential impacts will occur. Mitigation measures to achieve the SPS criterion of ‘no net loss’ for migratory waterbirds are described in Section 7.2.

Legally Protected Areas

242. Based on consultation with WMG environment protection department, the Shaanxi Forestry Bureau and the Shaanxi Environmental Protection Bureau, there are no legally protected areas within the Project area. The Pucheng Luyanghu NWP is not currently listed as a legally protected area under the Shaanxi Wetland Regulations or the State Forestry Administration Wetlands National Wetlands Framework. The Project implementation will support SFA final approval of the NWP, with an aim to include the wetland as a legally protected area under the Shaanxi Wetland Regulation and State Forestry Administration National Wetlands Framework.

7.7 Cumulative Impacts

243. Current and proposed development under the Luyanghu Industrial Development Zone Plan (2007-2025) includes residential, commercial, and industrial development, and expansion
of the aviation industry. Potential cumulative impacts may include a decline in water quality and habitat in the wetlands, due to new industrial wastewater entering the wetlands, and increasing risk of birdstrike with expanding aviation activity. The designation and management of the Luyanghu NWP, under Project output 3, will help reduce the risk of such impacts.

7.8 Cultural Relics and Physical Culture Resources

244. No national or provincial-listed cultural resources occur in the Project area, but the salt harvesting industry (Section 4.4.1) represents important cultural heritage. Under output 3 of the Project, development of the NWP master plan will enable continued salt-harvesting, and salt pans will be managed for the benefit of livelihoods, waterbird habitat, and potentially tourism. These issues are addressed in PPTA Final Report–Supplementary Appendix 9.

245. With regard to physical cultural resources, in case such resources are found during project construction, all construction work will be put to a halt and consultations will be held with the local authorities and project staff on how to proceed. Such events and the subsequent decisions and actions will be reported in the environmental progress reports. In any case, the provincial government has confirmed that the Project will not remove physical cultural resources unless the following conditions are met: (i) no alternatives to removal are available; (ii) the overall benefits of the Project substantially outweigh the anticipated cultural heritage loss from removal; (iii) removal is conducted in accordance with relevant provisions of national; and (iv) local laws, regulations, and protected area management plans and national obligations under international laws and employs the best available techniques.

7.9 Environmental Safeguard Assurances

246. The Project EMP (Appendix A) will form the primary document to be used by the EA and ADB for environmental management and monitoring of the project. An environmental safeguard assurance has been developed: the WMG will ensure that future development plans for the Project Area, including a nearby aviation industry, will not negatively impact the environmental benefits achieved by the Project. This will include ensuring that:

- construction of new salt pan habitat (in the west of the Project area) will be completed before the removal of salt pans for construction of Tianlu Lake;
- future development does not impact on the National Wetland Park;
- the master plan of the NWP is incorporated into future development plans;
- no further loss of wetland habitats in the Project area, including salt pans;
- human/aircraft safety is maximised, and the risk of birdstrike is minimised, by restricting aviation activity during the migratory bird seasons (March-April and September-October) and creation of seasonal no-fly zones; and,
- future development does not result in an increase in point- and non-point source pollution in the drainages (including Tianjiao and Tianlu Lakes) in the Project Area.

8. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

8.1 Legislative Framework for Public Consultation

247. Public participation in the evaluation of project design and implementation is required under ADB’s SPS and the PRC’s Environmental Protection Law and Regulations on the Administration of Construction Project Environmental Protection (Order of the State Council, No. 253). The latter require that “Environmental Impact Report formulated by construction unit shall be in accordance with relevant laws to solicit the opinions of units concerned and inhabitants of
project construction site”. The Project EIA included two rounds of public consultation, information dissemination, questionnaires, and analysis.

8.2 Public Consultation Activities

248. Figure 28 presents the public consultation process for the proposed project.

**Figure 28  Public Consultation Process Conducted**

- Define public consultation scope and method
- Disseminate information to the public and media
- Hold Questionnaires, discussion, and survey
- Collect comments and suggestions
- Analyse comments and give response and interview the public
- Disclose results and communicate the information to IAs

8.2.1 Public Consultation

249. During Project preparation, two rounds of public consultation (Figure 28), the first by the IA and EIA Institutes during August to December 2011.

250. Information Dissemination. In accordance with the requirements of PRC Interim Guidelines on Public Participation in Environmental Impact Assessment (2006), public notices were issued. The public notices were posted in prominent government offices related to the IA and local EPBs and local newspaper and local website. For example, the notices were posted at the main entrance of the County Environmental Protection Bureau. The notices included a detailed description of the planned developments and invited the views of residents (through e-mail, letters, telephone and other forms to the construction unit and EIA unit). The other subprojects have conducted the similar information dissemination activities.

251. Questionnaire and Responses. During and after the exhibition period of the Public Notices, the IAs and Institutes randomly distributed questionnaires among the residents and the public within the subcomponents’ area of influence. The standard distribution rate was 30 to 50 questionnaires per subcomponent, with high return rates of between 80 and 90%. The breakdown of comments and responses to the questionnaires is described in considerable detail in the subcomponent EIAs. In general, the respondents in the first round of public consultation supported the construction of the new subprojects. They believed that the subprojects would improve the existing environmental quality and living amenity, and they would support their implementation on condition that their reasonable requirements and recommendations were satisfied.
8.2.2 Stakeholder Consultations during the Environmental Impact Assessment

252. The EIA teams carried out the stakeholder consultations in the subproject districts and counties in August and December 2011. Following the PRC’s related requirement and ADB environmental assessment guidelines, the TA team ensured that people from areas where potential impacts might occur were consulted, as well as the appropriate representatives of age, gender, poverty, and ethnic categories. The objectives of the consultations were to gather information on public concerns about the Project before finalizing the draft EIAs. Concise project descriptions about the components were prepared and distributed to the public before or at the time of the consultation. The results of the consultations were used to modify the EIAs and the Project designs. The stakeholder consultations and disclosure exercises comprised:

(i) Dissemination of project information to local residents,
(ii) Public consultation meetings with groups directly affected by the proposed project, and
(iii) Distribution of public consultation questionnaires.

253. The affected people from the subprojects were mainly concerned about land use change and mitigation measures for this issue.

254. During the public consultations, the attending DEIS institute engineers, IAs representatives, and governmental officials addressed and noted all the initial concerns and suggestions raised by the participants. The majority of participants indicated that if the measures and policies recommended in the design, DEIS, and EMPs are carried out during construction and operation, they would be satisfied.

255. Consultation Results. The consultations revealed that 85%–95% of the consulted public are supportive of the Project, with the rest being unsure. The expected benefits include promotion of sustained agricultural development, protection of water resources, better access to market, better prospect for regional cooperation, better prospect for outside investment and better prospect for socioeconomic development.

256. The anticipated negative impacts include possible noise pollution, solid waste, and land use change. The consulted public made several suggestions for mitigating the potential adverse environmental and social impacts: (i) construction activities close to residential areas should stop between 10:00 pm and 7:00 am; (ii) heavy construction equipment located in close proximity to schools and residential areas should be fitted with noise suppression apparatus; (iii) dust-generating construction vehicles should be covered and dusty construction areas sprayed with water. Most of these suggestions have been incorporated in the DEIS report and EIA. Those concerns that are beyond the scope of the DEIS, such as a resettlement plan and protection of existing infrastructure during construction, have been conveyed to relevant authorities.

8.2.3 Information Disclosure

257. Environmental information on the Project was and will be disclosed as follows:

- the EIA Reports are available for review in the Project management department of local EPB
- the English CEIA will be available for review at www.adb.org for 120 days before the Project is considered by the ADB Board (posted on ADB’s website 8 August 2012);
- a new or updated EIA prepared during project implementation, if any; and
the environmental monitoring reports.

9. GRIEVANCE REDRESS MECHANISM

258. In order to settle unforeseen issues effectively, an effective and transparent channel for lodging complaints and grievances has been established. The grievance redress mechanism is detailed in the EMP (Appendix A).

10. ENVIRONMENTAL MANAGEMENT PLAN

259. The objective of the EMP (Appendix A) is to prescribe project-specific mitigation and monitoring measures. It is based on the findings of the EIA and Project discussions and agreements with the relevant government agencies. The Project EIA, including the EMP, not the domestic EIA, is the specific document which forms the loan agreement between the Weinan Municipal Government (WMG) and ADB. The EMP will be reviewed and updated, with the approval of WMG and ADB, at the end of the detailed Project design.

10.1.1 Mitigation Measures

260. The EMP contains measures to mitigate the potential environmental impacts. The responsibilities for implementing and supervising these measures are assigned to different agencies (Appendix A).

10.1.2 Organizational Structure for Environmental Management

261. The PMO within the WMG will be responsible for setting up the environmental management system, consisting of inspection, monitoring, reporting, and initiating corrective actions or measures. In the design stage the PMO and IA will pass the EMP to the design institute for incorporating mitigation measures into the detailed design. The EMP will be updated at the end of the detailed design, and finally passed to the construction contractors. To ensure that contractors will comply with the EMP provisions, the PMO and IA will prepare and provide the following specification clauses for incorporation into the bidding procedures: (i) a list of environmental management requirements to be budgeted by the bidders in their proposals; (ii) environmental clauses for contractual terms and conditions, and (iii) full DEIS and EIA for compliance. The PMO, IA, and contractors will each nominate dedicated, trained and qualified environment specialists to undertake environmental management activities and ensure effective EMP implementation. The IA will set up an environmental management unit (EMU). The independent environmental monitor contracted by the IAs will be responsible for inspection, monitoring, and evaluating implementation of mitigation measures.

262. Environmental training will be essential for the IA and contractors to implement the EMP. The PMO will be responsible for organizing training programs, which will cover (i) environmental laws, regulation and policies; (ii) implementing mitigation measures; (iii) environmental technologies and procurement; (iv) operating and maintaining environmental facility; (v) environmental monitoring, supervision; and (vi) documentation and reporting.

10.2 Inspection, Monitoring, and Reporting

263. The PMO will nominate at least one qualified full-time environmental management staff member to undertake environmental management and monitoring activities. The PMO will also recruit one environmental management consultant to assist itself and IA in carrying out internal environmental monitoring and inspections, reporting to ADB through quarterly project progress reports, semi-annual environmental monitoring reports, and a project completion report, and conducting necessary training. The PMO, with assistance from the environmental management
consultant, will submit to ADB quarterly project progress reports and semi-annual environmental monitoring reports on the progress of the EMP, information on project implementation, the environmental performance of the contractors and environmental compliance. In addition, within 3 months of physical completion of the Project, the PMO will submit to ADB a project completion report that describes the achievements in relation to the Project's expected impact, outcome and outputs including environmental terms.

264. A local environmental monitoring agency and/or company will be engaged by the IA as the independent environmental monitoring contractor (IEM). The IEM will include an environmental safeguard specialist suitably qualified to conduct independent environmental monitoring. The independent environmental monitoring will be conducted to ensure that contractors appropriately implement mitigation measures. The IEM will submit independent environmental monitoring reports on a semi-annual basis to the IA which will forward to the PMO, WMG, and the EPB. The reports will emphasize: (i) progress made in implementing the EMP, (ii) implementation of mitigation measures, (iii) environmental compliance, (iv) institutional strengthening and training, (v) public consultations, and (vi) any problems that occurred and corrective actions taken. The IEM will also assist WMG including the PMO to prepare quarterly project progress reports, semi-annual environmental monitoring reports and a project completion report, which will include the above information.

265. Within 3 months after project completion, or no later than 1 year with permission from the responsible environmental authorities, environmental acceptance monitoring and audit reports will be (i) prepared by qualified environmental institutes in accordance with the MEP Guideline on Project Completion Environmental Audit (2001), and (ii) reviewed for approval by the local EPB. The reports will focus on the Project compliance of environmental performance when it is put into operation. The reports will be sent to environmental authorities for review and approval and also to the PMO through the IA.

266. Results of the all reports mentioned above will be used for assessing: (i) the extent and severity of the environmental impacts against the predicted impacts, (ii) performance or effectiveness of the environmental protection measures or compliance with pertinent rules and regulations, (iii) trends in impacts, (iv) overall effectiveness of the Project EMP, and (v) the need for taking additional mitigation measures.

10.3 Mechanism for Feedback and Adjustment

267. The EMP and grievance redress mechanism will be refined during the detailed design phase of the Project when more design details become available. The updated documents will be approved by the WMG and ADB.

268. Once the Project has started, the Project environmental personnel (Section 10.2) will assess whether further mitigation measures are required or if improvement is required to strengthen the EMP. If monitoring and inspections reveal deviation from the EMP or changes in subproject activities, which may cause new adverse impacts to the environment or local communities, the PMO should consult with the WMG and ADB immediately and form an EIA team to conduct additional environmental assessment and, if necessary, further public consultation. The revised EIA report will be submitted to environmental authorities and to ADB for review and approval.
11. CONCLUSIONS AND RECOMMENDATIONS

269. The Shaanxi Weinan Luyang Integrated Saline Land Management Project will provide environmental benefits including (i) protection and rehabilitation of most of the remnant wetlands in the Project area, including 550 ha (75%) of salt pan habitat for waterbirds, protection of all remaining reed beds (Table 22), (ii) establishment of the Luyanghu NWP, (iii) reduced soil salinity, resulting in improved soil quality, crop harvest, and crop diversity, and (iv) reduced flooding, by increasing the flood storage capacity of the Luyanghu area by 4.4 million m³ along with improving the channel system draining to the lakes.

270. The Project will improve socio-economic conditions of farmers, by improving agricultural productivity through reduced soil salinity, reduced flood damage to homes and crops, and new income opportunities associated with tourism and increased commercial and industrial development supported by reduced flood risk. An addition of 4.1 km² of agricultural land will reach the classification of high-productivity, with a unit output increase of 50%.

271. Without mitigation, the Project will result in some adverse environmental impacts, including: (i) loss of 11% (110 ha) of salt pan habitat for migratory waterbirds for construction of Tianlu Lake, resulting in a cumulative loss of 29% (290 ha) salt pans when considered with the recently constructed Tianjiao Lake (Table 22), (ii) potential decline in the seasonal populations of some migratory waders that visit the Project area, and (iii) increased nutrient levels in the lake with the potential for eutrophication.

272. There is the potential for cumulative negative impacts relating to the proposed future commercial and industrial development in the Project area.

273. To mitigate potential environmental impacts, an Environmental Management Plan (EMP, Appendix A) has been prepared. The EMP addresses the potential impacts of construction and operation, including impacts to migratory waterbirds and salt pan habitat, and eutrophication. The EMP includes a grievance redress mechanism and protection of physical cultural resources.

274. For future commercial and industrial development in the Project area, it is recommended that an integrated development plan be developed incorporating the NWP. Along with an integrated approach to development planning, this plan must include air, noise, soil and water pollution emission limits for new developments to protect the ecological values of the wetlands, defined in the NWP master plan, and demonstrate adequate capacity and resources to regulate those discharge limits. It is difficult to obtain a specific project assurance on this issue, due to the lack of clarity about future development plans in and near the Project area, but the issue is at least partly addressed in a Project-specific environmental assurance (Section 7.9).
Appendix A:

Environmental Management Plan
### CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Objectives</td>
<td>90</td>
</tr>
<tr>
<td>B. Summary of Potential Impacts and Mitigation Measures</td>
<td>90</td>
</tr>
<tr>
<td>C. Environmental Monitoring and Inspection</td>
<td>104</td>
</tr>
<tr>
<td>D. Public Consultation</td>
<td>109</td>
</tr>
<tr>
<td>E. Responsibilities and Authorities for Implementation</td>
<td>110</td>
</tr>
<tr>
<td>F. Institutional Strengthening and Training</td>
<td>113</td>
</tr>
<tr>
<td>G. Reporting and Supervision</td>
<td>114</td>
</tr>
<tr>
<td>H. Work Plan</td>
<td>115</td>
</tr>
<tr>
<td>I. Cost Estimates for Environmental Management</td>
<td>116</td>
</tr>
<tr>
<td>J. Mechanism for Feedback and Adjustment</td>
<td>116</td>
</tr>
<tr>
<td>K. Grievance Redress Mechanism</td>
<td>117</td>
</tr>
</tbody>
</table>

This is an attachment to the Environmental Impact Assessment Report, which is an official document of the borrower. The views expressed herein do not necessarily represent those of ADB’s Board of Directors, Management, or staff and may be preliminary in nature. Your attention is directed to the “Terms of Use” section of this website.

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgement as to the legal or other status of any territory or area.
ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

The objective of this environmental management plan (EMP) is to mitigate the potential environmental impacts of the Project. It is considered that if this EMP is implemented fully and effectively, it will mitigate the potential impacts identified in the Project EIA to levels which satisfy the ADB Safeguard Policy (SPS, 2009). The EMP includes: (i) objectives, (ii) mitigation measures, (iii) environmental monitoring and inspection, (iv) public consultations, (v) responsibilities and authorities for implementation, (vi) institutional strengthening and training, (vii) reporting and supervision, (viii) work plan, (ix) cost estimates, and (x) mechanism for feedback and adjustment. The EMP will be reviewed and updated at the end of the detailed Project design in order to be consistent with the final detailed design.

B. Summary of Potential Impacts and Mitigation Measures

Potential environmental impacts of the pre-construction, construction and operation phases of the Project were identified in the Domestic Environmental Impact Assessment (DEIA) and Project PPTA team. These are described in the consolidated EIA (EIA; the main text of which this EMP forms Appendix A). Mitigation measures are described in Table A2.1. These will be incorporated into the tendering documents, construction contracts and operational management plans. They will be undertaken by the implementing agency (IA) and contractors, under the supervision of the Weinan Municipal Government project management office (PMO) and the Weinan Environmental Protection Bureau (WEPB). The effectiveness of these measures will be evaluated based on the results of the environmental monitoring to determine whether they should be continued or if improvements need to be made. Improvements need to be confirmed through stipulated environmental management procedures. Particular focus is given in the EMP to three areas: (i) mitigating the impacts to salt pan habitat for migratory waterbirds; (ii) establishment and management of the Luyanghu National Wetland Park (NWP); (iii) construction impacts to the local environment (hydrology, water quality, soil, air) and residents.
Table A2.1: Summary of Potential Impacts and Mitigation Measures. See text after this table for additional information on mitigation measures for migratory waterbirds and salt pan habitat. See Table A2.3 for monitoring.

<table>
<thead>
<tr>
<th>Impact Factor/Stage</th>
<th>Potential Impacts and/or Issues</th>
<th>Mitigation Measures</th>
<th>Implementing Agency</th>
<th>Supervising Agency</th>
<th>Cost&lt;sup&gt;34&lt;/sup&gt; (USD, '000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Pre-Construction (Detailed design phase)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1. Conservation of salt pan habitat and migratory waterbirds | Loss of 110 ha salt pans and potential impacts to migratory waterbirds due to construction of Tianlu Lake | - Reduce loss of salt pans during detailed lake design – exclude areas identified by waterbird survey which support the highest numbers of waterbirds. See Figure 1 after this Table of the ideal lake design. A compromise will need to be achieved between this and restrictions from topography and land tenure.  
- Finalize design of Tianlu Lake and calculate exact area of salt pans to be lost.  
- Design ‘soft’ transitional zone between western shore of lake and salt pans+reed beds to west; western shoreline of lake to be shallow-water areas with gentle gradient.  
- Construct new salt pans in the site of abandoned fishponds in west of Project area, before construction of Tianlu Lake. Specialist input to design the salt pans, water balances and salinity will be supported by an ADB grant ($350,000) to maximise the constructed habitat for small to medium sized waders and their food sources.  
- Prior to construction, delineate vegetation which will not be cleared, and if necessary erect temporary fencing. Ensure that all contractors are aware of these no-clearance zones and do not enter them. | Design and EIA Institutes and IA, supported by wetland and waterbird specialists | PMO, Weinan EPB, Weinan Forestry Bureau | Pre-project costs |

| 2. Review and revision of the EIA including this EMP after detailed engineering designs are completed | Spoil disposal sites | Finalize the exact locations of the 8 spoil sites. All will be located to the east / north-east of Tianlu Lake to avoid disturbance to remaining saltpans. Prepare a spoil disposal and rehabilitation plan | PMO, IA | Weinan EPB | Pre-project costs |
| | Update EIA and EMP | Review and update mitigation measures defined in the EMP and incorporate into the detailed design to minimize adverse environmental impacts | EIA institute, Design Institute, IA | PMO, Weinan EPB | Pre-project costs |
| | Public | Conduct public consultation and stakeholder consultation as outlined in Table A2.3 | As above | PMO | Pre-project costs |

<sup>34</sup> Cost estimated only when cost will be paid for by the Project and have not already been included under other Project procurement line items. Monitoring and auditing costs are included in Table A2.4.
<table>
<thead>
<tr>
<th>Impact Factor/Stage and/or Issues</th>
<th>Potential Impacts and/or Issues</th>
<th>Mitigation Measures</th>
<th>Implementing Agency</th>
<th>Supervising Agency</th>
<th>Cost&lt;sup&gt;34&lt;/sup&gt; (USD, '000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>consultations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Bidding documents and contractors qualifications | - Include the relevant sections of the DEIA, EIA and this EMP in the bidding documents and contracts for construction and supply contracts contractors  
|                                 | - Ensure that all salt pans, reed beds and other wetland habitats not cleared for lake construction are off-limits to construction personnel and this is stated in work contracts. | IA, procurement agency | PMO | Pre-project costs |
| 3. Bidding and Construction Preparation | Environmental operation and supervision | - Contractors will prepare an environmental operation, health, safety, and supervision manual for approval by the IA | Contractors | IA, PMO | Pre-project costs |
|                                 | Complaint and information office or appointed person | - A complaint and information office, with at least one staff member, will be established before construction begins  
|                                 |                                 | - Staff at this office will be trained to handle complaints from residents relating to environmental and cultural impacts | Contractors | IA, PMO | Pre-project costs |
|                                 | Environmental protection training | - Environmental specialists and/or officials from WEPB will provide training on implementation and supervision of environmental mitigation measures to relevant persons, especially construction engineers, managers, and contractors | WEPB, PMO, EMC | PMO | Pre-project costs |
|                                 | Engagement of EMC | - Prior to start of construction, a national environmental management consultant will be engaged | PMO | PMO | Pre-project costs |
|                                 | Engagement of IEM | - Prior to start of construction, an independent environmental monitoring contractor (IEM) will be engaged | IA | PMO | Pre-project costs |

### B. Construction Phase

1. Spoil disposal site management and rehabilitation | - Manage temporary spoil disposal sites in accordance with approved plan by the Weinan EPB  
|                                 | - Rehabilitate spoil disposal sites in accordance with this plan  
|                                 | - Conduct regular internal supervision and periodic external monitoring (licensed soil erosion institute) of the disposal sites  
<p>|                                 | - Conduct project completion audit to confirm the spoil disposal sites were rehabilitated in accordance with the plan | Contractors | IA, IEM, PMO, WEPB | 50 (Allowance estimate for sediment control equipment) |</p>
<table>
<thead>
<tr>
<th>Impact Factor/Stage</th>
<th>Potential Impacts and/or Issues</th>
<th>Mitigation Measures</th>
<th>Implementing Agency</th>
<th>Supervising Agency</th>
<th>Cost(^\d) (USD, '000s)</th>
</tr>
</thead>
</table>
| 2. Soil             | Soil erosion and sediment run-off due to construction activities | • Hold contractors liable in case of non-compliance  
• Implement erosion protection measures such as terraces and silt barriers during excavation works  
• Stabilize all excavation slopes, embankments, and other erosion-prone working areas during excavation works  
• All earthwork areas will be stabilized within 30 days after earthworks have ceased at the sites  
• Divert drainage around areas of excavation during channel rehabilitation and lake excavation works  
• Undertake excavation in sections, minimizing the area of active excavations at any one time during channel rehabilitation and lake construction activities  
• Establish temporary detention ponds to control silt runoff  
• Construct intercepting ditches and drains to prevent runoff entering construction sites, and divert runoff from sites to existing drainage  
• Strip and stockpile topsoil, cover or seed temporary soil stockpiles  
• Limit construction during heavy rain and high winds  
• Properly slope or re-vegetate disturbed surfaces  
• Locate construction camps and storage areas to minimize the land area required and impact on soil erosion | Contractors | IA, IEM, PMO, WEPB | 50 |
|                     | Soil erosion and sediment run-off due to construction activities - Additional measures around NWP | • Where channels drain into the NWP, additional silt barriers will be applied 100 m upstream of interception with the wetlands  
• During construction phase, wetland water quality will be monitored weekly at the intersection point of each drainage channel  
• If evidence of sediment runoff entering wetlands is recorded, construction works will be halted and corrective action (improved siltation protection measures) will be implemented | Contractors | IA, IEM, PMO, WEPB | 20 (Allowance estimate for sediment control equipment) |
|                     | Soil contamination | • Store petroleum products, hazardous materials and wastes on impermeable surfaces in secured and covered areas, using best management practice to avoid soil contamination  
• Remove construction waste to approved waste disposal sites  
• Establish emergency preparedness and response plan (Spill Management Plan) in compliance with PRC regulations and the Worldbank Group’s EHS Guidelines (General Guidelines, Toll | Contractors | IA, IEM, PMO, WEPB | - |
<table>
<thead>
<tr>
<th>Impact Factor/Stage</th>
<th>Potential Impacts and/or Issues</th>
<th>Mitigation Measures</th>
<th>Implementing Agency</th>
<th>Supervising Agency</th>
<th>Cost(^{34}) (USD, (^{000s}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads)</td>
<td></td>
<td>● Provide spill cleanup measures and equipment at each construction site and require contractors to conduct training in emergency spill response procedures</td>
<td>Contractors</td>
<td>IA, IEM, PMO, WEPB</td>
<td>Included in Table A2.4</td>
</tr>
<tr>
<td>Changes in hydrology</td>
<td></td>
<td>● Conduct drainage channel rehabilitation and lake construction works during the dry season (November to February). ● Provide adequate opening for flood flow before the rainy season (May to August)</td>
<td>Contractors</td>
<td>IA, IEM, PMO, WEPB</td>
<td>-</td>
</tr>
<tr>
<td>3. Water hydrology and quality</td>
<td>Changes in hydrology – Additional measures around NWP</td>
<td>● Establish drainage control sluice gates prior to channel rehabilitation and lake construction works ● Actively monitor and control water levels within wetlands with sluice gates during the construction phase</td>
<td>Contractors</td>
<td>IA, IEM, PMO, WEPB</td>
<td>-</td>
</tr>
<tr>
<td>Surface and groundwater pollution</td>
<td></td>
<td>● Prior to lake construction, wastewater entering the project area along the north-south canal will be permanently diverted to an existing canal east of the project area ● Map the existing channel network and ensure that channels for wetland drainage and urban/industrial drainage are kept separate ● Follow the national protocol for transferring fuels and oil (Standard JT 3145-88 - Transportation, Loading and Unloading of Dangerous or Harmful Goods) ● Collect wastewater from construction works in sedimentation tanks, retention ponds, and filter tanks to remove silts and oil ● Equip all areas where construction equipment is being washed with water collection basins and sediment traps ● Locate fuel storage, maintenance, and vehicle cleaning areas at least 300m from the nearest water body ● Locate storage facilities for fuels, oil, and other hazardous materials in secured areas on impermeable surfaces, and provide bunds and cleanup installations ● Locate labor camps at least 500 m from sensitive receivers ● Install eco-toilets and septic treatment and disposal systems at construction camps along with proper maintenance protocols During construction, monitor water quality (including SS, TP, TN, oil, grease) and water balance indicators (total flows into, and discharging</td>
<td>Contractors</td>
<td>IA, IEM, PMO, WEPB</td>
<td>-</td>
</tr>
<tr>
<td>Impact Factor/Stage</td>
<td>Potential Impacts and/or Issues</td>
<td>Mitigation Measures</td>
<td>Implementing Agency</td>
<td>Supervising Agency</td>
<td>Cost* (USD, '000s)</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>from) the drainage channels and Tianlu+Tianjiao Lakes as per this EMP (see Tables A2.2 and A2.3)</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Surface and groundwater pollution – Additional measures around NWP</td>
<td>• Discharge of wastewater into the wetlands is prohibited. Instead, wastewater will be discharged after pre-treatment to the municipal sewer and treated in the Pucheng Wastewater Treatment Plant&lt;br&gt;• Work camp will not be located within wetland areas&lt;br&gt;• Locate fuel storage, maintenance, and vehicle cleaning areas at least 1 km from the NWP boundary&lt;br&gt;• Implement awareness and training program for workers. Prohibit workers from entering non-work areas</td>
<td>Contractors</td>
<td>IA, IEM, PMO, WEPB</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Dust from construction sites</td>
<td>• Materials storage sites will be at least 400 m from sensitive receptors such as residential areas and wildlife habitats&lt;br&gt;• Extra care will be paid during dry, strong windy days&lt;br&gt;• Spray water on construction sites and material handling routes where fugitive dust is being generated&lt;br&gt;• Upon completion of civil works, all construction sites will be required to be re-vegetated with trees and grasses&lt;br&gt;• Cover materials during truck transportation, in particular, the fine material, to avoid spillage or dust generation</td>
<td>Contractors</td>
<td>IA, IEM, PMO, WEPB</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3. Air Quality</td>
<td>Air emission from asphalt pavement, vehicles and construction equipment</td>
<td>• Locate asphalt plants and mixers at least 200 m downwind from the nearest residential areas and other sensitive receptors&lt;br&gt;• Implement a regular inspection and certification system for vehicle and equipment emission&lt;br&gt;• Store petroleum or other harmful materials in appropriate places and cover to minimize fugitive dust and emission&lt;br&gt;• Ensure that all vehicles onsite meet the PRC emission standards for efficient running and fuel-burning: GB18352-2005, GB17691-2005, GB 11340-2005, GB3847-2005, and GB18285-2005&lt;br&gt;• Ensure that equipment and machinery emissions comply with GB16297-1996.&lt;br&gt;• Conduct monthly inspections to ensure that vehicles and machinery meet the standards listed above.</td>
<td>Contractors</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
<td>-</td>
</tr>
<tr>
<td>Noise from equipment and vehicles</td>
<td>• Conduct background checks of manufacturing specifications of all major equipment and machinery to be used on-site to ensure they comply with national standard GB12523-1990&lt;br&gt;• Provide routes for large trucks to avoid residential areas</td>
<td>Contractors</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
### Impact Factor/Stage

<table>
<thead>
<tr>
<th>Potential Impacts and/or Issues</th>
<th>Mitigation Measures</th>
<th>Implementing Agency</th>
<th>Supervising Agency</th>
<th>Cost (USD, '000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. Noise</strong></td>
<td>At construction sites within 500 m of the nearest residence, construction activity will be stopped between 22:00 and 06:00 hours, or in accordance with public consultation.</td>
<td>Contractors</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
<td>20</td>
</tr>
<tr>
<td><strong>Noise impacts on the NWP</strong></td>
<td>Conduct fortnightly interviews with residents near construction sites to identify any community complaints about noise and seek suggestions from community members to reduce noise annoyance. Community suggestions will be used to adjust work hours of noise-generating machinery.</td>
<td>Contractors</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
<td>50</td>
</tr>
<tr>
<td><strong>5. Solid waste</strong></td>
<td>Multi-compartment collection bins will be provided to facilitate reuse, recycling and composting of solid waste. Store waste away from water bodies. Waste will be regularly collected by the Weinan Municipal waste collection and hauled to the municipal sanitary landfill. Hold contractors responsible for proper removal and disposal of any significant residual materials, wastes or contaminated soils after construction. Any paving or revegetation shall be done as soon as materials are removed, to stabilize the soil. Prohibit burning of waste.</td>
<td>Contractors</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
<td>50</td>
</tr>
<tr>
<td><strong>5. Migratory waterbirds and other native flora and fauna</strong></td>
<td>In compliance with the PRC’s forestry law: (i) document the specific areas of trees and other vegetation which are cleared; (ii) undertake compensatory planting of an equivalent or larger area elsewhere in the project area. For replanting to compensate clearance of existing habitats, only native plant species of local provenance will be used. Restoration will focus on cleared/bare land, especially erosion-prone slopes, to reduce flooding, soil erosion, and benefit local biodiversity. Areas under rehabilitation will be temporarily fenced.</td>
<td>Contractors</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
<td>-</td>
</tr>
<tr>
<td>Impact Factor/Stage</td>
<td>Potential Impacts and/or Issues</td>
<td>Mitigation Measures</td>
<td>Implementing Agency</td>
<td>Supervising Agency</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>Fauna</td>
<td>• Construction at Tianlu Lake will be timed to avoid the waterbird migration seasons (March-April and Sep-Oct) as far as possible. • Secure and protect all remaining areas not to be cleared or constructed, including bunds of channels and remnant vegetation • If mammals, birds, amphibians or reptiles are found trapped in construction sites (e.g. new channels, pits), carefully catch these and immediately release them in the reed beds west of the proposed Tianlu Lake. Do not keep them in captivity • If any injured animals are found during construction, immediately report this to WFB and WEPB, who will decide whether the individual should be immediately euthanized or rehabilitated. Injured animals will only be held in captivity for rehabilitation and will then be released, after confirmation by a qualified vet it is disease-free. • Report all records of biodiversity to the WFB and WEPB • Ensure that Tianlu and Tianjiao Lakes are both included within the NWP master plan and subject to regulations for multiple use and wetland conservation</td>
<td>Research agency</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
</tr>
<tr>
<td></td>
<td>Flora and fauna – Activities to be conducted for Project Output 3 – not part of the EMP but which strengthen the EMP measures</td>
<td>• Gazettement of a new NWP, which will protect 75% of the remaining salt pan habitat for migratory waterbirds. • Potential inclusion of 100 ha of salt pans and ponds, west of the proposed NWP boundary, which were only recently identified. • Finalization of a NWP master plan, including participatory development of regulations to manage the park for biodiversity, local livelihoods and tourism. • Extensive training in waterbird and wetland management. • Construction of a wetland center. This will be located on unused land and will not involve loss of any wetland habitats.</td>
<td>Contractors</td>
<td>IA, OEEs, IEM, PMO, WEPB</td>
</tr>
<tr>
<td>Traffic disturbance</td>
<td></td>
<td>• Select transport routes to reduce disturbance to regular traffic • Divert traffic at peak traffic hour</td>
<td>Contractors, IA</td>
<td>IA</td>
</tr>
<tr>
<td>7. Social and Cultural Considerations</td>
<td>Cultural heritage</td>
<td>• Cultural heritage sites will be preserved where identified. In accordance with PRC regulations, no person shall destroy, damage, deface, conceal, or otherwise interfere with a relic • If a cultural resource is unearthed, work will be stopped immediately and the matter promptly referred to the county, municipal, provincial</td>
<td>Contractors, IA</td>
<td>PMO, WMG Cultural Heritage Bureau</td>
</tr>
</tbody>
</table>
### 8. Health and safety

**Occupational health and safety (OHS)**

- Appoint Environmental, Health and Safety Officer to implement and supervise the Environmental, Health, and Safety Management Plan (EHSMP) which shall include the following provisions:
  1. Provide clean and sufficient freshwater for construction and camps
  2. Provide adequate latrines and other sanitary arrangements at the site, maintained in a clean and hygienic state
  3. Provide sufficient garbage receptacles on site
  4. Provide personal protection equipment (PPE) in accordance with relevant health and safety regulations
  5. Develop an emergency response plan for incidents, including hazardous material spills and similar events, in compliance with PRC regulations and the WB Group's EHS Guidelines
  6. Provide a fully equipped first-aid base in all camps
  7. Establish an OHS Records Management System
  8. Train staff in OHS and emergency preparedness/response
  9. Implement awareness and prevention program for sexually-transmitted diseases
  10. Prior to construction, purchase insurance for casualty accident (workers) and third party insurance (for public)
  11. Implement OHS measures to protect the public such as warning signs for safety hazards and barriers to restrict public access
  12. Prohibit smoking on construction sites and in the NWP

**Implemented by:** Contractors, IA

**Supervising Agency:** PMO, WMG

**Cost (USD, ‘000s):** 50

### C. Operation phase

#### 1. Hydrology and water quality

**Eutrophication (Nutrient runoff)**

- Regulate surface water levels in NWP at pre-construction levels by use of sluice gates and monitoring
- Prohibit discharge of all sewage (untreated/treated) into the Luoxi drainage system
- Prior to construction and after detailed Project design, develop an integrated nutrient management plan for the Project area. Aim: to address sources of pollution (point, non-point) in the Project area. The plan will include:
  1. Improved monitoring and equipment in the Project area

**Implemented by:** Contractors, IA

**Supervising Agency:** PMO, WMG

**Cost (USD, ‘000s):** 100
<table>
<thead>
<tr>
<th>Impact Factor/Stage</th>
<th>Potential Impacts and/or Issues</th>
<th>Mitigation Measures</th>
<th>Implementing Agency</th>
<th>Supervising Agency</th>
<th>Cost&lt;sup&gt;34&lt;/sup&gt; (USD, '000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(ii) Improved fertilizer application rates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Use of constructed wetlands at drainage channel discharge points aimed at reducing nutrient levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Farmer training to improve fertilizer application</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mitigation will be guided by ongoing monitoring of surface and groundwater quality, including TN and TP concentrations in lake and drainage waters – see Table A2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity Discharge to Luo River</td>
<td></td>
<td>• Monitor salinity discharge from the drainage system into the Luo River as detailed in Table A2.4 to confirm the modelling results detailed in this EIA report (2012)</td>
<td>Contractors, IA</td>
<td>PMO, WMG</td>
<td>Included in Table A2.4</td>
</tr>
<tr>
<td>Salt pan habitat, migratory waterbirds and other biodiversity</td>
<td></td>
<td>• Document patterns of habitat use by waterbirds after construction of Tianlu Lake: establish seasonal protection zones of any new roosting / foraging sites in/around Tianjiao and Tianlu Lakes.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ensure that the 550 ha (75%) of remaining salt pans identified for inclusion in the NWP are identified within the draft NWP master plan. And, that park regulations are developed which only permit the use of the salt pans for current local livelihoods – salt harvesting – and no commercial development.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Biodiversity</td>
<td>Insufficient environmental management capacity</td>
<td>• Ensure that the environmental training activities to be implemented by the Project are integrated with activities under the EMP, including training in: (i) monitoring of waterbird populations, water levels and salinity concentrations; (ii) capacity building to implement the EMP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Environmental and social management</td>
<td></td>
<td>• Ensure that records of any grievances are well maintained and regularly updated and that the GRM is operational.</td>
<td></td>
<td></td>
<td>TOTAL: 950</td>
</tr>
</tbody>
</table>

ADB = Asian Development Bank, EIA = environmental impact assessment, EMC = environmental management consultant, EMP = environmental management plan, EPB = Environmental Protection Bureau, GB = Guo Biao (National Standards), IEM = independent environmental monitor, m = meter, IA = implementing agency, PMO = provincial project management office, PPTA = project preparatory technical assistance, PRC = People’s Republic of China, EIA = initial environmental examination, SARDI = Shaanxi Animal Research Design Institute, TP = total phosphorous content, TN = total nitrogen content, WEPB = Weinan Environmental Protection Bureau, WFB = Weinan Forestry Bureau, WMG = Weinan Municipal Government, WRB = Water Resources Bureau. Sources: Domestic EIA report, and consultations with WEPB.
Conservation of migratory waterbirds: impact mitigation

Mitigation measures to address the impacts of lake construction to migratory waterbirds were developed to achieve the SPS criteria of ‘no net loss’ of biodiversity. They comprise measures for project design, lake construction and operation, future threats, the overall framework for wetland management, and monitoring.

1. Project design. The Project will implement the following actions.
   - **Reduce loss of salt pan habitat through detailed lake design.** (i) Remnant salt pans in the proposed lake location which appear to be favoured by migratory waterbirds have been identified and a revised design has been developed (Figure 1 in Appendix A). Under this design, Tianlu Lake would be approximately 80 ha in size i.e. the loss of approximately 30 ha salt pans could be avoided. Although potentially significant, the final area of salt pan loss avoided will only be estimated during detailed lake design and the need to consider topographic limitations and current land use. (ii) A transitional wetland zone will be maintained between the lake and salt pans and reedbeds to the west. (iii) The western shore of the lake will be constructed with a shallow, sloping gradient, to create shallow-water habitat. (iv) A third lake which was previously planned in the Project area has been removed from the Project design.

   - **Construct new salt pan habitat to replace the salt pans removed by lake construction.** Prior to construction of Tianlu Lake, at least 110 ha new salt pan habitat will be constructed in the west of the Project area (see ‘area 2’ in Figure 11b, Section 3.3). This area comprises abandoned ponds and salt pans surrounded by old spoil mounds. The spoil mounds (which have no biodiversity or livelihood value) will be bulldozed and new salt pans created. Salt pan shape, depth, and seasonal water levels will emulate the existing salt pans in the Project area where salt harvesting occurs, and will be based on the expertise of local salt farmers. Active salt harvesting in these new salt pans by local residents will be permitted, and indeed supported, under the new wetland park (see below), to maintain the food sources and conditions which support migratory waterbirds. Technical input by waterbird and wetland specialists will be provided to
ensure issues of waterbird food supply and roosting sites are addressed in the salt pan design, to maximize the habitat for small to medium sized waders. The involvement of these specialists, and the training of local agencies required to support subsequent management, will be funded by an ADB grant which will complement the project loan.

2. Construction of Tianlu Lake. The Project will implement the following actions.
   - **Minimize construction disturbance.** (i) Spoil from the excavation of Tianlu Lake will be disposed in the eastern portion of the lake (as islands) or adjacent to the eastern shoreline, to avoid impacts to salt pans to the west. (ii) Construction of the lake will be timed to avoid, as far as possible, peak migration times in March-April and September-October. (iii) Nearby salt pan habitats will be off-limits to construction personnel and signs delimiting 'no-go' zones will be installed. (iv) Regulations for spoil disposal, human and vehicle access etc will be included in contractor guidelines to avoid salt pans.

3. Operation of Tianlu Lake. The Project will implement the following actions.
   - **Include Tianlu and Tianjiao Lakes within the NWP.** Both lakes have been included in the proposed NWP. This will ensure that the lakes are subject to park regulations for both multiple use and wetland conservation.
   - **Implement seasonal regulations to protect migratory waterbirds.** If monitoring (see below) reveals that migratory waterbirds are utilizing the lake, sites of habitat use will be zoned and human activities will be regulated during the migration seasons.

4. Waterbird monitoring. The Project will implement a 5-year monitoring program (2013–2017; the Project duration) to monitor waterbird species richness, abundance of individuals, and the effects of Project actions, including salt pan loss and gain. The program will be implemented by the Shaanxi Animal Research Design Institute (SARDI) following training in capacity building. The methodology for this program will be developed during Output 3 of the Project and will include waterbird and wetland specialists funded through the Project, SARDI, Shaanxi Forestry Department, Shaanxi Environment Protection Department and relevant bureaus of the Weinan Municipal Government. The program will consider some of the following points.

   **Monitoring locations.** Fig. 2 shows key waterbird monitoring (green highlight) and the secondary areas (grey highlight). Flooded farmland south of the main east-west road must also be surveyed because these are important habitats for waterbirds and other birds. All lands owned by WLCDC must be surveyed. Lands not owned by WLCDC should be surveyed where permission can be obtained.

   **Figure 2. Lubotan salt pans: primary (green) and secondary (grey) areas to sample for waterbirds**
The monitoring area for the reed beds is shown in Figure 3. It should extend from its west boundary eastward about 1.9 km to the eastern limit of the reed bed at a major N-S water canal. The west boundary of the reed bed lies at approximately 109.500261 E longitude. The eastern boundary of the sampling area is marked by an irrigation channel at approximately 109.520845 E longitude. The “potholes” or small lakes/ponds in the reed bed are of special interest for survey.

**Figure 3. Reed beds**

The proposed location for excavation of Tianlu Lake) is shown in yellow highlight on Figure 4. This area extends from the western extent of the lake at approximately 109.529235 E longitude to its eastern boundary at Zhonggangou drainage channel, approximately 109.536212 E longitude. The survey area should include all salt pans that are proposed for conversion to lake.

**Figure 4. Proposed Tianluhu sample area (yellow highlight)**

The Tianjiao Lake survey area includes the lake water surface, shoreline, islands, and embankments (Figure 5). The survey area should extend from Zhonggangou, the eastern
boundary of the Tianluhu survey area eastward to the east bank of the lake. Migrating passerine birds might be using the new plantation sites around the lake and these should be surveyed.

**Figure 5. Tianjiaohu construction site westward to Zhonggangou**

Sampling methods. The following sampling methods should be employed:

(i) Four survey seasons should be defined as: (a) spring migration (mid March - mid May), (b) summer breeding (mid May - mid August), (c) autumn migration (mid August - November), and (d) winter (early December - mid March). This is a best-model sampling regime. At the minimum, monitoring should be conducted twice a year (March-April and September-October).

(ii) Sampling sites should be sampled on foot weekly during migration seasons and monthly during summer and winter. If weekly sampling is not feasible during the spring and autumn migrations, then the un-sampled areas should be rotated such that the entire survey area can be sampled over the course of no more than one month (within four weekly sampling periods). If a survey area cannot be sampled during a weekly sampling period, the area of the un-sampled portion must be estimated as a percentage of the total area. This will enable later correction of bird counts to account for un-sampled areas.

(iii) In survey areas with identifiable salt pans or farm fields, these should be individually numbered and bird counts recorded by salt pan or field number. Print-outs of imagery of the survey sites or current topographic maps showing pond and field numbers must be carried in the field for data recording.

(iv) Sampling should be undertaken by teams of two persons using binoculars (two sets per team) and telescopes (one set with tripod per team). One team member should use binoculars or telescope to locate and identify birds while the second team member records data. Care must be taken to avoid disturbance of birds on salt pans because this can lead to double-counting when counted birds fly to salt pans not yet sampled.

(v) The reed beds lack identifiable boundaries and should be sampled along line-transects. The first of these should be along the E-W irrigation channel that divides the bed into north and
south halves. Two additional line-transects can be sampled along channels running N-S near the west and east ends of the reed bed. The eastern transect might not cover large expanses of reed bed, and if not, the habitat type(s) should be defined. From north to south the reed bed measures about 1,000 m. A single line transect through the middle of the bed cannot cover the nearly 500 m of reed habitat on either side because visibility will extend only to about 100 m either side of the transect center-line. Additional E-W transects might be needed along the N and S boundaries of the reed bed to increase the sampled area.

(vi) Ponds in the reed bed should be numbered and birds counted for each accessible pond. These will be point counts that can be added to the line-transect counts as it is unlikely the line-transects will cover the small ponds.

Data analyses. The following data analysis is recommended: (i) Correction for areas unsampled: Weekly estimates should be made of the proportion of area sampled versus unsampled at each of the four survey sites. Estimates should then be corrected to account for the unsampled area. (ii) Correction for duration of residence: Seasonal corrections will only be made for any species whose time of residence is estimated to differ appreciably from one week. This will be based on published records of species residence times on migration. Corrections will follow methods presented in the literature. (iii) Standard distance sampling adjustments should be made for line-transect counts in the reed bed. This will account for decreasing bird detectability with increasing distance from the transect center-line. (iv) Total counts: Sums of corrected weekly counts will be reported for each of the four survey areas.

Reporting. Progress reports will be prepared after each monitoring season. An annual report will be prepared at the end of each year. These reports will include: species and total counts, habitat use, methods employed, observers, appendices to explain the quantitative corrections made in raw counts for each survey area and season, and analyses of habitat and survey area use by season and over the survey year.

5. Measures to be undertaken as part of output 3 (wetland ecosystem conservation) of the Project which complement the EMP.

Activities under output 3 (wetland ecosystem conservation) build upon measures 1-4 described above. They are not part of the EMP but collectively, contribute to the mitigation of potential Project impacts to migratory waterbirds and their habitats. They include: (i) designation and implementation of the NWP and master plan, (ii) the inclusion in the NWP of at least 75% (550 ha) of the remaining salt pan habitat and all (100%) remaining reed beds, (iii) the development of management regulations for the NWP which will include actions to manage the salt pans and other habitats for the benefit of waterbirds, other biodiversity, livelihoods, and tourism, (iv) the potential inclusion of an additional 99 ha salt pans (adjacent to the western portion of the proposed NWP boundary), (v) baseline biodiversity surveys (flora, aquatic invertebrates, fish, amphibians, reptiles, mammals) to inform park management, and (vi) an extensive training program for local agencies in waterbird and wetland management. See Sections 3.3 and 7.2.1 for details.

C. Environmental Monitoring and Inspection

The environmental monitoring program is in Tables A2.2 and A2.3. The estimated cost of the program is in Table A2.8. The program identifies the monitoring variables, time and frequency, and the implementing and supervising agencies. For pollutants, air, water, noise, and waste,
monitoring follows national discharge/emission standards. Before implementation of the program, the responsible agencies will provide detailed cost estimates. During project implementation the costs will be adjusted based on actual requirements.

**Project Impact Monitoring and Inspection.** The PMO will nominate at least two qualified full-time environmental management staff to undertake environmental management and monitoring activities. The PMO will also engage a national environmental management consultant (EMC) to assist itself and the IA including the PIO in carrying out internal monitoring and inspection, reporting to ADB through quarterly project progress reports, semi-annual environmental monitoring reports, and a project completion report, and conducting necessary training. With assistance from the EMC, the PMO and IA will conduct internal monitoring and inspection on the progress of the EMP, project implementation, environmental performance of the contractors, and compliance with the EMP requirements. This will be evaluated through the review of reports submitted by contractors and environmental institutes, and results from environmental monitoring stations (EMSs) and independent environmental monitoring contractors.

**Independent Environmental Monitors (IEMs).** Local environmental institutes or firms will be engaged by the IA as IEMs. Each IEM will include an environmental safeguard specialist qualified to conduct independent environmental monitoring. The results of the monitoring will form part of the quarterly project progress reports, semi-annual environmental monitoring reports, and project completion report to WMG and ADB. The IEM will assist WMG including the PMO in preparing these reports.

**Environmental Acceptance Monitoring and Audit.** Within 3 months of Project completion, or no later than 1 year with permission from the responsible authorities, environmental monitoring and audit reports will be (i) prepared by a qualified environmental institute in accordance with the *Guideline on Project Completion Environmental Audit (2001)* of the Ministry of Environmental Protection, (ii) reviewed for approval by environmental authorities who have given the approval to the same individual EIA, and (iii) finally reported to the Asian Development Bank (ADB) through quarterly project progress reports and/or project completion report.

The results of all monitoring mentioned above will be used to evaluate: (i) the extent and severity of environmental impacts compared with the predicted impacts, (ii) performance of the environmental protection measures or compliance with related rules and regulations, (iii) trends of impacts, and (iv) effectiveness of the EMP. Effectiveness of mitigation and monitoring will be evaluated through a feedback reporting system. The PMO and PIO play critical roles in this feedback and adjustment mechanism as shown in Figure A1.
## Table A2.2: Environmental Monitoring Parameters, Standard Limits and Baseline

<table>
<thead>
<tr>
<th>Media</th>
<th>Selected Monitoring Parameters</th>
<th>PRC Guideline Standard Limit</th>
<th>Baseline(^{36})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class III</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mg/L - Luo River</td>
<td>DO</td>
<td>5</td>
<td>8.8 – 10.2</td>
</tr>
<tr>
<td></td>
<td>COD</td>
<td>20</td>
<td>32 - 45</td>
</tr>
<tr>
<td></td>
<td>BOD(_5)</td>
<td>4</td>
<td>10.6 – 16.3</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>1.0</td>
<td>3.83 – 6.16</td>
</tr>
<tr>
<td></td>
<td>TP</td>
<td>0.2</td>
<td>0.15 – 0.19</td>
</tr>
<tr>
<td></td>
<td>Fecal Col</td>
<td>10,000</td>
<td>7,933 - 16,000</td>
</tr>
<tr>
<td></td>
<td>Salinity (TDS)</td>
<td>-</td>
<td>1.100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mg/L - Tianjiao Lake</td>
<td>DO</td>
<td>3</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>COD</td>
<td>30</td>
<td>27 - 37</td>
</tr>
<tr>
<td></td>
<td>BOD(_5)</td>
<td>6</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>1.5</td>
<td>1.6 – 3.3</td>
</tr>
<tr>
<td></td>
<td>TP</td>
<td>0.1</td>
<td>0.03 – 0.1</td>
</tr>
<tr>
<td></td>
<td>Fecal Col</td>
<td>20,000</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>Salinity (TDS)</td>
<td>-</td>
<td>251 – 7,669</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water balance*</td>
<td>Monthly flow volumes</td>
<td>None</td>
<td>Pre-construction</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Monitoring only required in a pollution event occurs</td>
<td>(GB/T14848-93)</td>
<td>NA</td>
</tr>
<tr>
<td>Soil</td>
<td>Arsenic</td>
<td>30</td>
<td>4.11 – 6.37</td>
</tr>
<tr>
<td>Spoil from excavation pH&gt;7.5(^{36})</td>
<td>Lead</td>
<td>300</td>
<td>17.9 – 31.5</td>
</tr>
<tr>
<td>mg/kg</td>
<td>Chromium</td>
<td>200</td>
<td>47.7 – 67.9</td>
</tr>
<tr>
<td></td>
<td>DDT</td>
<td>0.50</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>TPH</td>
<td>100</td>
<td>ND</td>
</tr>
<tr>
<td>Air</td>
<td>TSP</td>
<td>0.30</td>
<td>0.141 – 0.3</td>
</tr>
<tr>
<td>mg/m(^3)</td>
<td>PM10</td>
<td>0.15</td>
<td>0.06 – 0.15</td>
</tr>
<tr>
<td></td>
<td>NO(_2)</td>
<td>0.12</td>
<td>0.019 – 0.08</td>
</tr>
<tr>
<td></td>
<td>SO(_2)</td>
<td>0.15</td>
<td>0.036 – 0.15</td>
</tr>
<tr>
<td>Noise</td>
<td>Day</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Class II dB(A)</td>
<td>Night time</td>
<td>50</td>
<td>45</td>
</tr>
</tbody>
</table>

BOD = biochemical oxygen demand, COD = chemical oxygen demand, dB(A) = A-weighted decibel, m = meter, pH = measure of acidity and alkalinity, PM\(_{10}\) = particulate matter smaller than 10 micrometers, TN = total nitrogen, TP = total phosphor, TSP = total suspended particulates, TSS = total suspended solids. Source(s): Domestic EIA, and consultations with PMO, WEPB, and IA. *Flow volume will be measured at key water entry points (channels) into the wetlands + Tianlu + Tianjia Lakes and, at key discharge outlets from the wetlands and both lakes.

\(^{36}\) Baseline data from monitoring events undertaken in 2011 and 2012 as reported in the PPTA EIA Report (2012)

\(^{36}\) Note, all soils tested within Project Area where pH>7.5
# Table A2.3: Environmental Monitoring Program

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameters</th>
<th>Location</th>
<th>Frequency</th>
<th>Implementing Agency</th>
<th>Supervising Agency</th>
<th>Construction Cost Estimate ($/yr, ‘000s)</th>
<th>Operation Cost Estimate ($/yr, ‘000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Contractor performance against EMP</td>
<td>Auditing and inspections</td>
<td>All sites</td>
<td>Weekly</td>
<td>PMO, IA, EMC</td>
<td>WEPB</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>2. Water Quality and groundwater</td>
<td>As per Table A2.2</td>
<td>Luo River 100 m upstream of drainage discharge, Luo River 100 m downstream of drainage discharge, Wetlands 4 locations, Main channels 6 locations</td>
<td>Monthly during construction, Quarterly following construction</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sedimentation</td>
<td>Visual inspection</td>
<td>Weekly during construction</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>5</td>
</tr>
<tr>
<td>3. Water hydrology, including flow volumes into and out of the NWP and Tianlu+Tianjiao Lakes</td>
<td>Surface water level</td>
<td>Wetlands 4 locations</td>
<td>Monthly during construction, Quarterly following construction</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Groundwater level</td>
<td>Wetlands 4 locations</td>
<td>Monthly during construction, Quarterly following construction</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>4. Soil (Spoil)</td>
<td>As per Table A2.2</td>
<td>Excavated spoil</td>
<td>One sample per 100,000 m³ excavated (approximately 100 samples in total), Additional samples in event of pollution spill</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Item</td>
<td>Parameters</td>
<td>Location</td>
<td>Frequency</td>
<td>Implementing Agency</td>
<td>Supervising Agency</td>
<td>Construction Cost Estimate ($/yr, ‘000s)</td>
<td>Operation Cost Estimate ($/yr, ‘000s)</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>5. Noise</td>
<td>As per Table A2.2</td>
<td>• 10 monitoring locations associated with major construction works</td>
<td>• Monthly during construction; two times per day (day plus night)</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>6. Air</td>
<td>As per Table A2.2</td>
<td>• 5 monitoring locations associated with major construction works</td>
<td>• Monthly during construction</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>7. Water birds</td>
<td>NA</td>
<td>• Monitoring sites will follow those of the 2012 waterbird survey</td>
<td>• Minimum twice per year over the 5 years of the Project (2013-2017)</td>
<td>SARDI</td>
<td>EMC, IA, PMO, WEPB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>8. EOHS</td>
<td>Audit and inspection as per Table A2.1</td>
<td>• All sites</td>
<td>• Random inspections • At least 1 per year at each construction camp</td>
<td>IEM, EMS</td>
<td>EMC, IA, PMO, WEPB</td>
<td>20</td>
<td>-</td>
</tr>
</tbody>
</table>

|             | **TOTAL**                           | **250**                                                                 |                                                                                 |                     |                    | **50**                                    |                                        |

EMC = environmental management company/consultant, EMP = environmental management plan, EMS = Environmental Monitoring Station at the city level, EPB = Environmental Protection Bureau, IEM = independent environmental monitor, IA = implementing agency, PMO = project management office, SARDI = Shaanxi Animal Research Design Institute, WEPB = Weinan Environmental Protection Bureau, EOHS = Environmental Occupational Health and Safety.
D. Public Consultation

1. Public Consultation during Project Preparation

Various public consultations were conducted in the course of the preparing the feasibility study report and EIA. During the feasibility study report preparation, the respective county governments were consulted to support the project design including the development of the revised NWP master plan (2012), the proposed agricultural practice improvements and the proposed ecotourism educational centre. During EIA preparation and project preparatory technical assistance, public consultations with various groups of stakeholders were conducted. The main focus of public consultation was to assess the environmental impacts of the Project on nearby residents and mitigation measures. These activities were carried out in accordance with Interim Guidelines on Public Participation in Environmental Impact Assessment (2006) of the Ministry of Environmental Protection, and ADB’s Safeguard Policy Statement (2009). A grievance redress mechanism was also discussed with people who might be affected during project preparation, through several rounds of public consultations with various stake holders groups as outlined in the EIA report (Section 8).

2. Future Public Consultation Plan

Future plans for public involvement during the design, construction, and operation phases were developed during the project preparation. These plans include public participation in (i) monitoring impacts and mitigation measures during the construction and operation stages, (ii) evaluating environmental and economic benefits and social impacts, and (iii) interviewing the public after the Project is completed. They include several types of consultations, e.g., site visits, workshops, investigation of specific issues, interviews, and public hearings (Table A2.4).

Public participation plans are part of the project implementation and management plan. The IA is responsible for public participation during project implementation.

The IA will establish an environmental management unit (EMU) within the Project Implementation Unit (PIU) for supervising implementation, continuing public consultation, monitoring progress, and responding to grievances. The staff within the EMU will be well trained to handle crisis situations or conflicts with residents due to distress from environmental impacts. Costs for public participation activities during project construction are included in the project funding. The costs are estimated around CNY3,000 for each site visit, CNY5,000 for each public workshop, and CNY6,000 for each press conference/public hearing. Costs for public participation activities during operation will be covered by the IA. In addition, the established feedback mechanisms (Figure A1) will ensure timely feedback and measures to address any concerns raised by the project affected communities.

Table A2.4: Public Consultation Program

<table>
<thead>
<tr>
<th>Organizer</th>
<th>Approach / Frequency</th>
<th>Subjects</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project Preparation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMO, IA, Design Institute, EIA institute, WEPB</td>
<td>EIA public opinion surveys</td>
<td>Priority, design, environmental benefits and impacts, social benefits and impacts, mitigation measures, attitudes toward project, and suggestions</td>
<td>PMO, IA, Design institute, EIA institute, WEPB, other provincial, municipal, county government stakeholders, community representatives</td>
</tr>
<tr>
<td></td>
<td>Socioeconomic and AP surveys</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public consultation meeting and questionnaire</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site visits: multiple times</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMO, IA, EMC,</td>
<td>Public consultation and site visits: at least once a year</td>
<td>Adjusting mitigation</td>
<td>Residents within</td>
</tr>
</tbody>
</table>
### 3. Test Operation

**PMO, IA, EMC, IEM**

- Questionnaire survey: at least once during test operation
- Site visits: multiple, depending on results of project completion environmental audit

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusting mitigation measures if necessary, construction impacts, comments and suggestions</td>
<td>Representatives of residents and social sectors</td>
</tr>
<tr>
<td>Comments and suggestions on operational impacts, public suggestions on corrective actions</td>
<td>Local residents and social sectors, WEPB</td>
</tr>
</tbody>
</table>

### 4. Operation

**PMO, IA**

- Site visits: once every 6 months by IEM and PMO
- Expert workshop or press conference: as needed based on public consultation and workshop

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation system operational performance, informal interviews with local residents</td>
<td>Farm manager, local residents adjacent to farms</td>
</tr>
<tr>
<td>Expert comments and suggestions on corrective measures</td>
<td>Experts from residents, social sectors, media</td>
</tr>
</tbody>
</table>

**Source(s):** Domestic EIA, and consultations with PMO, WEPB, and IA.

### E. Responsibilities and Authorities for Implementation

The Weinan Municipal Government is the executing agency (EA). A Project Leading Group (PLG) has been established to help guide the project. The PLG is directed by the WMG Deputy Mayor, and includes the following agencies: Weinan Finance Bureau, Weinan Development and Reform Commission, Weinan Environmental Protection Bureau, Weinan Land Management Bureau, Weinan Water Services Bureau, and Weinan Forestry Bureau.

The PMO is located in the Weinan Finance Bureau. Delegated by the EA, the PMO will have overall responsibility for supervising the implementation of mitigation measures and reporting to ADB. The PMO will be responsible for replying to petitions and/or complaints from affected persons, if such petitions and/or complaints are appealed to the PMO.

The Weinan Luyanghu Modern Industrial Development Zone Management Commission will be the implementing agency (IA). The IA has established a project implementation office (PIO) to coordinate the preparation and implementation of the Project. Within the PIO, the Weinan Luyanghu Construction Development Co. Ltd, (as part of the Weinan Luyanghu Modern Industrial Development Zone Management Commission) has established the PIU which will be responsible for contractor management.
The PMO, IA, and contractors will each nominate dedicated, trained, and qualified environment specialists to undertake environmental management activities and ensure effective EMP implementation. Project management consultants engaged by the PMO will assist the EA/PMO and IA/PIO in preparing quarterly project progress reports and carrying out training programs. Table A2.5 shows the environmental responsibilities in different phases of the project.

The IA will be largely responsible for environmental management and implementation of mitigation measures. The IA will ensure that the EMP is carried out. The IA will also engage Design institute, EIA institute, and IEM contractors to help with environmental management at the preparation, design, construction, and operation phases. The IA will be responsible for arranging environmental monitoring reviews and responding to any adverse impacts beyond those foreseen in the EIA report.

The IA will address requests for mitigation measures from the county EPB and ADB. If affected persons appeal, petition, and/or complain to an IA, the IA will reply within 30 days, based on consultations relevant institutes and/or agencies as necessary.

Construction contractors will be responsible for implementing mitigation measures during construction. The IA will be responsible for implementing such measures during the operation. In accordance with the EMP, the PIU will set up an environmental management unit (EMU) that will require two employees. The EMU will be responsible for (i) implementing the EMP and developing further implementation details, (ii) supervising contractors’ implementation of mitigation measures during construction; (iii) implementing training programs for contractors; (iv) incorporating environmental management, monitoring, and mitigation measures into construction and operation management plans; (v) developing and implementing internal routine environmental monitoring; (vi) reporting performance of the EMP to the PMO and responsible agencies; and (vii) assisting the IA in replying to petitions and/or complaints appealed from affected persons, if such petitions and/or complains are appealed to the IA. The EMU will be supported and supervised respectively by the IA, EMC, IEM, and WEPB.

**Table A2.5: Environmental Responsibility Matrix**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Agencies</th>
<th>Environmental Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>Design institute</td>
<td>Review and select alternatives (technological, design, location, etc.)</td>
</tr>
<tr>
<td>EIA institute</td>
<td></td>
<td>Prepare EIA and EMP for the Project, including public consultations</td>
</tr>
<tr>
<td>NEPB</td>
<td></td>
<td>Review and approve EIA, including the EMP</td>
</tr>
<tr>
<td>PPTA consultant</td>
<td></td>
<td>Prepare EIA including EMP and public consultations</td>
</tr>
<tr>
<td>PMO</td>
<td></td>
<td>Coordinate and supervise EIA, EIA and public consultations</td>
</tr>
<tr>
<td>IA</td>
<td></td>
<td>Review and endorse EIA, including the EMP, for posting at ADB website</td>
</tr>
<tr>
<td>Design</td>
<td>Design institute</td>
<td>Update the EMP in cooperation with EIA institute, and incorporate mitigation measures in engineering detail designs and contracts</td>
</tr>
<tr>
<td>PMO, IA</td>
<td></td>
<td>Review and approve environmental measures</td>
</tr>
<tr>
<td>Tendering and Contracting</td>
<td>PMO, IA, procurement agency</td>
<td>Incorporate EMP clauses in bidding documents and contracts</td>
</tr>
<tr>
<td>Construction</td>
<td>IA</td>
<td>Ensure implementation of mitigation measures, and public consultations</td>
</tr>
<tr>
<td></td>
<td>Contractors</td>
<td>Implement mitigation measures</td>
</tr>
</tbody>
</table>

111
<table>
<thead>
<tr>
<th>Phase</th>
<th>Agencies</th>
<th>Environmental Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMO, WEPB</td>
<td></td>
<td>Advise and supervise implementation of mitigation measures</td>
</tr>
<tr>
<td>EMC contracted by PMO</td>
<td></td>
<td>Conduct internal monitoring and inspection, and public consultations</td>
</tr>
<tr>
<td>IEM</td>
<td></td>
<td>Conduct independent monitoring (including public consultations), and prepare periodic monitoring reports to IA</td>
</tr>
<tr>
<td>EMS</td>
<td></td>
<td>Conduct compliance monitoring</td>
</tr>
<tr>
<td><strong>Test Operation</strong></td>
<td>IA</td>
<td>Conduct project completion environmental audit, including sampling and lab tests, and prepare project completion environmental audit report</td>
</tr>
<tr>
<td></td>
<td>WEPB</td>
<td>Review and approve project completion environmental audit report, and order corrective actions if necessary</td>
</tr>
<tr>
<td></td>
<td>EMC, IEM</td>
<td>Assist IA in conducting environmental audit and preparing progress reports to the PMO</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>IA</td>
<td>Ensure proper operation of Project facilities according to design standards, and implementation of mitigation measures and public consultations</td>
</tr>
<tr>
<td></td>
<td>IA, EMC</td>
<td>Conduct internal environmental monitoring and inspection, supervise implementation of the EMP, and conduct public consultations</td>
</tr>
<tr>
<td></td>
<td>IEM</td>
<td>Conduct independent monitoring (including public consultations), and prepare periodic monitoring reports to IA</td>
</tr>
<tr>
<td></td>
<td>EMS on behalf of WEPB</td>
<td>Conduct regular and unannounced environmental compliance monitoring and inspection</td>
</tr>
<tr>
<td><strong>Grievance Redress Mechanism</strong></td>
<td>Contractors, project managers</td>
<td>Tries to resolve a concern arose by affected persons during construction directly with the affected persons</td>
</tr>
<tr>
<td></td>
<td>Village committees</td>
<td>If petitions and/or complains are submitted to village committees from affected persons, reply to the affected persons within 2 weeks.</td>
</tr>
<tr>
<td></td>
<td>Township governments, district offices</td>
<td>If petitions and/or complains are submitted to township governments and/or district offices from affected persons, reply to the affected persons within 2 weeks.</td>
</tr>
<tr>
<td></td>
<td>IA</td>
<td>If petitions and/or complains are submitted to IA from affected persons, reply to the affected persons within 30 days</td>
</tr>
<tr>
<td></td>
<td>PMO</td>
<td>Deal with petitions and/or complains, if such petitions and/or complains are appealed to the PMO</td>
</tr>
</tbody>
</table>

EIA = environmental impact assessment, EMC = environmental management consultant, EMP = environmental management plan, EPB = environmental protection bureaus, IA = implementing agency, EIA = initial environmental examination, IEM = independent environmental monitor, EMS = environmental monitoring station at city or county level, IA = project implementing agency, PMO = provincial project management office, PPTA = project preparatory technical assistance. Source(s): Domestic EIA, consultations with PMO, WEPB, and IA.
F. Institutional Strengthening and Training

An assessment undertaken during the project preparatory technical assistance indicates that the PMO has adequate technical and institutional capacities for project implementation. However, the IA has weak capacity in environmental management and monitoring. For proper implementation of the EMP, it is necessary to strengthen the capacity of the IA. The proposed training is shown in Table A2.6.

A two-tier implementation arrangement – the PMO and IA – will provide a reasonable framework for project management and control. The definition of roles, responsibilities and relationships between the PMO, IA, and other relevant agencies (e.g., WEPB, WEPB) is considered adequate to ensure the effective implementation of the project.

Environmental specialists in the PMO, IA, and contractors will receive training in environmental management, environmental monitoring and supervision, mitigation planning, emergency response, environmental policymaking, and other environmental management techniques. Funding for this training will be included in the project budget and in the operation and maintenance budget in the operation phase.

| **Table A2.6: Institutional Strengthening and Training** |
| **Activities** | **Target Agencies/Attendees** | **Contents** | **Timing** |
| Institutional Strengthening | PMO, IA, WEPB, WEPB | • Defining institutional arrangements for environmental management, monitoring, and supervision  
• Defining positions and responsibilities  
• Appointing and recruiting personnel | During project preparation |
| EMC | | • Recruiting and contracting EMC for internal environmental management consultancy and monitoring | Prior to project implementation |
| IEM | | • Recruiting and contracting IEM to conduct independent environmental monitoring for the Project | Prior to project implementation |
| Environmental Management Clauses and Protocols | IA, procurement agency, EMC | • Developing environmental management clauses and incorporating them into construction and operational contracts  
• Developing/refining environmental monitoring protocols  
• Developing environmental emergency response procedures | During project preparation |
| Training | PMO, IA, contractors | • Environmental laws and regulations  
• Environmental policies and plans  
• Basic environmental management  
• Environmental emergency response | Prior to project implementation |
| EMP Implementation | PMO, IA, contractors | • Responsibility and duties for project construction, management and environmental protection  
• Tasks of environmental protection in the project construction | Prior to and during project implementation |
Appendix A

### Environmental Monitoring, Inspection and Reporting

<table>
<thead>
<tr>
<th>Activities</th>
<th>Target Agencies/Attendees</th>
<th>Contents</th>
<th>Timing</th>
</tr>
</thead>
</table>
| Environmental Monitoring, Inspection and Reporting | IA, contractors | • Key environmental protection contents in project construction  
• EMP improvement and corrective actions | Prior to and during project implementation |
| | | • Monitoring and inspection methods, data collection and processing, interpretation of data, reporting system  
• Environmental reporting requirements | |

EMC = environmental management consultant, EMP = environmental management plan, EPB = environmental protection bureau, IA = implementing agency, IEM = independent environmental monitor, PMO = provincial project management office, WEPB = Weinan provincial Environmental Protection Department.

Source(s): Domestic EIA, and consultations with PMO, WEPB, WEPB, and IA.

### G. Reporting and Supervision

**Monthly Construction Reports.** During the construction, land preparation and planting period, contractors will submit monthly construction reports to the IA. The reports will summarize: (i) environmental issues during construction, land preparation and planting; (ii) mitigation measures taken, if any; and (iii) consequences of the impacts on the environment and/or surrounding communities.

The contractors will be trained to take immediate actions to remedy unexpected adverse impacts or ineffective or inefficient mitigation measures, as required by the EMP. The IA will also respond to these reports in order to ensure that the contractors have taken appropriate and timely action. Additional measures may be taken, if needed, to ensure that all issues raised by the reports are appropriately addressed.

The reported environmental issues, mitigation measures, and the impacts will be reported to the PMO quarterly, and WEPB semi-annually. WEPB may request that further environmental mitigation actions be taken, as they deem necessary, and may determine further mitigation measures for different stages, if necessary.

**Independent Environmental Monitoring Reports.** IEM will submit independent environmental monitoring reports on a semi-annual basis to the IA, which will forward them to the PMO, WEPB, and WEPB. The reports will emphasize: (i) progress made in implementing the EMP, (ii) implementation of mitigation measures, (iii) environmental compliance, (iv) institutional strengthening and training, (v) public consultations, and (vi) problems occurred and corrective actions taken.

**Semi-annual Project Progress Reports and Project Completion Report.** Based on the monthly construction reports, compliance monitoring reports, environmental acceptance monitoring and audit reports, and independent environmental monitoring reports submitted to the PMO, the PMO, with assistance from the EMC, will report to ADB on a semi-annual basis the progress of the EMP, information on project implementation, and the environmental performance of the contractors, through semi-annual project progress reports. In addition, within 3 months of physical completion of the project, the PMO will submit to ADB a project completion report that describes the achievements in relation to the project's expected impact, outcome, and outputs including environmental terms. ADB may request that further environmental mitigation actions be taken, as they deem necessary, and may determine further mitigation measures for different stages, if necessary. Given that quarterly progress reports will be
provide to ADB for other elements of the Project, the PMO is encouraged to include to include a brief summary of environmental progress in these quarterly reports as well.

**Environmental Acceptance Monitoring and Audit Reports.** Within 3 months after Project completion, or no later than 1 year with permission from the responsible environmental authorities, environmental acceptance monitoring and audit reports will be prepared by qualified environmental institutes in accordance with the *Guideline on Project Completion Environmental Audit* (2001) of the Ministry of Environmental Protection. The reports will focus on the project compliance of environmental performance when it is put into the operation. The reports will be sent to environmental authorities for review and approval and also to the PMO through the IA. If non-compliance is found, the project will be asked to be improved to the requirements before the official commencement of the operation.

The environmental reporting plan is presented in Table A2.7.

<table>
<thead>
<tr>
<th>Reports</th>
<th>From</th>
<th>To</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction, land preparation and planting reports</td>
<td>Contractors</td>
<td>IA</td>
<td>Monthly</td>
</tr>
<tr>
<td>Independent environmental monitoring reports</td>
<td>IEM</td>
<td>IA (forwarded to PMO, WEPB, and WEPB)</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>Semi-annual Project Progress Reports and Project Completion Report. <strong>Note:</strong> brief updates on environmental progress should be included in the overall quarterly progress reports to be provided by the Project to ADB.</td>
<td>PMO, EMC</td>
<td>ADB</td>
<td>Semi-annual and within 3 months of physical completion of the project</td>
</tr>
<tr>
<td>Environmental acceptance monitoring and audit reports</td>
<td>Qualified environmental institutes</td>
<td>IA (forwarded to PMO, and WEPB)</td>
<td>Within 3 months after the Project completion, or no later than 1 year with permission from the responsible environmental authorities</td>
</tr>
</tbody>
</table>

ADB = Asian Development Bank, EMC = environmental management consultant, EPB = environmental protection bureau, EMS = environmental monitoring station at city or county level, IEM = independent environmental monitor, IA = implementing agency, PMO = provincial project management office, PRC = People’s Republic of China, WEPB = Weinan provincial Environmental Protection Department.

Source(s): Domestic EIA, and consultations with SPMO, SEPD, EPB and IA.

**H. Work Plan**

Before construction, land preparation and planting, the PMO and IA will develop detailed responsibilities and requirements for contractors and will provide detailed cost estimates of mitigation measures and environmental monitoring in the construction, land preparation and planting contracts. The PMO and IA will also detail the responsibilities of their environmental management offices and prepare their work schedules.
Before operation, the IA will develop detailed work plans for environmental management and monitoring during operation based on the EMP. These work plans will be submitted to WEPB and WEPB to help them to supervise implementation.

I. Cost Estimates for Environmental Management

The IA with help from the PMO will develop detailed plans for procurement of equipment and materials, and civil works for implementing mitigation measures and monitoring plans. Environmental considerations will be incorporated into the bidding documents and contracts to ensure environmentally responsive procurement.

Cost estimates for mitigation measures, environmental monitoring, and environmental administration are summarized in Table A2.8. Before implementing a monitoring plan, responsible agencies will present a more detailed breakdown of the estimated budget. During project implementation, the budgets will be adjusted based on actual requirements. Contractors will bear the costs for all mitigation measures during construction, land preparation and planting, which will be included in the bidding documents and contracts. The IA will bear costs related to mitigation measures during operation. Costs related to environmental supervision during construction, land preparation and planting and operation will be borne by the IA. Costs for capacity building will be borne by the project as a whole. During the operation phase, the training costs will be included in the operation and maintenance budget.

<table>
<thead>
<tr>
<th>Table A2.8: Cost Estimates for EMP (USD ‘000)</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment, dust, noise, solid waste control equipment</td>
<td>290</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>290</td>
</tr>
<tr>
<td>Wetland flora and fauna protection measures during construction</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>OHS</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Nutrient Management Plan</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Monitoring - construction phase (annual)*</td>
<td>10</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>-</td>
<td>760</td>
</tr>
<tr>
<td>Monitoring - operation phase (annual)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Total of the project</td>
<td>500</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>50</td>
<td>1,300</td>
</tr>
</tbody>
</table>

Note: * Monitoring – construction phase includes air, water, soil, noise, and years 1 to 4 of waterbird survey (Table A2.2). Monitoring – operation phase includes water and Year 5 of waterbird survey (Table A2.2).

J. Mechanism for Feedback and Adjustment

Based on environmental reports, environmental authorities will decide whether: (i) further mitigation measures are required as corrective action, or (ii) some improvement is required to environmental management practices. If it is found during inspection that there has been substantial deviation from the EMP or any changes made to the project which may cause substantial adverse environmental impacts or increase the number of affected people, then PMO should consult with environmental authorities and ADB immediately and form an environmental assessment team to conduct additional environmental assessment and, if necessary, further public consultation. The revised EIA reports including EMP should be submitted to the environmental authorities for approval, and finally report to ADB. The revised EMP will be passed to the contractor(s) and IA for implementation.
K. Grievance Redress Mechanism

Public consultation and information disclosure were undertaken during the domestic EIA and PPTA fieldwork. Continued public consultation is emphasised as a key component for project implementation. Any grievances which may arise due to Project activities will be managed through a Grievance Redress Mechanism (GRM), as follows.

(i) Stage 1: If a concern arises during construction, the affected person tries to resolve the issue with the contractor and project manager. If successful, no follow-up is required.

(ii) Stage 2: If not successful, the affected person can submit an oral or written petition/complaint to the village committee. For an oral complaint, the village committee must make a written record. The village committee must respond to the affected person within 2 weeks. The IEM will assist the committee in replying to the affected person.

(iii) Stage 3: If the affected person is not satisfied with the reply in Stage 2, he/she can appeal to the township government after receiving the reply in Stage 1 and the township government must give a clear reply within 2 weeks. The IEM will assist the township government in replying to the affected person.

(iv) Stage 4: If the affected person is still not satisfied with the reply of township government, he can appeal to the IA. The IA, through the LPMO and PMO, must report to the ADB project officer as soon as the complaint is recorded, by submitting relevant documents. The IA, through the EMU established in the IA, must prepare a clear reply in consultation with the EPB, EMC, and IEM, and give it to the affected person within 30 days.

(v) Stage 5: If the affected person is still not satisfied with the reply of the IA, he/she can appeal to the PMO after receiving the reply of Stage 4. The PMO must report to ADB as soon as the complaint is recorded by submitting relevant documents, and prepare a clear reply in consultation with ADB, EMU, EMC, and IEM. The PMO must give the reply to the affected person within 30 days. The ADB project team will assess the situation, contact the affected people and Government project counterparts, and provide advice to the government. Stages (ii)-(v) will be further refined during the detailed design stage.

(vi) Stages 1-5: At any time, an affected person may contact ADB directly, specifically the East Asia Department, including the ADB Resident Mission in the PRC. If this approach is unsuccessful, people who are, or may in the future be, adversely affected by the project may submit complaints to ADB’s Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB’s operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make a good faith effort to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, should they approach the Accountability Mechanism.\footnote{For further information see: http://compliance.adb.org/}
Figure A1: Mechanism for Feedback and Adjustment

ADB = Asian Development Bank, DI = design institute, EMC = environmental management consultant, EMS = Environmental Monitoring Station at the county and district level, EPB = Environmental Protection Bureau, IA = implementing agency, IEM = independent environmental monitor, PMO = provincial project management office, PLG = Project leading group, WEPD = Weinan Environmental Protection Bureau

Source(s): Feasibility study reports, domestic EIA, and consultations with PMO, WEPB and IA.