Initial Environmental Examination

May 2013

People's Republic of China: Qinghai Delingha Concentrating Solar Thermal Power Project

Prepared by China General Nuclear Solar Energy Development Co., Ltd.
for Asian Development Bank

CURRENCY EQUIVALENTS

(Inter-bank average exchange rate as of May 2013)

Currency Unit	-	Yuan (CNY)
CNY 1.00	=	US$ 0.1613
USD 1.00	=	6.20 CNY

For the purpose of calculations in this report, an exchange rate of $1.00 = 6.20 CNY has been used.

ABBREVIATIONS

ADB	–	Asian Development Bank
ASL	–	above sea level
CGN	–	China General Nuclear Power Group
CHP	–	combined heat and power
CGN	–	China General Nuclear Power Holding Corporation
CGN-DSE	–	China General Nuclear Delingha Solar Energy Co. Ltd.
CNY	–	Chinese yuan
CSC	–	construction supervision company
CSP	–	concentrating solar power
DI	–	design institute
DNI	–	direct normal irradiance
EA	–	executing agency
EHS	–	environment, health and safety
EIA	–	environmental impact assessment
EMP	–	environmental management plan
EMS	–	environmental monitoring station
EMU	–	environmental management unit
EPB	–	Environmental Protection Bureau
FSR	–	feasibility study report
GDP	–	gross domestic product
GHG	–	greenhouse gas
GRM	–	grievance redress mechanism
HTF	–	heat transfer fluid
IA	–	implementing agency
IEE	–	initial environmental examination
IT	–	interim yarget
LFR	–	linear fresnel reflector
MEP	–	Ministry of Environmental Protection
MSDS	–	material safety data sheet
NDRC	–	National Development and Reform Commission
PPCU	–	project public complaint unit
PPE	–	personnel protective equipment

PPTA	–	project preparatory technical assistance
PRC	–	People's Republic of China
SCA	–	solar collector assembly
SCE	–	solar collection element
SEDC	–	Solar Energy Development Co., Ltd.
SPS	–	Safeguard Policy Statement, ADB
TA	–	technical assistance
TES	–	thermal energy storage
WHO	–	World Health Organization

WEIGHTS AND MEASURES

BOD_5	–	biochemical xxygen demand, five days
cm	–	centimeter
CO_2	–	carbon dioxide
COD	–	chemical oxygen demand
dB(A)	–	A-weighted sound pressure level in decibels
DO	–	dissolved oxygen
DOD	–	dissolved oxygen deficit
GJ	–	gigajoule
ha	–	hectare
kcal	–	kilocalories
kg	–	kilogram
km	–	kilometer
kWh	–	kilowatt-hour
m	–	meter
m/s	–	meters per second
m^3	–	cubic meters
mg/l	–	milligrams per Liter
mg/m^3	–	Milligrams per cubic meter
MW	–	megawatt
NO_2	–	nitrogen dioxide
NO_x	–	nitrogen oxides
^oC	–	degrees celsius
pH	–	a measure of the acidity or alkalinity of a solution
PM_{10}	–	particulate matter smaller than 10 micrometers
SO_2	–	sulfur dioxide
TN	–	total nitrogen
TSP	–	total suspended particulates

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Project Location in Delingha, Qinghai Province, People's Republic of China

EXECUTIVE SUMMARY

A. The Project and Rational

1. This Initial Environmental Examination (IEE) Report was prepared for the proposed Qinghai Delingha Concentrating Solar Thermal Power Project (the project) in Qinghai Province of the People's Republic of China (PRC). The project will construct 50 megawatt (MW) concentrating solar thermal power (CSP) plant and reduce emission of greenhouse gases (GHGs) and other pollutants. The project is the first-of-its-kind CSP demonstration plant in the PRC. The Asian Development Bank (ADB) considers providing a loan in the amount of $150 million to China General Nuclear Delingha Solar Energy Co., Ltd. (CGN-DSE), a subsidiary of China General Nuclear Power Group Company (CGN) to finance the project.

2. In 2007, the National Development and Reform Commission (NDRC) issued the Medium and Long-Term Development Plan for Renewable Energy in the PRC, which aims to increase the share of renewable energy in the total primary energy consumption to 15% by 2020. The Twelfth Five-Year Plan (2011-2015) has set an intermediate targets to increase the share of renewable energy to 11.4%, and to decrease carbon intensity by 17% by 2015 compared with 2005 levels to meet the 2020 targets. During the first two years of the Twelfth Five Year plan it surged to about 5 GW by 2012 to achieve the plan target of 21 GW by 2015.

3. In the PRC, more than 700,000 square kilometer (km^2) is suitable for CSP installation. The project location is one of the most suited locations in Qinghai Province with high DNI and over 3,100 daylight hours per year. The project will utilize a parabolic trough CSP and it will annually generate 197 GWh electricity, thereby avoiding annual CO_2 emission by 154,446 tons. The electricity to be generated by the project will be fed into existing northwest transmission system and dispatched to the load centers in the eastern region of PRC. The project will provide valuable hands on experience and mitigate some of the technology risks associated with first-of-kind projects. Successful demonstration will lead to market acceptance and large scale CSP deployment in the PRC. The proposed project will utilize a parabolic trough CSP, which is one of the four major CSP technologies and the most mature CSP technology available

B. Legal Framework of Environmental Impact Assessment

4. Environmental impact assessment (EIA) procedures have been established in the PRC for over 20 years. Domestic EIA studies are required to be undertaken by the PRC relevant environmental laws and regulations. National and local legal and institutional framework for EIA review and approval has been established to ensure that proposed projects are environmentally sound, designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards. The domestic EIA report was prepared and submitted to the Qinghai Environmental Protection Bureau (EPB) for review. The EIA was approved on 28 December 2012.

5. In addition to the PRC laws and regulations, ADB's Safeguard Policy Statement (SPS 2009) was also carefully considered. This project is classified as category B for environmental impact and an IEE is required. All applicable environmental requirements in the SPS 2009 are covered in the IEE.

C. Project Scope

6. The proposed demonstrative project will construct (i) 621,300 m^2 of solar field area

with 190 solar collector loops; (ii) one 50 MW steam turbine; (iii) two molten salt-tanks with seven hours thermal energy storage capacity; and (iv) a natural gas fired heater for startup, anti-freezing protection for HTF. Air cooling system will be adopted for the steam condensing system to conserve water.

D. Components of the CSP Plant

7. The parabolic trough solar collector system is designed to concentrate the sunrays via parabolic curved solar reflectors (mirrors) onto a thermally efficient linear receiver (absorber tubes). The receiver is located in the optical focal line of the collector. The receiver consists of a specially coated absorber tube embedded in an evacuated glass envelope. Synthetic thermal oil is used as heat transfer fluid (HTF) and is circulated in the absorber tubes.

8. The HTF will be heated to approximately 400°C by the sunrays. Heat exchangers will transfer the collected solar energy to water and this process continues until the temperature of the water is heated sufficiently to generate steam. After pre-heater, evaporator, and super-heater, superheated stream will be used to run a conventional steam turbine generating kinetic energy and converting it into electrical energy. The cooled HTF will be circulated back to absorber tubes. The exhaust steam leaving the turbine is transported to a condenser, which cools the steam and form water. Then, the water is returned to the heat exchanger. This cycle is repeated.

E. Implementation Arrangements

9. China General Nuclear Power Holding Corporation (CGN) will be the executing agency. China General Nuclear Delingha Solar Energy Co. Ltd. (CGN-DSE) will be the implementing agency responsible for day to day project implementation management including procurement and contract, payment to contractors, operation and maintenance, and social and environment safeguard monitoring of the Project.

F. Description of the Environment

10. **Geography, meteorology and climate.** Delingha City is located in the northeast part of the Qaidam Basin with an elevation ranging from 2,790 m to 5,808 m ASL. It is cold and dry area with continental climate. The local climate can be characterized as high altitude, thin air, clear sky, low humidity, good atmospheric transparency, long sunshine duration, strong solar irradiance, low temperature, and short frost-free period. This area is dry and windy in spring with frequent cold fronts. Much of the rain occurs in summer from May to August. Winter is cold with very little precipitation. The annual average precipitation is 487.7 mm while the average annual evaporation is 3,526.1 mm.

11. **Hydrological conditions.** There are seven rivers in Delingha City's administrative area. The main source of the surface water is from the mountain in the north. Located in the northeast of Qaidam Basin in Qinghai Province, Bayin River is the largest river flowing through Delingha City. Bayin River is 326 km in total length from its starting point to Tuosuo Lake. The annual mean flow rate is 10.2 m^3 per second and its annual runoff is 320 million m^3.

12. **Ecological resources.** The soil in plant site is dominated by sandy soil. Sand runs through the entire soil layer. Such soil has strong water permeability and poor soil fertility-holding capacity. Vegetation is sparse very few types and vegetation coverage is very low. Only drought-tolerant plant can survive in this area.

13. The project site is located in an unused land without any residential area nearby. The

project area has no large beasts and other animals, while a few small wild animals exits occasionally. There is no rare and endangered wildlife. There is no surface water source protection area, nature reserve and other environmentally sensitive objects in project area.

G. Environmental Baseline

14. In order to understand the current environmental conditions and establish baseline environmental quality, environmental monitoring was conducted by a third-party certified environmental monitoring organization during the PPTA and funded by ADB. The monitoring results and analyses indicate that the background PM10 in ambient air concentration and total phosphorus and total nitrogen are high in surface water monitoring locations.

H. Anticipated Impacts and Mitigation Measures

15. **Anticipated Impacts.** The potential environmental impacts of the proposed CSP project were examined and screened during the IEE preparation. The relative significance of potential impacts from the project activities was identified. More detailed assessments were performed for major, critical, and specific impacts.

16. The results of the screening process showed that during the construction phase, the major negative environmental impacts are associated with potential soil erosion, construction noise and fugitive dust. During the operation phase, the major negative environmental impact is the potential risks from HTF leakage, waste water, some pollutant emissions from the nature gas combustion.

17. **Mitigation measures.** Some of the major mitigation measures during construction and operation phases to minimize the direct and induced impacts are summarized in the table below:

Summary of the Major Impacts and Mitigation Measures

Phase	Environmental Impact Parameter	Major Mitigation Measure
Construction	Soil erosion and contamination	Minimize active open excavation, stabilize earthwork disturbance areas, remove construction wastes. Plant trees and grass in the CSP plant to control soil erosion and properly slop or re-vegetate disturbed surfaces.
	Noise and vibration	Restrict operation of machinery with high noise and vibration at night and place noise barriers around noise sources.
	Fugitive dust	Spray water to suppress dust and cover soil piles.
	Solid waste	Provide waste storage containers at construction site; transport spoil to suitable disposal sites; prohibit on-site burning.
	Occupational health and safety	Provide personnel protective equipment (PPE) to worker; conduct trainings, and provide signage in risk areas.
Operation	Fugitive dust	Apply recycled water dust suppression.
	Noise from steam and power generation systems	Install acoustic enclosures, barriers, shields; restrict access to high noise areas.
	Wastewater	Domestic wastewater CSP plant wastewater will be collected and sent to onsite wastewater treatment plant; use recycled water for dust control.

Phase	Environmental Impact Parameter	Major Mitigation Measure
	Chemicals and hazardous materials	Store chemicals and hazardous materials on impermeable surfaces with protective dikes; provide training and PPEs to workers.
	HTF and hazardous waste	HTF waste and hazardous waste will be stored temporarily in closed containers and collected and disposed by licensed contractors; wear PPEs when handling HTF waste.
	Emergency response plan	Provide training and conduct emergency exercises; take appropriate actions according to the plan; notify local authorities if emergency affects public safety.

Source: Environment impact assessment and TA consultants.

I. Alternative Analysis

18. Coal has provided 70% of the primary energy consumed and nearly 75% of electricity generation in the PRC. If the CSP project is not implemented, a traditional coal-fired power plant would be built to meet the increasing demand for electricity. This will cause an increase in greenhouse gases and air pollutants.

19. To demonstrate the CSP technology, evaluate the performance of the CSP plant in the PRC and achieve the optimal operating efficiency, the most common and mature CSP technology, parabolic trough CSP with thermal storage and natural gas backup, has been selected for this project. Base on the overall alternative analysis, the project has selected a suitable location and with the right choice of technologies. The selected alternative design options, such as dry cooling will minimize the potential impact of the project to the environment.

J. Information Disclosure and Public Consultations

20. Information disclosure and public consultations were conducted in the project city during the preparation stage. The information disclosure and consultations included: (i) website information disclosures, (ii) questionnaire surveys, and (iii) informal phone calls to households.

21. The survey results show that survey participants support the project in general but a small number of participants had some concerns about air pollution, noise, wastewater and solid waste. After considering the mitigation measures that will be implemented during construction and operation phases of the project, the participants supported the project.

22. A dialogue channel will be maintained with the affected stakeholders throughout project implementation. Public notice boards will be set at each construction site. The contact information of the Project Public Complaints Unit will be disclosed on the construction site information boards.

K. Grievance Redress Mechanism

23. A project-level grievance redress mechanism (GRM) will be established in order to solve complaints timely and effectively. The GRM includes a procedure for receiving grievances, recording/ documenting key information, and evaluating and responding to the complainants in a reasonable period of time. Any concerns raised through the GRM will

need to be addressed quickly and transparently, and without retribution to the affected person.

L. Environmental Management Plan

24. A comprehensive EMP was developed to (i) ensure implementation of identified mitigation measures to avoid, reduce, mitigate, and compensate for anticipated adverse environment impacts; and (ii) monitor and report against the performance indicators, to comply with the PRC's environmental laws, regulations and standards and to ADB's Safeguard Policy Statement. Organizational responsibilities and budgets are clearly identified for execution, monitoring and reporting.

25. The potential impacts of the project during construction as well as operation were identified and appropriate mitigation measures have been proposed and will be implemented during the project implementation. The effectiveness of mitigation measures will be evaluated through environmental monitoring.

26. An environment monitoring plan was developed which covers air quality, wastewater, solid waste during construction as well as operation. Monitoring frequencies, responsible parties and estimated costs are identified in the plan.

27. Reporting requirements. The EA will submit EMP monitoring reports to ADB semiannually during construction and annually during operation.

M. Conclusions

28. The proposed CSP project in Delingha City, Qinghai Province, is one of the kind demonstration renewable energy project in the PRC. It will bring positive environmental benefits locally as well as globally by generating electrical power with zero emission solar energy and clean natural gas instead of by traditional coal-fired power plants. The project will save 70,000 tons of standard coal or 122,554 tons of raw coal annually. The associated annual avoided emission of CO_2 is 154,446 tons.

29. The project (i) selected an appropriate technology to reduce the emission of pollutants, (ii) identified negative environment impacts and appropriately established mitigation measures, (iii) received public support from the majority of affected people, (iv) established an effective project GRM, (v) prepared a comprehensive EMP, and (vi) included a project component to strengthen the project capacity during project implementation. Mitigating measures for potential adverse environmental impacts are included in the EMP, which will ensure the environmental performance of the project and reduce the adverse impacts to acceptable levels.

I. INTRODUCTION

A. The Project

1. In 2007, the National Development and Reform Commission (NDRC) issued the Medium and Long-Term Development Plan for Renewable Energy in the PRC, which aims to increase the share of renewable energy in the total primary energy consumption to 15% by 2020. The Twelfth Five-Year Plan, 2011-2015, has set an intermediate targets to increase share of renewable energy to 11.4%, and to reduce decrease carbon intensity by 17% by 2015 compared with 2005 levels to meet the 2020 targets. During the first two years of the Twelfth Five Year plan (2011–2015) it surged to about 5 GW by 2012 to achieve the plan target of 21 GW by 2015.

2. The proposed project will construct 50 megawatt (MW) concentrated solar thermal power (CSP) plant in Delingha City, Qinghai Province. The Project is the first-of-its-kind CSP demonstration plant using seven hours thermal energy storage in the PRC. On completion, the project will annually generate 197 gigawatt hour (GWh) of electricity, thereby avoiding annual CO_2 emission by 154,446 tons. It will provide valuable hands on experience and mitigate some of the technology risks associated with first-of-kind projects. Successful demonstration will lead to market acceptance and large scale CSP deployment in the PRC. The proposed project will utilize a parabolic trough CSP, which is one of the four major CSP technologies and most mature CSP technology. The Asian Development Bank (ADB) considers provide a loan in the amount of $150 million to China General Nuclear Solar Energy Development Co., Ltd. (SEDC), a subsidiary of China General Nuclear Power Group (CGN) to finance the proposed project.

B. Implementation Arrangements

3. China General Nuclear Power Holding Corporation (CGN) will be the executing agency. China General Nuclear Delingha Solar Energy Co. Ltd. (CGN-DSE) will be the implementing agency (IA) responsible for day to day project implementation management including procurement and contract, payment to contractors, operation and maintenance, and social and environment safeguard monitoring of the Project. China General Nuclear Solar Energy Development Co., Ltd. (CGN-SEDC) will provide project management support and oversight to the implementing agency, under the guidance of the executing agency.

C. Report Purpose

4. ADB's environmental safeguard requirements are specified in the Safeguard Policy Statement (SPS 2009). The Project is classified by ADB as Environment Category B because the project has limited environmental impact. Thus, an Initial Environmental Examination (IEE) including an environmental management plan (EMP) is required. This IEE for the project has been prepared in compliance with the ADB's SPS requirements.

D. Approach to IEE Preparation

5. This IEE report has been prepared based on domestic environmental impact assessment report (EIA) prepared for project in compliance with the PRC's environmental assessment requirements and regulatory framework at the national and local levels (see Chapter II for additional information on the domestic environmental assessment process). It was also supported by site visits, stakeholder consultations, and additional surveys undertaken by environmental consultants. **Project Description.** Data sources include (i) feasibility study report (FSR) prepared by qualified consultants from a certified domestic feasibility study institute; (ii) domestic project EIA report prepared by qualified domestic EIA consultants with a certified environmental impact assessment institute; and (iii) project due

diligence work undertaken by the ADB technical assistance (TA) consultants, including environment and social specialists, and CSP technical specialist.

6. **Climate.** Data sources for local climate include data collected by the environmental impact assessment (EIA) consultants from available databases.

7. **Topography, geology, soil.** Data sources include: (i) field surveys conducted by domestic EIA consultants from 2011 to 2012; and (ii) field surveys conducted by the ADB environmental consultants in October 2012.

8. **Terrestrial ecological resources.** Data sources include: (i) ecological field surveys conducted by domestic EIA consultants from 2011 to 2012; and (ii) ecological field surveys conducted by the ADB environmental consultants in October 2012.

9. **Air quality baseline.** Air quality data sources include: **(**i) public available ambient air monitoring data; and (ii) subproject specific air quality monitoring for particulate matter less than ten micrometer in diameter (PM_{10}), total suspended particulates (TSP) sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) undertaken by a certified organization on behalf of the IA; and (iii) data collected by the EIA consultants from available existing databases.

10. **Background noise.** Data for background noise levels come from onsite noise monitoring undertaken by a certified organization in April 2013.

11. **Water resources.** Samples were collected and analyzed by a certified organization in April 2013.

12. **Socioeconomic status.** Socioeconomic surveys and data were collected by the domestic EIA consultants and the ADB social consultant.

13. **Public consultation and information disclosure.** The project information was disclosed by the IA with the assistance from environmental consultants between December 2012 and January 2013. Additional public consultations were undertaken by the IA through questionnaire surveys in the same time period.

14. **Energy efficiency and emissions reduction.** Coal saving data is calculated by the ADB environmental consultants based on the domestic FSRs and information from ADB's technical consultant. Analyses on air pollutant emission reduction were conducted ADB environmental consultants.

E. Structure of IEE

15. This IEE report consists of an executive summary, nine chapters and two appendixes. The chapters of the main report are summarized below.

16. The Executive Summary presents the summary of all chapters of the IEE including potential environmental impacts and mitigation measures. Chapter one is the introduction, which briefly introduces project scope, report purpose, approach to IEE preparation, and the structure of the IEE.

17. Chapter two describes the policy, legal, and administrative framework and it also discusses PRC's and ADB's environmental assessment legal and institutional frameworks.

18. Chapter three provides the description of the project providing information of the detailed project components. Chapter four provides the description of the current environmental conditions in the proposed project area.

19. Chapter five provides anticipated impacts and mitigation measures, expected positive and negative environmental impacts of the project during construction and operation. It further covers the proposed mitigation measures.

20. Chapter six presents the results of alternative analysis of different ways of generating electrical power, alternative locations and technologies. Chapter seven discusses information disclosure and public consultations. It covers the public consultation activities of the project. A grievance redress mechanism is presented in Chapter eight.

21. The last chapter, Chapter nine, summarizes the conclusions of various analyses. The environmental management plan is presented in Appendix 1 and the environmental monitoring plan is shown in Appendix 2.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Legal Framework of the PRC

22. The environmental protection and management system in the PRC consists of a well-defined hierarchy of regulatory, administrative and technical institutions. At the top level the People's Congress of the PRC has the authority to pass and revise national environmental laws; the Ministry of Environmental Protection (MEP) under the State Council promulgates national environmental regulations; the MEP either separately or jointly with the Administration of Quality Supervision, Inspection and Quarantine issues national environmental standards. The provincial and local governments can also issue provincial and local environmental regulations and guidelines in accordance with the national ones. In addition, national and local five-year environmental protection plans form an important part of the legal framework.

23. Environmental impact assessment procedures have been established in the PRC for over 20 years. Domestic EIA studies are required within the PRC national and local legal and institutional framework for new projects. The primary laws that govern the EIA study of new projects are provided in **Table 2-1**.

Table 2-1: Applicable Environmental Laws

No.	Title of the Law	Year Issued
1	Environmental Protection Law	1989
2	Environmental Impact Assessment Law	2003
3	Water Law	2002
4	Water Pollution Prevention and Control Law	2008
5	Air Pollution Prevention and Control Law	2000
6	Noise Pollution Control Law	1999
7	Solid Waste Pollution Prevention and Control Law	2005
8	Water and Soil Conservation Law	2011
9	Forest Law	1998
10	Wild Fauna Protection Law	2004
11	Energy Conservation Law	2008
12	Cleaner Production Promotion Law	2012
13	Urban and Rural Planning Law	2008
14	Land Administration Law	1999

Source: TA consultants.

24. The implementation of environmental laws is supported by a series of associated

management and technical guidelines, which were issues by the MEP and are summarized in **Table 2-2**.

Table 2-2: Applicable Environmental Assessment Guidelines

No.	Guideline	Code/Year
1	Guideline for Technical Review of EIA on Construction Projects	HJ 616-2011
2	Management Guideline on EIA Categories of Construction Projects	2008
3	Further Enhance the Management of EIA and Preventing Environmental Risks	2012
4	Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects	2009
5	Guideline on EIA Categories of Construction Projects	2008
6	Interim Guideline on Public Consultation for EIA	2006
7	Technical Guidelines for EIA–General Program	HJ 2.1-2011
8	Technical Guideline for EIA–Atmospheric Environment	HJ 2.2-2008
9	Technical Guideline for EIA–Surface Water	HJ/T 2.3-1993
10	Technical Guideline for EIA–Acoustic Environment	HJ 2.4-2009
11	Technical Guideline for EIA–Groundwater Environment	HJ 610-2011
12	Technical Guideline for EIA–Ecological Impact	HJ 19-2011
13	Technical Guidelines for Environmental Risk Assessment for Construction Projects	HJ/T 169-2004

Source: TA consultants.

25. The environmental quality standard system that supports the implementation of the environmental protection laws and regulations in the PRC is classified into two categories by function, pollutant emission/discharge standards and ambient environmental standards. The relevant main standards applicable to the project are shown in **Table 2-3.**

Table 2-3: Applicable Environmental Standards

No.	Standard	Code
1	Surface Water Quality Standards	GB 3838-2002
2	Environmental Quality Standards for Noise	GB 3096-2008
3	Ambient Air Quality Standards	GB 3095-1996 and 2000 revision, 2012
4	Integrated Emission Standard of Air Pollutants	GB 16297-1996
5	Integrated Wastewater Discharge Standard	GB 8978-1996
6	Underground Water Quality Standard	GB/T 14848-93
7	Standards for Drinking Water Quality	GB 5749-2006
8	Pollution Control Standards for Storage and Disposal Site of General Industrial Solid Waste	GB 18599-2001
9	Noise Standards for Construction Site Boundary	GB 12523-2011
10	Noise Standards for Industrial Enterprises	GB 12348-2008
11	Wastewater Quality Standards for Discharge to Municipal Sewers	CJ343-2010
12	Emission Standard of Air Pollutants from Coal-Burning, Oil-Burning and Gas-Fired Boilers	GB13271-2001

No.	Standard	Code
13	Standard for Pollution Control on Hazardous Waste Storage	GB18597-2001

Source: TA consultants.

26. In addition to environmental laws and regulations, there are some occupational health and safety laws and regulations the IA should comply with, including the *PRC Safety Production Law (2002), State Administrative Regulations of Safety Production (2004), PRC Occupational Illness Law (2011) and Administrative Regulation of Administration of Occupational Health (2009)*.

B. Applicable ADB Policies, Regulations and Requirements

27. The major applicable ADB policies, regulations, requirements, and procedures for EIA are (i) applicable sections of the Environmental Assessment Guidelines of ADB (2003), (ii) Environmental Safeguards—A Good Practice Sourcebook, and (iii) the Safeguard Policy Statement (SPS 2009), which provides the basis for this IEE. With respect to the environment, these policies are underpinned by the ADB's Operations Manual, Bank Policies (OM Section F1, 2010). The policy promotes good international practice as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health, and Safety Guidelines (EHS Guidelines)[1].

28. The domestic EIA was prepared for the PRC approval processes, which are required to adopt PRC standards for the quality of water, air, noise, etc. The ADB's SPS 2009 promotes the use of country safeguard systems; however, the application of country safeguard systems requires an equivalence and acceptability assessment followed by an ADB Board approval.

29. All projects funded by ADB must comply with the SPS 2009, which establishes 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 line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards.

30. The SPS 2009 requires a number of additional considerations, including: (i) project risk and respective mitigation measures and project assurances, (ii) project-level grievance redress mechanism, (iii) definition of the project area of influence, (iv) physical cultural resources damage prevention analysis, (v) climate change mitigation and adaptation, (vi) occupational and community health and safety requirements (including emergency preparedness and response), (vii) economic displacement that is not part of land acquisition; (viii) biodiversity conservation and natural resources management requirements, (ix) provision of sufficient justification if local standards are used, (x) assurance of adequate consultation and participation, and (xi) assurance that the EMP includes an implementation schedule and measurable performance indicators. These requirements, which may not be covered in the EIA, have been considered by the TA consultants. All applicable environmental requirements in the SPS 2009 are covered in the IEE.

C. International Agreements

31. The PRC has signed a large number of international agreements regarding environmental and biological protection. Those which have potential application to the project are listed in **Table 2-4**.

[1] *World Bank Group, Environmental, Health, and Safety Guidelines*, April 30, 2007, Washington, USA. http://www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

Table 2-4: Applicable International Agreements

No.	Agreement	Year	Purpose
1	Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat	1975	Prevention of the progressive encroachment on and loss of wetlands for now and the future
2	Convention on Biological Diversity	1993	Conservation and sustainable use of biological diversity
3	United Nations Framework Convention on Climate Change	1994	Stabilization of greenhouse gas concentrations in the atmosphere
4	Kyoto Protocol to the United Nations Framework Convention on Climate Change	2005	Further reduction of greenhouse gas emissions
5	Montreal Protocol on Substances That Deplete the Ozone Layer	1989	Protection of the ozone layer
6	United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification	1996	The combating of desertification and mitigating of the effects of drought

Source: TA consultants.

D. Other Relevant Guidelines

32. The World Bank Group's Environmental, Health and Safety Guidelines is considered as recognized standards for pollution prevention and control technologies and practices in the ADB's SPS. The general EHS guidelines, in conjunction with the Industry Sector Guidelines, provide the context of international best practice and will contribute to establishing targets for environmental performance. The relevant sector guidelines referenced include: General EHS Guidelines (covering occupational health and safety and community health and safety); Waste Management Facilities sector guidelines; and Water and Sanitation sector guidelines. The air, noise, and water quality standards in the WB's EHS guidelines have also been referenced in the PRC.

E. Applicable Standards

33. The ambient air quality limits are intended to indicate safe exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Such limits are given for one or more specific averaging periods, typically one-hour average, 24-hour average, and/or annual average. There are three sets of ambient air quality standards for Class 1, 2 and 3 areas[1], respectively as stated in the PRC Ambient Air Quality Standards (GB3095-1996 and revisions in 2000). The World Health Organization (WHO) Air Quality Guidelines are recognized as international standards. The PRC standards and WHO guideline values are shown in **Table 2-5**. In addition to guideline values, interim targets (IT) are given for each pollutant by the WHO. These are proposed as incremental steps in a progressive reduction of air pollution and are intended for use in areas where pollution is high. The PRC standards are closer to the WHO IT-1 values[2] which are also shown in **Table 2-5**. The PRC standards for Class 2 area are applicable for the project.

[1] Class 1 area includes natural reserve and environmentally sensitive areas; Class 2 area includes most of PRC areas other than Class 1 and 3; and Class 3 is for specially designated industrial area.

[2] T-1 levels are associated with about a 15% higher long-term mortality risk relative to the WHO air quality guideline level.

Table 2-5: PRC Standards and WHO Ambient Air Quality Guidelines

Standard	PM_{10}	SO_2	NO_2
WHO annual mean/IT-1	20/70	--	40
WHO 24-hr mean/IT-1	50/150	20/125	--
WHO 1-hr mean			200
PRC GB annual mean (class 1/class 2)	40/100	20/60	40/80
PRC GB 24-hr mean (class 1/class 2)	50/150	50/150	80/120
PRC GB 1-hr mean (class 1/class 2)		150/500	120/240

NO_2 = nitrogen dioxide, PM_{10} = particulate matter smaller than 10 micrometers, PRC = People's Republic of ChinaSO_2 = sulfur dioxide, WHO = World Health Organization.
Source: WHO Air Quality Guidelines (2006) and PRC GB3095-1996 and 2000.

34. The emission limits for fugitive and uncontrolled discharge of new pollution sources covered by "Integrated Emission Standard of Air Pollutants (GB16297-96)" will be followed for fugitive dust emission from the CSP plant.

35. During construction of the CSP facility, noise levels will comply with the standards in "Noise Standards for Construction Site (GB12523-2011)," and during operation, the applicable standard is Category-II Standard stated in "Noise Standards for at Industrial Enterprises (GB12348-2008)." Construction noise is evaluated at sensitive receptor sites and operational noise is evaluated within one meter of boundaries of CSP facility.

36. Category I standard of "Pollution Control Standards for Storage and Disposal Site of General Industrial Solid Waste (GB 18599-2001)" shall be complied. As the project involves hazardous materials like HTF, a properly licensed hazardous waste management company will be hired and strictly follow the relevant national standards for handling and disposal of hazardous chemicals and wastes, which are (i) Order No. 591 of the State Council "Safety Management Regulations for the Hazardous Chemical"; (ii) Order No. 27 of China State Environmental Protection Agency (SEPA) " Prevention Method for Polluting the Environmental of the Hazardous Waste Chemical" [2005]; (iii) Pollution Control Standard for the Storage of the Hazardous Waste (GB 18597-2001); and (iv) Order No. 5 of China SEPA "Management Method for the Transfer Sheet of Hazardous Waste".

37. Considering the current environmental conditions, the project specific situations, and environmental benefits the project will bring, it is appropriate for the project to comply with relevant PRC standards.

F. PRC's Environmental Impact Assessment and its Administrative Framework

38. Article 16 of the "PRC Law on Environmental Impact Assessment (2003)" stipulates that an EIA document is required for any capital construction project producing significant environmental impacts so as to provide a comprehensive assessment of these potential environmental impacts. On 2 September 2008, the Ministry of Environment Protection (MEP) issued the "Management Guideline on EIA Categories of Construction Projects," which classifies projects into three categories:

(i) **Category A:** Projects with significant adverse environmental impacts, for which an full EIA report is required;

(ii) **Category B:** Projects with adverse environmental impacts which are of a lesser degree and/or significance than those of Category A, for which a simplified tabular EIA report is required; and
(iii) **Category C:** Projects unlikely to have adverse environmental impacts, for which an EIA registration form is required.

39. Based on MEP's guidelines, a full EIA report and a simplified tabular EIA report for category A and B are similar to ADB's consolidated EIA and IEE, respectively. The registration form of an EIA is similar to an ADB Category C project. The guidelines provide detailed classifications of EIAs for 23 sectors and 198 subsectors based on the project's size, nature (e.g., water resources development, agriculture, energy, waste management, etc.), and environmental sensitivity (e.g., protected nature reserves and cultural heritage sites). In accordance with the guideline, the proposed project has been classified into the subcategories of social and regional development and energy efficiency improvement.

40. The PRC MEP's "Guidelines on Jurisdictional Division of Review and Approval of EIAs for Construction Projects (2009)" provide two prescribed lists of projects for which EIAs must be reviewed and approved. The guidelines include a list of construction projects for which EIAs require MEP review and approval, and a list of projects for which EIAs are delegated to the provincial EPBs.

G. EIA Report Approval Status and Conditions

41. The EIA report was prepared by qualified domestic EIA consultants and submitted to the Qinghai provincial EPB, which organized an environmental team to review the EIA report. Based on the evaluation's recommendation, the Qinghai EPB approved EIA for the project on 28 December 2012. The approval document has some specific requirements for the IA to comply during construction and operation and the they are summarized as follows:

(i) Qinghai EPB has authorized the Haixi EPB to take the lead for environmental monitoring and inspection of the project during the construction period.
(ii) If there is any change to the project after this approval, the IA must timely fulfill all of the relevant requirements.
(iii) Rationalize the layout of construction sites and optimize the working time of construction activities.
(iv) During the design and construction of the 110 kV transmission line, it is required to take measures for anticorona, noise-reduction and electromagnetic protection to make sure that (a) 0.5 megahertz radio interference is less than 46 decibel (microvolt/meter) within the 20-meter boundary from the substation and transmission line, (b) the power frequency electric field will be less than 4 kilovolt/meter in good weather, and (c) the power frequency magnetic field will be less than 0.1 milliteslas outside the boundary and on the ground under transmission line.
(v) Minimize the impact of construction activities by limiting the areas of temporary facilities such as worker's camp, construction road, etc.
(vi) Remove the top soil first and put it aside for later use before excavation begins for pipeline trenches.
(vii) Clean up the temporarily occupied areas to recover natural landscape after the construction is completed.
(viii) Give priority to utilizing equipment with low noise levels in construction and operation periods and implement noise-reduction measures for equipment with high levels of noise to avoid disturbance to the public; During construction period, noise levels from the equipment and CSP plant shall comply with the requirements of the Emission Standard of Environmental Noise for Boundary of Construction Site (GB12523-2011). In the operation period, the noise levels shall comply with the Class II standard of the Noise

Emission Standard for Industrial Enterprises at Boundary (GB12348-2008).

(ix) During construction period, wastewater coming from sand and stone washing, concrete mixture, equipment cleaning and sanitary sewage, after precipitation, should be collected and used for dust-reduction for construction sites and roads after sedimentation.

(x) Sanitary sewage shall be processed by the septic tank. Wastewater from washing of reflectors during operation period should be collected and used for dust reduction around the CSP plant.

(xi) Sewage sludge of septic tanks shall be regularly taken away by the environmental protection department via fecal suction trucks. Sanitary waste collected shall be sent to the Delingha municipal refuse landfill on a regular basis.

(xii) Measures against leakage, contamination, erosion and explosion should be adopted according to the requirements of environmental protection in the emergency oil pit and heat transfer oil treatment facility in case of environmental pollution under abnormal conditions.

(xiii) The IA shall (a) comply with the industrial operation rules for safe operation of the CSP plant, (b) take risk prevention measures and prepare contingency plans, (c) establish and implement a complete system for environment management, and (d) establish training programs and provide training to staff on environmental safety protection and prevention and precautions against contamination accidents.

(xiv) The temporary storage of waste storage batteries, electrical components, transformer fluid and greasy filth from the recycling of heat transfer oil shall stringently comply with the requirements of the Standard for Pollution Control on Hazardous Waste Storage (GB18597-2001) to prevent pollution.

(xv) After the completion of the project and when the CSP plant is operational, the IA shall submit an application to the Haixi Prefecture Environmental Protection Bureau (EPB) for environmental acceptance testing in compliance with the Management Guidelines for Environmental Protection for Check and Acceptance of Completed Construction Projects. The CSP plant can only be put into operation after receiving approval from the Haixi EPB.

III. PROJECT DESCRIPTION

A. The Project

42. The proposed project will construct 50 megawatt (MW) concentrating solar thermal power (CSP) plant in Delingha City, Qinghai Province. The Project is the first-of-its-kind CSP demonstration plant using seven hours thermal energy storage in the PRC. On completion, the project will annually generate 197 GWh of electricity, thereby avoiding annual CO_2 emission by 154,446 tons.

B. Project Rational

43. The power sector in the PRC has grown rapidly in tandem with the economic growth. Installed power capacity has expanded by about 70% in the past five years alone. Since the power sector relies heavily on coal-fired power generation which accounts for more than 75% of total electricity produced, the rapid expansion in capacity has caused large increase in Carbon Dioxide (CO_2) emission, the major greenhouse gas (GHG) responsible for climate change. Promoting more diversified energy mix with higher share of renewable energy is a core priority to decarbonize the country's power sector to reduce its carbon intensity. In 2005, the Renewable Energy Law of the PRC was enacted to stimulate large scale renewable energy development. The Renewable Energy Law was accompanied by a set of incentives and policy measures to promote non-hydro renewable technologies. In 2007, the National Development and Reform Commission (NDRC) issued the Medium and Long-Term Development Plan for Renewable Energy in the PRC, which aims to increase the share of renewable energy in the total primary energy consumption to 15% by 2020. The Twelfth Five-Year Plan, 2011-2015, has set an intermediate targets to increase share of renewable energy to 11.4% , and to reduce decrease carbon intensity by 17% by 2015 compared with 2005 levels to meet the 2020 targets.

44. CSP is a state-of-the-art renewable energy technology that converts direct solar irradiation into usable heat generating the medium to high temperature saturated steam that runs steam turbine for power generation. Combined with thermal energy storage, CSP plants can run at full load during night time or in case of insufficient direct solar irradiation during the day time. Thus, CSP plants produce reliable, predicable, and dispatchable electricity at any time of the day to allow the grid company to schedule their dispatch economically. This unique feature enables it to overcome grid integration issues posed by unpredictable wind and solar PV plants. By 2012, utility scale CSP plants of 2.46 GW installed capacity were in commercial operation and additional 2.36 GW install capacity are under construction, mainly in Spain and the United States.

45. CSP plants require direct normal irradiance (DNI) of at least 1,900 kilowatt hour per square meter (kWh/m^2). In the PRC, more than 700,000 square kilometer (km^2) is suitable for CSP installation, which is estimated to potentially generate more than 51,000 terrawatt hour (TWh) of electricity per year compared to PRC's total electricity generation of 4,700 TWh in 2011. But CSP is at an early stage of development in the PRC primarily due to limited hands-on experience with the technology. Other factors such as extreme cold climate and water scarcity in suitable locations combined with a lack of CSP specific development policy, and insufficient tariff support have inhibited or slowed investment in CSP thereby causing the delay in CSP demonstration and deployment.

46. Qinghai province which is located in the north-eastern part of the Qinghai-Xizang plateau in the western PRC is rich in solar resources with a DNI of about 2,100 kWh/m^2. It is the fastest growing solar region in the PRC. Its solar photovoltaic (PV) capacity expanded from 76.3 MW in 2010 to 1,010 MW in 2011, which was 47.2% of total solar PV installed capacity in the PRC. The Qinghai provincial government targets to expand solar energy

install capacity to 4 GW including 300 MW of CSP by 2015, and to10 GW including 2GW CSP by 2020, which are about 20% of the national targets.

47. The project location is one of the most suited locations within Qinghai province with a DNI of about 2,187 kWh/ m^2 and over 3,100 daylight hours per year. The project will utilize a parabolic trough CSP, which is one of the four major CSP technologies, with 50 MW of installed capacity and seven hours thermal storage system. The project will annually generate 197 GWh electricity, thereby, avoiding annual CO_2 emission by 154,446 tons. The electricity to be generated by the project will be fed into existing northwest transmission system at 330 kilovolt and dispatched to the load centers in the eastern region of PRC.

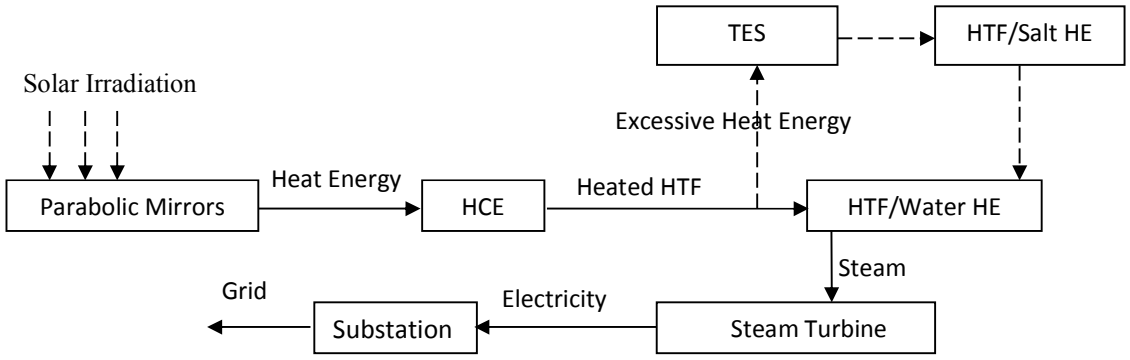
C. Project Scope

48. The proposed demonstrative project will construct (i) 621,300 m^2 of solar field area with 190 solar collector loops, (ii) one 50 MW steam turbine with a generation efficiency 39.5%, (iii) two molten salt-tanks with seven hours thermal energy storage (TES) capacity—995 MWh capacity, and (iv) a natural gas fired heater for startup, anti-freezing protection for HTF. The designed annual power generation is 197 GWh. Air cooling system will be adopted for the steam condensing system to conserve water.

D. Components of the CSP Plant

49. CSP technologies generate electricity in a similar way to conventional power stations by using steam to drive a turbine. The fundamental principle of CSP technologies is to collect the energy carried by sunrays, allowing a heat transfer fluid (HTF) to absorb the collected energy and then converting the thermal energy into electricity. Excessive energy will be stored in molten salt tanks and will be used when sunrays are insufficient to generate energy. The process of energy conversion in a CSP plant is illustrated in Figure 3-1

Figure 3-1: Major Components of a CSP Plant



HCE = heat collection element, HE = heat exchanger, HTF = heat transfer fluid, TES = thermal energy storage.
Source:TA consultants

50. The parabolic trough solar collector system is designed to concentrate the sunrays via parabolic curved solar reflectors (mirrors) onto a thermally efficient linear receiver (absorber tubes). The receiver is located in the optical focal line of the collector. The receiver consists of a specially coated metal absorber tube embedded in an evacuated glass envelope. Synthetic thermal oil is used as HTF and is circulated in the absorber tubes.

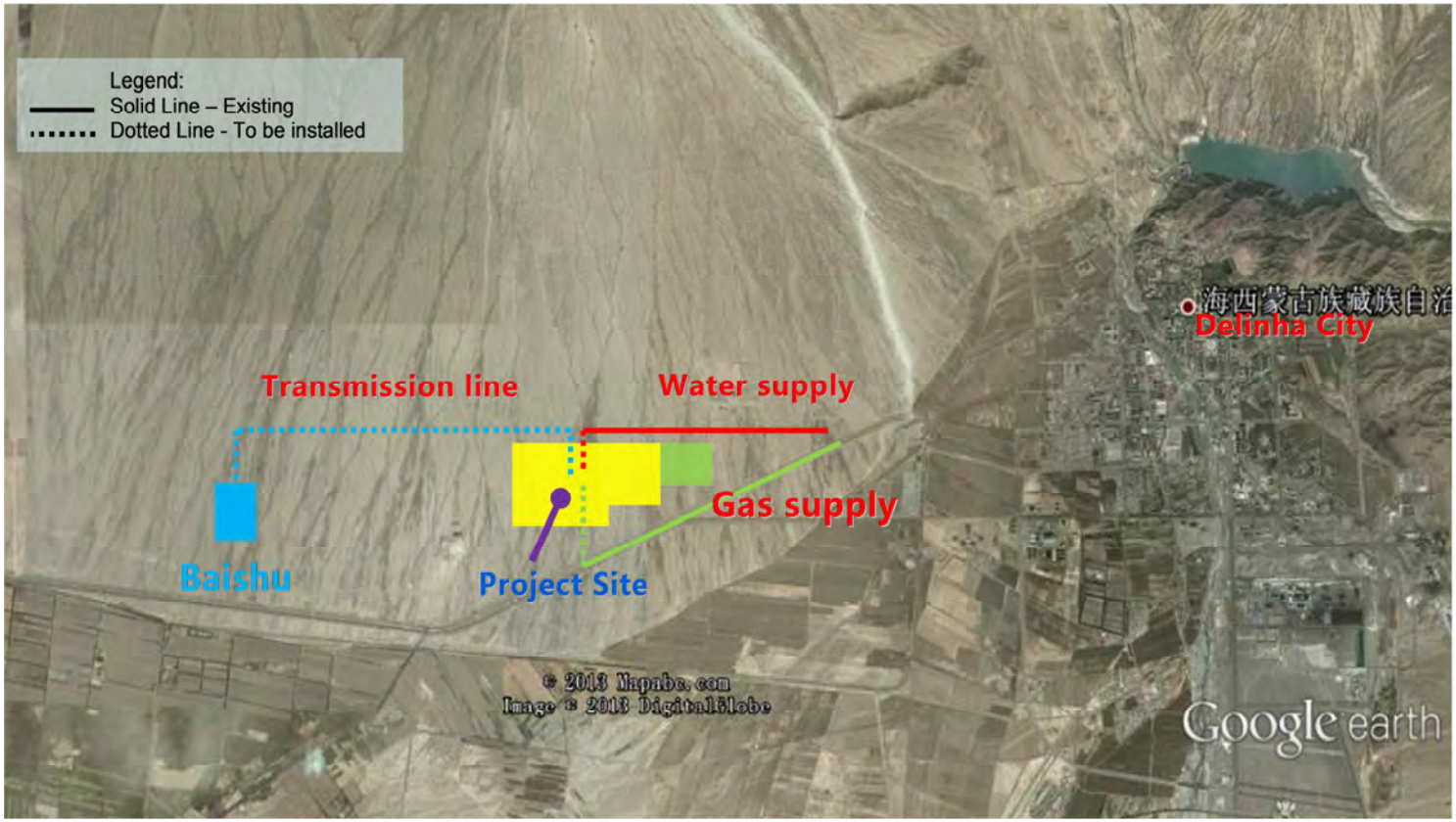
51. The HTF will be heated to approximately 400°C by the sunrays. Heat exchangers will

transfer the collected solar energy to water and this process continues until the temperature of the water is heated sufficiently to generate steam. After pre-heater, evaporator, and super-heater, superheated stream will be used to run a conventional steam turbine generating kinetic energy and converting it into electrical energy. The cooled HTF will be circulated back to absorber tubes. The exhaust steam leaving the turbine is transported to a condenser, which cools the steam and form water. Then, the water is returned to the heat exchanger. This cycle is repeated.

E. CSP Plant Location and Layout

52. **Plant site.** The plant site is located about 7 km northwest of Delingha City. The south site is the national highway #315, and the existing natural gas pipeline is passing along the same highway. The total land occupied by the project is 2.46 km^2 while the majority of the land (approximately 2.28 km^2) will be used for the solar field. The project location including its boundary of the project and main infrastructure (water supply, natural gas supply, transmission line) is shown in **Figure 3-2.**

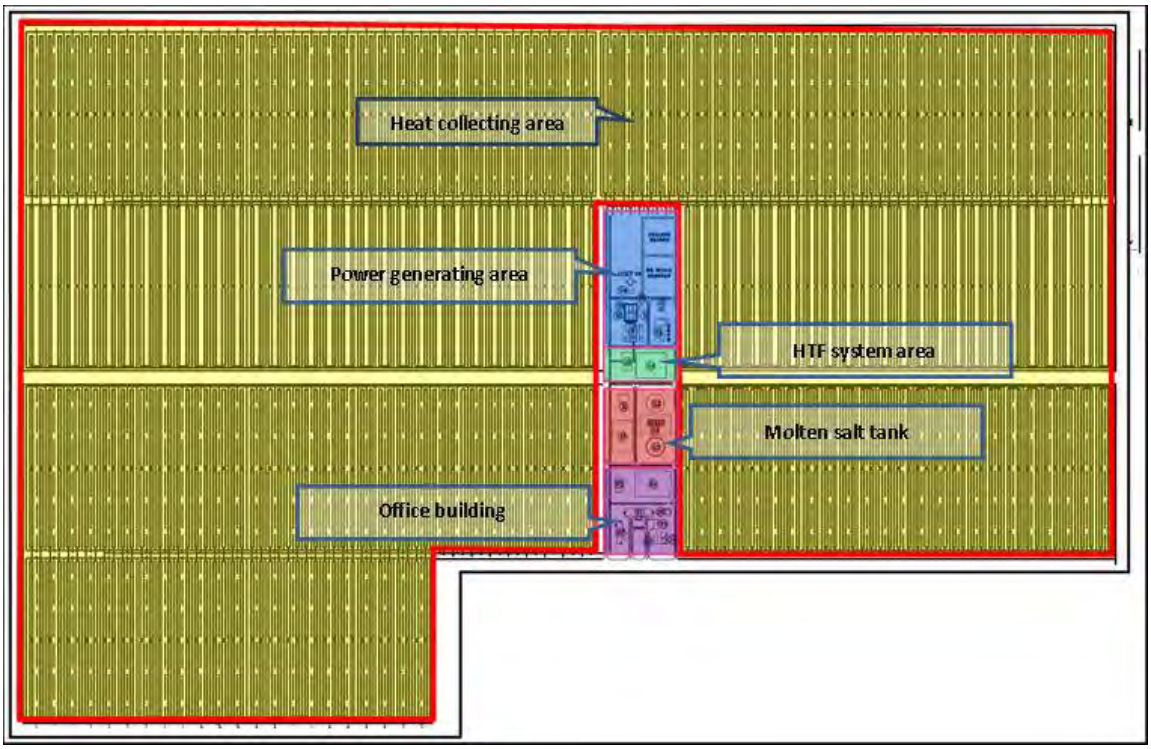
Figure 3-2: Project Location and Main Infrastructures



Source:TA consultants

53. **Layout of CSP.** The CSP plant will be divided into two areas: solar energy collection area and electrical power generation area (see **Figure 3-3**). The power generating area is arranged at the center in the CSP plant. The main plant with air cooling platform is located at the northwest of the power generating area. The southern part of the main plant is the heat transfer fluid (HTF) main pumping station, HTF system area, fire truck house, molten salt tank area, heat conversion system, natural gas supply station, office building, water pumping station, impounding water ponds and wastewater treatment facility.

Figure 3-3: Layout of CSP Plant



Source: FSR

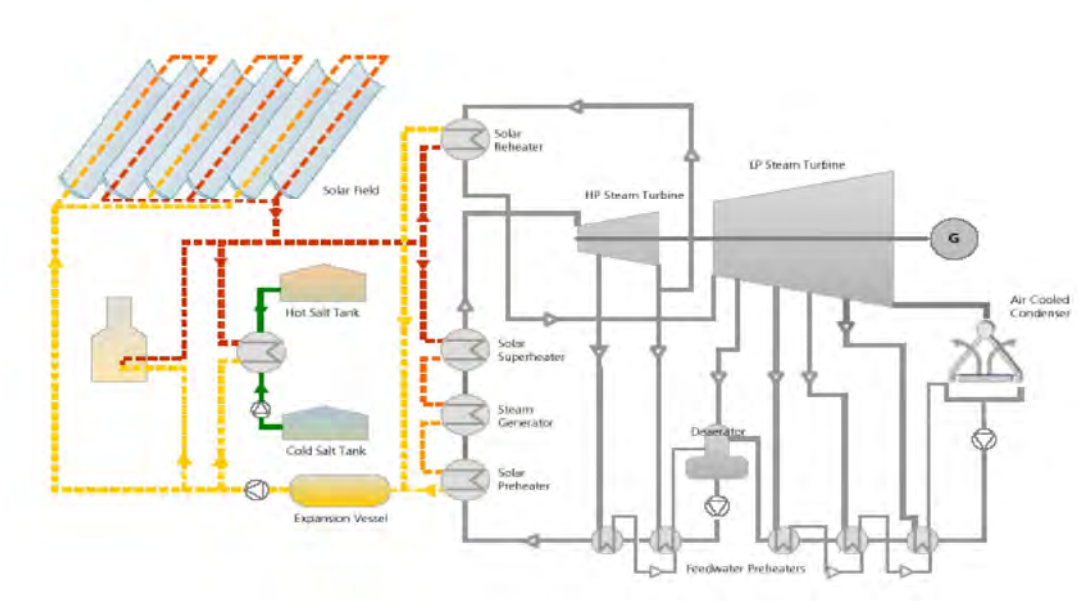
F. Concentrated Solar Power Generation System

54. The CSP system includes five subsystems: (i) concentrating solar energy, (ii) heat exchange, (iii) power generation, (iv) heat accumulation and storage, and (v) auxiliary power. The entire CSP system is illustrated in **Figure 3-4**.

1. Concentrating Solar Energy Subsystem (Solar Field)

55. The concentrating solar energy subsystem is a core of the entire CSP system. The solar field is a modular distributed system of **solar collector assemblies (SCAs).** Each module is called a “loop”, which is formed with four SCAs. Two SCAs are connected in series by pipes to form one row and two rows next to each other forms a loop. The loops are connected in parallel through insulated pipes and they work independently. The solar field in this project consists of 190 loops.

Figure 3-4: Concentrated Solar Power System

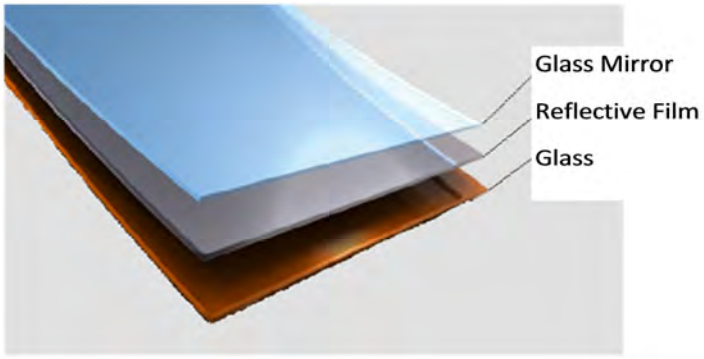


Source:TA consultants

56. Each SCA is formed by twelve **solar collection elements (SCEs)**. SCE includes reflective mirrors, supporting structure, heat receivers, monitoring control equipment, and driving devices.

57. **Reflective mirrors** are critical optical components of the CSP system. The mirrors are in parabolic shape and they are made of low-iron glass with silver coated on the back surface. Such glass has the good feature of sunlight irradiance transmission because of the low iron content, which prevents sun rays to be absorbed by glass. Ultra-white thin glass is used for the mirrors to ensure the solar energy reflection rate more than 94%. The glass is composed by one low iron glass layer, coated by high reflection silver at the back, and then, protected by a copper layer and a final weather resistant layer at the further back (see Figure 3-5). This structure increases the strength of the mirror so it is not easy to break and can have a long life time. The mirrors will be periodically cleaned using water except for winter time due to risks of damaging mirrors from icing.

Figure 3-5: Three Layer of the Glass Mirror



Source: TA consultants

Figure 3-6: Mirrors Mounted on Supporting System

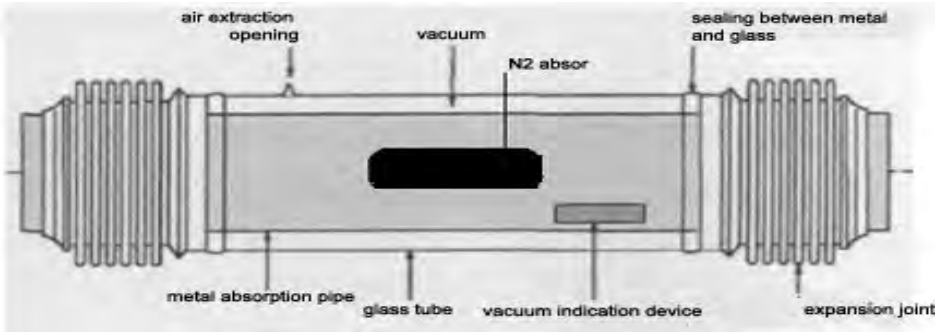
Source: FSR.

58. The concentrated solar energy is transferred to low temperature **HTF** distributed in the solar field pipes and heat up HTF in the receiver-absorber tube. The project uses synthetic oil as HTF, which consists of diphenyl ether (73.5%) and biphenyle (26.5%). HTF is an ordorless and colorless chemical with density of 700kg/m^3. At the temperature of 393 °C, its specific heat is 2.6 KJ/kg. HTF is flammable and toxic, and condenses at 12 °C. HTF oxidizes when it is exposed to temperature over 100 °C. Thus, nitrogen gas will be used to prevent HTF from contacting with air. HTF piping system is a pressurized system. Detecting devices on the HTF piping system will detect any pressure change, which can be considered to be HTF leakage. When pressure drops, automatic controlled valves will shut off at the entrance and exit of the loop in problem so that the loop can be isolated from the rest of the solar field.

59. **The heat receiver-absorber tube**, which is located in the focus line of the reflective mirror, consists of two concentric tubes separated in vacuum condition. The inner tube is made of carbon steel and coated with heat absorbing paint. The inner tube, which contains HTF, is insulated by evacuated outer tube that is made of glass with high solar transmittance. The reflection-reduction coating is applied outside the glass tube so that 96% of the solar energy can go through the glass tube. At the both ends of the tube, expansion joints are installed to accommodate difference between the steel pipe and glass pipe. Inside each glass tube, there is a detecting device through color change when vacuum level is changed. As the vacuum loss is considered as the HTF heat loss, daily visual inspection will be conducted to check all the tubes and detect any change in vacuum level of tubes.

60. The structure of the solar energy receiving piping is illustrated in **Figure 3-7**.

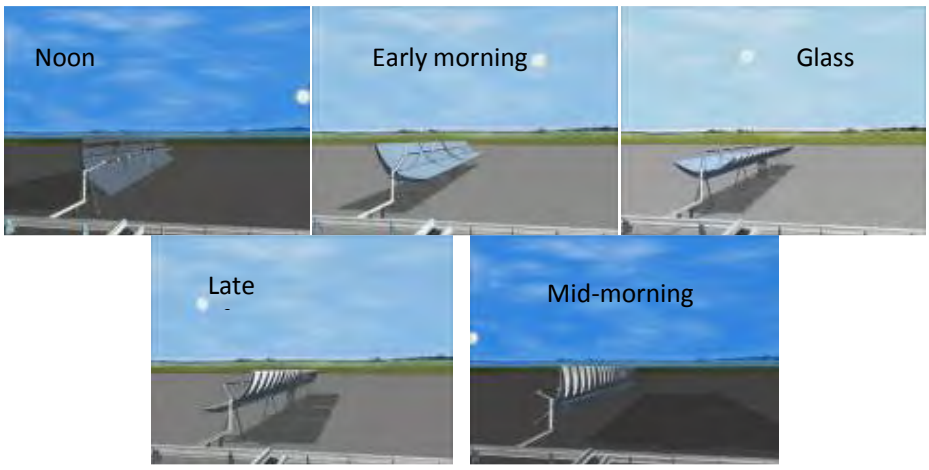
Figure 3-7: The Structure of the Heat Absorber Tube



Source: FSR.

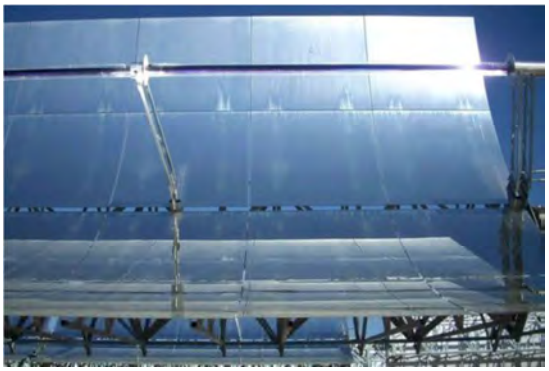
61. Each SCE is mounted to the **supporting structure,** which interfaces with the collector foundation and provides the rigidity to the SCAs. The structure with tracing and driving system is designed to enable SCAs to track the sun from sunrise to sunset.The axles to support SCAs usually lines up in south-north direction. Each SCA, equipped with a sun sensor, can rotate from east to west along with a rotation axle so that it can trace the sunlight and maximize solar energy to be collected (see Figure 3-8). During cloudy days and at night, the mirrors will be in the position facing down to protect the mirrors and minimize the dust deposition on the surface of the mirrors. The structure will be designed taking into consideration of wind directions and loads in the project site. Average wind speed average in the project site is 2.2 meter per second (m/s) and the maximum hourly wind speed is 15.1 m/s. The SCE structure will be constructed with 15.6 m/s of wind resistance capacity, which is typical resistance capacity for SCE structure. As an additional safety measure, the structure of the first three loops facing the East and Northeast wind directions will be constructed with 30% higher wind resistance capacity.

Figure 3-8: Solar Collection System Tracking the Sun during the Day



Source:

Figure 3-9: Solar Concentration Element




Source:FSR.

2. Heat Conversion Subsystem

62. The heat tranferring system will transfer the collected solar heat energy from heat collection loops to the water/steam circulation loop in the power block area via heat exchangers. In addition, the surplus heat energy collected in the solar energy collection field will be transferred to the molten salt for thermal energy storage.

63. Concentrated sun rays will heat up HTF approximately up to 400°C. The heated HTF will be circulated within the closed collector pipe system and fed into HTF-water heat exchangers, where the collected solar energy in HTF is imparted to water that is circulated in the turbine loop. This process continues until the temperature of the water is heated sufficiently to generate steam. Under normal operation, the temperature of HTF entering the solar energy heat collection area is about 290 °C and when it leaves solar loop, its temperature reachees 393 °C.

64. The cooled HTF will be sent back to to the solar field or thermal storage system where the surplus heat from HTF can be stored. The HTF containing surplus heat will be sent to HTF-molten salt heat exchangers and will heat up molten salt in the thermal storage system. All parts of the HTF system and the piping will be insulated with mineral wool to reduce thermal energy loss and thermal-bridge stoppers will be attached wherever HTF pipes have contact with other metal and concrete materials in order to minimize heat loss. All connection and ball joints will be equipped with weather resistant gasket and covers to prevent leakage and sand damage protection.

65. Maintaining the high quality HTF is critical for ensuring the high efficiency of the solar energy collection and conversion systems. Overtime, HTF will be slowly degraded and will require replacement. Around 2% out of total HTF in the project, which is around 56 tons of HTF, will be replaced annually. The processes of injecting new HTF and extracting waste HTF will occur at **the ullage system**, where the HTF cleaning process is performed by filtering HTF and capturing HTF degradation gases. The degraded HTF will be collected in a waste oil storage tank and will be treated as hazardous waste. An identified and licensed contractor will collect waste HTF on a regular base. The entire area of the ullage system will have a concrete foundation with bund walls, which are high enough to hold expected amount of degraded HTF to be collected at the ullage system so that it can minimize the impacts of HTF leak and spillover in the ullage system.

66. When HTF is heated, its volume increases. To accommodate HTF expansion, the project will have **the HTF expansion system**, which consists of expansion tanks, overflow containers, and pipes. The HTF expansion tank is filled with nitrogen gas, usually located in

allevated position. The HTF expansion system will have a concrete dike underneath with enough capacity to hold all HTF in the expansion tank so that it can prevent soil contamination from accidental HTF leak and spillover. Overflow containers will be installed to hold addition HTF when the expansion vessel reaches its maximum capacity. When the volume of HTF is reduced, overflow return pumps will move the HTF from the overflow containers back to to the expansion tank, so that sufficient amount of HTF is maintained in the expansion tank.

67. The temperature of HTF in some parts of the HTF system may drop in the evening or cold weather. When the thermal gage detects temperature drop, main pumps in the HTF system will operate to keep circulating HTF to regulate HTF temperature in the entire HTF system. If the temperature of HTF cannot be kept above 250^{o}C, a natural gas heater will be used to heat HTF to **prevent freezing**. The pump and HTF heater will operate until the HTF system out of the anti-freeze mode.

3. Power Generation System

68. The power generation system consists of a 50MW steam turbine generator, a preheater, a steam generator, a super-heater and a re-heater. The flow of steam is illustrated in Figure 3-4. The main parameters of the steam turbine generator are shown in Table 3-1.

69. Thermal energy from the heated HTF is transferred to water through HTF-water heat exchangers, which act as a boiler. Through the pre-heater, the stream generator, and the super-heater, the water turns into super-heated steam, which will run a conventional steam turbine in the power block to generate kinetic energy, which then, is converted to electrical energy. The system has two-pressure turbine configuration which is adapted to the working temperature achievable by the HTF and is designed for an efficient solar energy recovery. The exhaust steam from turbines is then transported to a **condenser**, where the steam will be cooled and form water. The water will be returned to HTF-water heat exchangers.

70. In this project, **dry cooling system** will be used for condensing steam using air. The condensate—water—is pumped back to heat exchanger. Mechanical fans will induce air flow for the condensation process. The air cooling can drastically reduce water consumption for the CSP project.

Table 3-1: Parameters of Steam Turbine Generator Unit

Parameter	Unit	Data
Rated power	MW	50
rated voltage	kV	10.5
rated frequency	Hz	50
Rated speed	r.p.m	3,000
turbine-inlet temperature	℃	383
turbine-inlet pressure	MPa	9.5
Rated turbine-inlet steam	t/h	220

C = degrees celsius, Hz =herz , kV = kilovolt, MPa = megapascal , MW = megawatt, r. p. m. = , t/h = ton per hour.
Source: FSR.

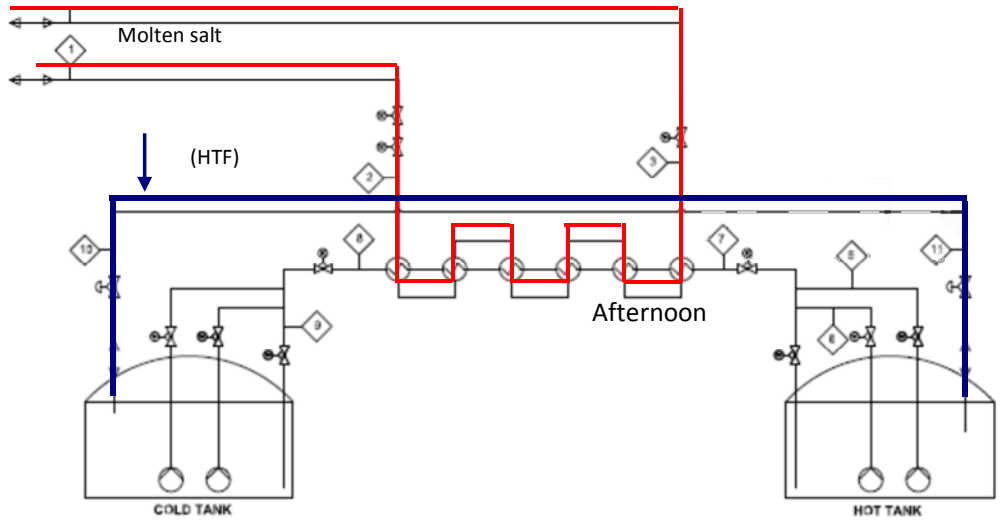
4. Thermal Energy Storage

71. The concept of thermal energy storage (TES) is simple: the excess heat collected

from sun is diverted to a storage material such as molten salt. When power production is required after sunset or during cloudy time, the stored heat is released into the steam cycle and the plant continues to produce electricity. Having thermal storage will give a "buffering" capacity to the CSP plant, allowing smooth electricity production and eliminating short-term variations that other solar technologies exhibit during cloudy days. In this project, TES is designed to generate power for a maximum of seven hours.

72. The TES system contains two tanks—hot and cold molten salt tanks, six tubular heat exchangers, molten salt pumps, and immersed electric heaters. The thermal storage medium is the molten salt mixture with 60% $NaNO_3$ and 40% KNO_3. It can absorb moisture, so that the nitrogen is used to prevent the water entering the tanks.The molten salt tanks will be insulated by mineral wool or insulation fiberglass. A good insulation at the bottom of the tanks is critical to prevent heat loss.

Figure 3-10: Thermal Energy Storage System



Source:TA consultants

73. When there is excessive heat in HTF, the heat will be transferred to molten salt through HTF-molten salt heat exchangers. The heated molten salt will be pumped and taken to the thermal storage tank. The temperature of the hot molten salt can reach 386 °C. If the temperature of molten salt drops between 223 and 238 °C, it becomes solid. Thus, the temperature of the molten salt should be maintained above 240 °C at all time to avoid damage to the TES system. The molten salt can be heated up using the heat from the HTF or the immersive electric heaters to be installed inside the molten salt tanks.

74. When no sufficient heat is generated from the solar energy collection system, the heat stored in the hot molten salt will be transferred to HTF via HTF-molten salt heat exchangers. Then, the heated HTF will be sent to HTF-water heat exchangers to heat water to generate steam for running the turbine.

5. Auxiliary Facilities

75. **Oil tank.** After the completion of the system installation, HTF needs to be filled up into the HTF piping system of the plant. Here, the total amount of HTF needs to be first collected in an oil tank filled with nitrogen gas. Nitrogen gas will prevent HTF to contact with air. Once the total of 2,800 tons of HTF is stored in the oil tank, it will be heat up slowly and gradually pumped into the HTF system. It is expected to take at least a week to complete

this process. After HTF is filled in the entire system, the oil tank will be emptied and disconnected from the system. Under the normal operation of CSP plant, the oil tank will be not be used. The oil tank will be reserved for any emergency case to empty HTF from the system and/or decommissioning of the CSP plant.

76. **Nitrogen storage tanks.** Nitrogen gas is used to prevent HTF and molten salt from contacting air. Nitrogen will be delivered to the project site in cylinder. Nitrogen will be compressed by a nitrogen compressor and stored in liquid nitrogen storage tanks onsite.

77. **Water purification system.** The water used for mirror cleaning and generating steam is supplied from the municipal water supply network but it needs to be purified before it can be used. The suspended solids and dissolved impurities need to be removed using chemical treatment system, which contains a foam modifier that acts as a filtering blanket on the surface of the water that considerably purifies it to required quality.

78. **Salt melting system.** The molten salt that is used for thermal storage of the CSP project is a mixture of sodium nitrate and potassium nitrate, which will be delivered separately to the project site in solid form and will be mixed properly to reach a desired composition of salt—sodium nitrate (60%) and potassium nitrate (40%)—in order to control the melting point and reduce by-products, which my create deposits on piping or any fitting of the system. The salt mixture will be crushed and be melted in a melting furnace, then, pumped into the molten salt tanks. The tanks need to be warmed up prior to the filling of molten salt liquid. The temperature of internal tank surface will be above 240 ºC in order to avoid the salt liquid from being coagulated.

79. **Automatic control system.** The project will install a Distributed Control System (DCS), which can monitor all major components of the CSP plant, including their system configurations and working status. DCS enables the automation in plant operation and enhances the ability of the plant to quickly response to any defaults and risks during the plant operation.

6. Other Project Components

80. **Water supply pipeline and water ponds.** The production water and domestic water will come from the municipal water supply network, which is managed by Delingha Water Company. The water supply pipeline with a diameter of 400 mm already exists near the project site. The project will construct around 300 m water supply pipeline from the main water pipeline network to the project site. No land acquisition issue is involved. The water pipe will be insulated and buried underground below the frozen soil layer. The water consumption of the project will be 385,000 m^3 per annum, which accounts around 1% of the municipal water supply. The water company has approved the water supply for the project.

81. The project will also construct two water storage ponds onsite with 2,000 m^3 of holding capacity each. The water stored in the ponds will be used for emergency backup in case of any interpretation of water supply.

82. **Natural gas pipeline.** Natural gas will be used for CSP plant start-up, and, freeze-protection. The estimated annual natural gas consumption is approximately 10 million Nm^3. According the FSR, approximately15% of the total electrical power generation will come from natural gas fired heater. The Sebei-Xining-Lanzhou Natural Gas Pipeline goes through the Delingha area and near the project site. The project will install around 500 m of natural gas intake pipeline from the main gas pipeline to the project site. No land acquisition issue is involved. The natural gas pipeline will be buried underneath. The Delingha Natural Gas Company has agreed to supply natural gas for the project.

83. **Power transmission line.** A 110 kV substation, called Baishu Substation is located west of the project; approximately 8.5 km away from the project site (see Figure 3-2). The project will construct around 8.5 km transmission line between the power generation block to Baishu substation. The transmission line will be installed within the right-of-way of the project's service road. No land acquisition issue is involved. No human settlement or any kind of building structure exists along the proposed route of the transmission line to be installed.

84. **Wastewater treatment facility.** The project will construct an onsite wastewater treatment facility to collect and treat waste water from the power plant, office building and worker's living quarters. The treated waste water will be recycled for dust control and water the plant onsite.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Haixi Prefecture

85. The proposed CSP project is located in Delingha City, Haixi Prefecture (Haixi), Qinghai Province. Haixi is located in the west part of Qinghai Province and the north part of the Qinghai-Tibet Plateau, which is the center of the Qinghai Province, Gansu Province, Xinjiang Uyghur Autonomous Region, and Tibet Autonomous Region. In Haixi, there are two cities of Delingha and Golmud; three counties of Tianjin, Dulan and Ulan; and three administrative districts of Lenghyu, Da Qaidam and Mangnai. The total land area of Haixi is 325,785 km^2, occupying 45.17% of Qinghai Province. The main part of the Haixi is occupied by Qaidam Basin, one of the four main basins in the PRC. Qaidam Basin is a hyperarid basin, covering the area of 256,600 km^2, which represents 78.76% of the Haixi's total area. The total population of Haixi was 495,700 in 2011, 76% of which is non-agricultural population and 24% is agricultural population. Around 24% of the population represents ethnic minorities such as Mongolian and Tibetan. The GDP of the Haixi reached CNY 48.14 billion in 2011 an increase of 19% over the previous year. The ratios of the first, second, and tertiary sectors are 2.5%, 78.2% and19.3%, respectively. This indicates that industrial production is the major contributor to local economic development. The major industries are metallurgy and manufacture of chemicals. The Haixi's capital is Delingha City. The administrative map of Haixi is shown in **Figure 4-1**.

86. **Geography and topography.** The Haixi latitude ranges from 35°001′ to 39°020' N and the longitude ranges from 90°006′ to 99°042' E. It borders Jiuquan County of Gansu Province in the north, Xinjiang Bayinguole Mongolian Autonomous Prefecture in the west, Yushu and Guoluo Tibetan Autonomous Prefecture in the south, and Haibei and Hainan Tibetan Autonomous Prefecture in the east.

87. The topography of the Haixi consists of mainly two types: Qaidam Basin and plateau in the north of Tanggula Mountain. Qaidam Basin is surrounded by the Kunlun Mountains in the south, Aerjin Mountain in the northwest and Qilian Mountains in the north. The average elevation of the Qaidam Basin is about 3,000 m above sea level (ASL). The north and east sides of Qaidam Basin is higher and the middle and northwest lower. The lowest location is located in Dabuxun and Huobuxun Lake District with an average elevation of 2,675 m ASL. There are mountains, hills, plain and lakes from the boundary of the Qaidam Basin to the middle. There are more than 100 rivers and more than 90 lakes in the basin, in which the Chaerhan salt lake is biggest.

88. The other type of the topography is the plateau in the north of Tanggula Mountain. The main peak of Tanggula Mountain Geladandong is the source of Yangtze River. The Tanggula Mountain pass is the important gate of the Tibet. So the strategic position of Haixi is very important.

89. **Meteorology and climate.** Haixi has a continental climate with distinct seasons. The solar energy resource is very rich, and the solar irradiation intensity is very strong. The annual average temperature is 5.2 °C. The annual average precipitation is 487.7 mm and the average annual evaporation is 3,526.1 mm, indicating that the climate of Haixi is dry.

Figure 4-1: Administrative Map of Haixi Prefecture

90. **Ecological resources.** The topography of the Qaidam Basin is flat, and the natural conditions (sunlight, water and land) are good for the agriculture and animal husbandry. There are 5.33 million mu land suitable for agriculture in the Qaidam Basin. The total area of cultivated land is 64.5 mu. The total grassland area in Haixi is 167 million mu, in which 106 million mu can be used for animal husbandry. There are 62 kinds of national protective wild animals, include wild yak, wild donkey, white-lipped deer, snow leopard, Tibetan antelope and black-necked crane etc., and 27 kinds of herb plants include ephedra, cynomorium songaricum, reed, wolfberry, rheum officinale, gentian etc.

91. There are 281 mines 57 mineral products in Haixi, including oil, natural gas, coal, raw salt, potassium, boron, lithium, magnesium, strontium, bromine, iodine, sodium sulfate, golden, silver, asbestos and limestone etc., in which the reserves of raw salt, potassium, magnesium, lithium, strontium, asbestos and sodium sulfate is the first in China.

92. **Hydrology.** The total volume of fresh water resource in Haixi is approximately 7.3 billion m^3, in which 6.9 billion m^3 is surface water and 4.4 billion m^3 is groundwater (including 4.1 billion m^3 changeable between the surface water and groundwater). The source of fresh water is mainly from rain and melting snow. The surface water is composed of rivers, lakes and snow. There are more than 160 rivers in Haixi, and the total area covered is about 500 km^2, in which 40 rivers have water year round. There are 16 rivers in Haixi with an average runoff of more than 100 million m^3 each and they are Nalinggele River, Buha River, Qaidam River, Shule River, Golmud River, Yuka River, Hulun River, Wutumeiren River, Dang River, Tuotuo River, Heleteng River, Bayin River, Muli River, Nuomuhong River, Tataling River and Chahanwusu River, and the total area covers over 300,000 km^2. In addition there are 21 freshwater lakes and 1,855 km^2 glacier in Haixi.

B. Delingha City

93. Delingha City is the capital of the Haixi and it is the political, educational, cultural and technological center in Haixi. It is also the center of the East Economic Development Zone in Haixi, which is a part of the national level Qaidam Circular Economic Zone. The total area of Delingha City is 27,700 km^2, the urban planning area is 71.28 km^2 and built-up area is 22 km^2. The total population of Delingha City is 73,331 at the end of 2010; the agricultural population is 30,040 and non-agricultural population is 43,291. There are 18 ethnic minority groups in Delingha. The major ethnic groups are Han, Mongol, Tibetan, Tu, Hui, and Shala. The ethnic minority population accounted for about 27% of the total population in 2010.

94. The GDP of the Delingha City reached CNY 3.2 billion in 2011. The ratios of the first, second, and tertiary sectors are 5.42%, 52.24% and 42.34%, respectively. This indicates that industrial production is the main contributor to the local economy and that the tertiary sector is also important for the local economy. The GDP per capita is CNY44,757 in 2011. The average income per capita of rural population was CNY6,192 in 2011, an increase of 18% over the previous year. The average income per capita for urban population was CNY17,210, an increase of 11.06% over the previous year.

95. **Infrastructure.** Delingha City is located in the middle of the Qinghai Province. The Qinghai-Tibet railway and the national highway #315 pass through the city. Delingha-Dulan highway is connected with the national road #109, which is transportation junction for Tibet, Gansu Province, Xinjiang and Xining. The Lanzhou-Xining-Lasa fiber optical cable and 110 kV electric transmission line go through the administration area of Delingha. And the Sening-Lanzhou natural gas pipeline also passes through Delingha.

96. **Geography and topography**. Delingha City is located in the northeast part of the Qaidam Basin. Its latitude ranges from 36°65′N to 39°10′N and its longitude from 95°40′E to 98°10'E with an elevation ranging from 2,790 m to 5,808 m ASL. It is adjacent to Tianjjin

County and Ulan County in the east, Dulan County in the south, adjacent to Da Qaidam Administrative Region in the west and Subei Mongolian Autonomous County in Gansu Province in the north (see **Figure 4-2**). It is 514 km east to the Xining City, the capital city of Qinghai Province, and 384 km west to Ge'ermu City.

Figure 4-2: Administrative Map of Delingha

97. There is over 330,000 mu land suitable for agriculture in the administrative area of Delingha city. Farmers own 300,000 mu and the cultivated land area per agriculture population is 2.6 mu. Main crops include wheat, highland barley, pea, potato and cole. In addition, there are 14.72 million mu (9,862 km^2) meadow can be used for the animal husbandry, including 207 km^2 irrigated land.

98. The project site is located 7 km west to Delingha City, north of the Qinghai-Xinjiang highway, south of Zongwulong Mountain, and west of Ziyuan Road. The terrain in the project site is generally flat with a slop around 3% from the north to south with the natural elevation of 3,0093-3,076 m ASL.

Figure 4-3: Photos of the Project Site

Source:TA consultants

99. The project site is located in an area of basic seismic intensity of level 7 classification. The geological formation structure is relatively simple and stable without other adverse geological phenomenon. The terrain of the construction site is open and relatively flat. It is suitable for industrial facilities.

100. The maximum seasonal frozen soil is 1.4-1.5 m below the ground. It is initially determined that the soil and water environment are not corrosive to the concrete and steel, but necessary protective measures should still be taken for main buildings and other infrastructure.

101. **Meteorology and climate.** Delingha City is located in the northeast of Qaidam Basin in the interior of Qinghai-Tibet Plateau. The warm and wet air from the southwest is difficult to enter in Qaidam Basin due to barrier by Himalayas Mountain, Tanggula Mountain, Kunlun Mountain and other mountains. Here is cold and dry area with continental climate. The local climate can be characterized as high altitude, thin air, clear sky, less water steam content, good atmospheric transparency, long sunshine duration, strong solar irradiance, low temperature, great difference in temperature between day and night and short frost-free period. This area is dry and windy in spring with frequent cold fronts. Much of the rain occurs in summer from May to August with potential flash flood in some areas. Winter is cold with very little precipitation. The data provided by Delingha Municipal Weather Bureau show characteristic values of local meteorological parameters as in **Table 4-1.**

Table 4-1: Main Meteorological Parameters of Delingha City

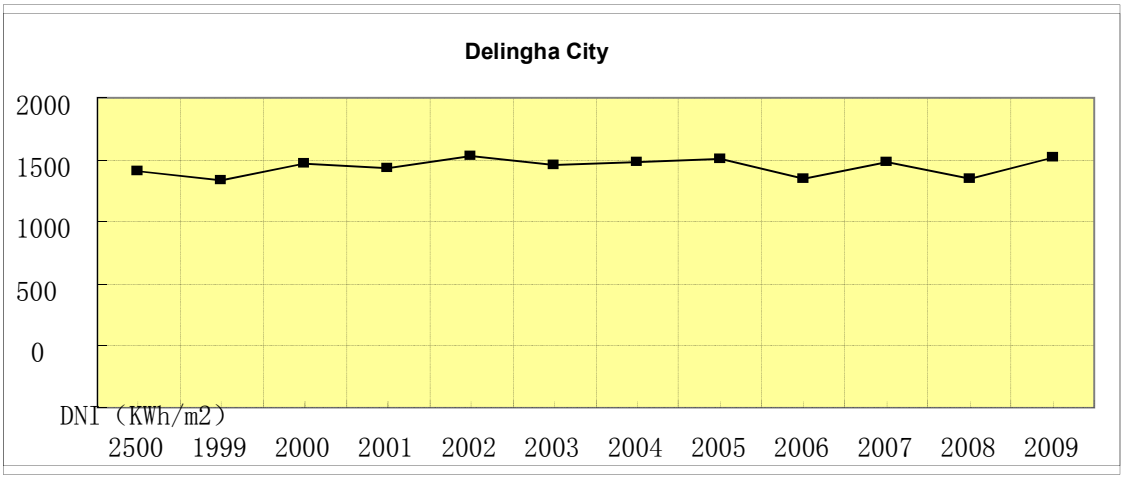
Weather elements	Unit	Value	Note
Average temperature	℃	4.0	
Extremely high temperature	℃	34.7	23 June 2000
Extremely low temperature	℃	-27.9	27 December 1997

Weather elements	Unit	Value	Note
Annual temperature difference	°C	27.3	
Average temperature in the hottest month	°C	16.4	July
Average temperature in the coldest month	°C	-10.9	January
Average pressure	kPa	70.88	
Average relative humidity	%	38	
Annually average precipitation	Mm/a	182.3	
Maximum precipitation in a single day	mm	84.0	30 July 1974
Average wind speed	m/s	2.2	
Average evaporation amount	mm/a	2,092.5	
Average days of snowfall	d/a	29.1	
Maximum snow accumulation	cm	18	1994
Maximum frozen earth depth	cm	196	7 February 1974
Average thunder days	d/a	19.5	
Average strong windy days	d/a	24.1	
Average sand storm days	d/a	6.1	
Average fog days	d/a	0	
Dominant wind direction in the entire year		ENE	

C = degrees celsius, cm = centimeter, d/a =days per annum , ENE = East North East , KPa = kilopascals , mm = millimeter, mm/a = millimeter per annum , m/s = meter per second.
Source: FSR report.

102. Solar irradiation resource is the most important factor for the concentrating solar thermal power generation. The solar irradiance data in Delingha from 1999 to 2010 were evaluated. The annual direct solar irradiance curve in the region for the last 12 years is shown in **Figure 4-4.** It can be seen from the figure that the direct solar irradiance in the region is relative constant, in the range of 1,800 KWh/m^2 to 2,100 KWh/m^2.

Figure 4-4: Direct Solar Irradiation in Delingha (1999–2010)



Source: Delingha Meteorological Station (quoted in the FSR).

103. **Hydrological conditions.** There are seven rivers in Delingha City's administrative area, namely Bayin River, Bayinguole River, Suolebuguole River, Aeranggeer River, Ariguole River, Tekuanguole River, Ulanhadeguole River and Sulingguole River. The main source of the surface water is from the mountain in the north. The annual average flow is 923 million m^3, in which 465 million m^3 can be used for Delingha. The total annual water consumption in Delingha is 240 million m^3, including 230 million m^3 for the irrigation and 2 million m^3 for the industry.[4]

104. Located in the northeast of Qaidam Basin in Qinghai Province, Bayin River is the largest river flowing through Delingha City and the forth largest inland river in Qaidam Basin. Bayin River is originated from Quexunli Anbujile (Buffalo Ridge Mountain), a branch of Qilian Mountains, which is 5,000 m ASL. Its upstream section runs from east to west through Xuji Canyon and Zeling Valley to Black Rock Hill Reservoir; its middle course runs from north to south through the downtown of Delingha City; its downstream section runs from east to west through Guolimu and Gobi Village and ultimately to Keluke Lake in Tuosuo Lake Area which is about 50 km southwest from Delingha City. Bayin River is 326 km in total length from its starting point to Tuosuo Lake. The annual mean flow rate is 10.2 m^3/s and its annual runoff is 320 million m^3. Including its two branches - White Water River and Balegeng River, Bayin River has a catchment area of 10,800 km^2. The length of the river from dam site of Black Rock Mountain Reservoir to Tuosuo Lake is 229 km with a catchment area is 7,354 km^2. The total elevation drop of the river is 1,761 m.

105. The groundwater of plant site is mostly Quaternary loose stratum groundwater. Generally, buried depth of groundwater is shallow, about 5 m. The groundwater is mainly from Zongwulong Mountain in the north. Rainfall has small impact on runoff direction which is basically from north to south. Some of the groundwater is connected to salt lakes in the south and Bayinguole River. The chemical characteristics of groundwater are mainly affected by geology, topography, runoff and drainage conditions. The groundwater in the plant site flows poorly with much resistance with high salinity and salt content.

[4] Delingha Water Affairs Bureau website http://www.qh.xinhuanet.com/dlh

Figure 4-5: Bayin River Running Through Delingha City

Source:TA consultants

106. There is a freshwater lake (Keluke Lake) and a salt water lake (Tuosu Lake) located over 30 km in the southwest of Delingha City (see Figure 4-6).

Figure 4-6: Keluke Lake and Tuosu Lake

Source:TA consultants

107. **Ecological resources.** The soil in the project site is dominated by sandy soil. Sand runs through the entire soil layer. Such soil has strong water permeability and poor soil fertility-holding capacity. It is easy to get dry. The soil is too poor to be cultivated. As the area has harsh climatic conditions and dry weather with little rainfall, soil desertification is very serious. Vegetation is sparse very few types and vegetation coverage is very low. Only drought-tolerant plant such as Alhagi maurorum can survive in this area.

108. The project site is located in an unused land without any residential area nearby. There is no mining activity near project site. The project area has no large beasts and other animals, while a few small wild animals exits occasionally. In addition, preliminary investigation results show that the project area does not belong to the main bird habitat and is not located in the main route for bird migration. Meanwhile, it is found no rare and endangered wildlife protected by the state here. There is no surface water source protection area, scenic sport, nature reserve and other environmentally sensitive objects in project area.

C. Environmental Baseline

109. Since the project is subjected a simplified EIA according regulations of the PRC, baseline monitoring is not required. Thus, the domestic EIA does not contain baseline monitoring data. In order to understand the current environmental conditions and establish baseline environmental quality, environmental monitoring was conducted by a third-party certified environmental monitoring organization during the PPTA and funded by ADB. The monitoring results and analyses are presented below.

110. **Air quality.** Four monitoring locations within the project area were selected for baseline air quality monitoring during 13-19 April 2013. The monitoring locations are shown in **Figure 4-7** and also summarized in **Table 4-2**. The monitoring data are shown in **Table 4-3** and **4-4**. According to the monitoring results, the monitored SO_2 and NO_2 are in compliance with the applicable standard—Class II Standard of the PRC's "Ambient Air Quality Standard"[5] (GB 3095-2012)[6] in all monitoring locations. But four out of seven days the measured TSP and PM_{10} are higher than the standards in all monitoring locations. The background TSP and PM10 concentrations on the project site are very high because the wind during spring time is strong, bringing sand dust.

Table 4-2: Baseline Air Monitoring Locations for the Project

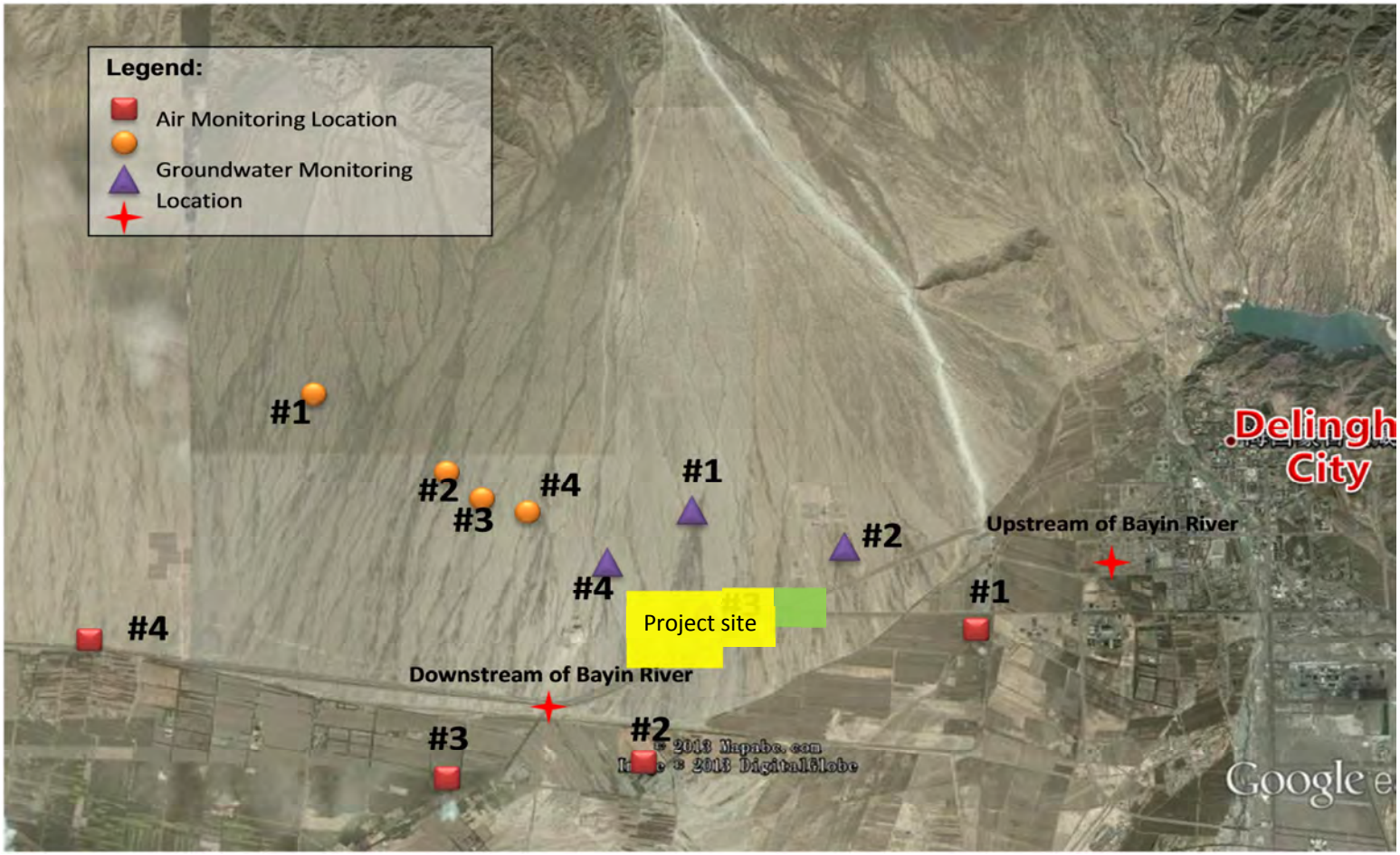
Sampling Code	Monitoring Location	Direction from the Project	Distance to the Project (m)
#1	Farm Division #5	SE	4.68
#2	Farm Division #4, Subdivision #2	S	4.16
#3	Farm Division #4	SW	6.09
#4	Balagan Village	SW	10.24

m = meter, S = south, SE = southeast, SW = southwest.
Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

[5] The Class II daily average concentration standards in GB 3095-2012 are: TSP: 0.3 mg/m^3, PM_{10}:0.15 mg/m^3, SO_2: 0.15 mg/m^3, NO_2: 0.08 mg/m^3.

[6] Class I standards only apply natural reserve area and other protected areas while the other areas are subject to Class II standards.

Figure 4-7: Locations of Monitoring and Baseline Sampling for Air Quality, Water Quality and Noise



Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

Table 4-3: Daily Average Concentrations of the Monitored Pollutants during Baseline Monitoring Period (13–19 April 2013)

Monitoring Parameter	Monitoring Location	Concentration (mg/m^3)	Value of Class II Standard (mg/m^3)	Assessment Result
PM_{10}	#1	0.123–0.205	0.15	4 out of 7 days exceed standard
	#2	0.121–0.201	0.15	4 out of 7 days exceed standard
	#3	0.125–0.204	0.15	4 out of 7 days exceed standard
	#4	0.119–0.202	0.15	4 out of 7 days exceed standard
TSP	#1	0.243–0.341	0.3	4 out of 7 days exceed standard
	#2	0.234–0.357	0.3	4 out of 7 days exceed standard
	#3	0.246–0.338	0.3	4 out of 7 days exceed standard
	#4	0.284–0.331	0.3	4 out of 7 days exceed standard
SO_2	#1	0.013–0.023	0.15	In compliance
	#2	0.011–0.021	0.15	In compliance
	#3	0.014–0.020	0.15	In compliance
	#4	0.012–0.023	0.15	In compliance
NO_2	#1	0.016–0.027	0.08	In compliance
	#2	0.017–0.032	0.08	In compliance
	#3	0.015–0.025	0.08	In compliance
	#4	0.017–0.030	0.08	In compliance

NO_2 = nitrogen dioxide, PM_{10} = particulate matter smaller than 10 micrometer, , TSP = total suspended particulate.
Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

Table 4-4: Hourly Average Concentrations of SO_2 and NO_2

Monitoring Parameter	Monitoring Location	Concentration (mg/m^3)	Value of Grade II Standard (mg/m^3)	Assessment Result
SO_2	#1	0.009-0.030	0.5	In compliance
	#2	0.009-0.028	0.5	In compliance
	#3	0.010-0.029	0.5	In compliance
	#4	0.007-0.028	0.5	In compliance
NO_2	#1	0.008-0.032	0.2	In compliance
	#2	0.009-0.035	0.28	In compliance
	#3	0.008-0.028	0.2	In compliance
	#4	0.008-0.041	0.2	In compliance

NO_2 = nitrogen dioxide, SO_2 = sulfur dioxide.
Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

111. **Ground water quality.** Four monitoring locations within the project area were selected for baseline groundwater quality monitoring during 19-20 April 2013. The monitoring locations from which the samples were taken are shown in **Figure 4-7**. The groundwater quality falls into the Grade III of National Ground Water Quality Standard" (GB/T14848-93)[7]. According to the monitoring results as shown in **Table 4-6**, all the monitored parameters meet the national standards, except the concentration of sulfate in one location exceeds the standard.

Table 4-5: Ground Water Quality Monitoring Location

Code	Monitoring Location	Direction from the Project	Distance to the Project (km)	Depth (m)
#1	Well in Shandong Linuo Solar Photovoltaic Power Plant	NW	6.65	100
#2	Well in Huanghe Medium-sized Solar Photovoltaic Power Plant	W	4.59	60
#3	Well in Beijing Reiqida Solar Photovoltaic Power Plant	W	4.19	120
#4	Well in Qinghai Huawei Solar Photovoltaic Power Plant	W	3.42	85

km = kilometer, m = meter, NW = northwest, W = west.
Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

Table 4-6: Monitoring Results of Groundwater Quality

Locations Monitoring Dates	Monitoring Result (mg/L)								GB/T14848-93 Category III
	#1		#2		#3		#4		
	4.19	4.20	4.19	4.20	4.19	4.20	4.19	4.20	
Parameter									
Temperature ℃	9.0	8.3	9.1	9.0	9.3	9.2	9.0	8.3	—
pH	8.11	8.27	8.76	8.78	8.28	8.35	8.11	8.27	6.5 ~ 8.5
Hardness	252	252	101	101	130	129	252	252	≤450
Nitrate Nitrogen	1.09	1.09	1.81	1.81	1.56	1.57	2.10	2.11	≤20
Sulfate	84.6	82.7	109	107	96.6	95.4	283	282	≤250
Fluoride	0.54	0.54	1.24	1.23	0.91	0.90	1.20	1.21	≤1.0
Iron (Fe)	BDL	BDL	0.14	0.13	0.11	0.12	0.56	0.57	≤0.2
Bacterium	BDL	BDL	BDL	BDL					≤100
Coliform	BDL	BDL	BDL	BDL					≤3

C = degrees Celsius, BDL = below detection limit.
Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

112. **Surface water quality.** Two monitoring locations of Bayin River were selected for baseline surface water quality monitoring during 19-20 April 2013. The surface water quality falls into the Grade III of National Surface Water Quality Standard" (GB3838-2002).[8] According to the monitoring results as shown in **Table 4-7**, the monitored parameters meet the national standards, except the concentrations of total phosphorus and total nitrogen in all monitoring locations.

[7] Grade III is for water primarily used for drinking water and for industrial and agriculture use.
[8] Grade III surface water standards apply to drinking water source.

Table 4-7: Monitoring Results of Surface Water Quality

Parameter	Monitoring Result (mg/L)				GB/T14848-93 Category III
	Upstream		Downstream		
	4.19	4.20	4.19	4.20	
Temperature ℃	13.5	13.4	13.8	13.4	—
pH	8.09	8.06	8.10	8.06	6 ~ 9
DO	7.6	7.7	7.4	7.7	>6
TP	1.09	1.09	BDL	BDL	≤0.1
TN	1.28	1.28	1.25	1.28	≤0.5
COD	0.44	0.52	BDL	BDL	≤15
BOD	0.9	0.8	1.0	0.8	≤3
Coliform	BDL	BDL			≤2000

pH = acidity or alkalinity, BDL = below detection limit BOD = biological oxygen demand, COD = chemical oxygen demand, DO = dissolved oxygen, mg/L = milligram per liter, TN = total nitrogen, TP = total phosphorus.
Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

113. **Acoustic environment.** The background noise levels were monitored at four monitoring locations in the project site during 16-17 April. The monitoring locations are shown in **Figure 4-7**, and the monitoring data shows that the baseline noise level meet the Grade III standard of GB3096-2008 for industrial area as shown in **Table 4-8** below.

Table 4-8: Baseline Noise Monitoring Data within the Project Area

No.	Monitoring Location	Date	Monitoring Result (dB(A))		Grade III standard of GB3096-2008 (dB(A))
#1	North of the Project site	16 April 2013	Day	37.0	65
			Night	31.3	55
		17 April 2013	Day	37.4	65
			Night	31.6	55
#2	East of the CSP	16 April 2013	Day	37.2	65
			Night	30.2	55
		17 April 2013	Day	37.5	65
			Night	31.0	55
#3	South of the CSP	16 April 2013	Day	36.8	65
			Night	29.7	55
		17 April 2013	Day	37.1	65
			Night	30.4	55
#4	West to the CSP	16 April 2013	Day	37.8	65
			Night	30.5	55
		17 April 2013	Day	37.9	65
			Night	31.2	55

dB = decibel.
Source: Delingha CSP Project Baseline Monitoring Report by Pony Center for Physical and Chemical Analysis.

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. Expected Positive Impact

114. **Environmental and climate change impact.** The electrical power generated by the proposed CSP will replace the power generated by the coal-fired power plants. The

designed annual power generation of the CSP plant is 197 GWh. It is estimated that 70,000 tons of standard coal will be saved each year after this project is put into operation.[9] This is corresponding to annual CO_2, reduction of 154,446 tons.

115. Without the CSP, the incremental power demand will have to be met by coal-fired power plants with heavy coal consumption and GHG emission. Thus the construction of the CSP will play a role of utilizing renewable natural resources, saving non-renewable fossil energy, reducing pollution and protecting the ecological environment. It is clear that the development of solar power will not only save the precious non-renewable resources, but also bring good benefits to the environment, thus it serves as an important means to realize the sustainable development of energy, economy and society.

B. Potential Impacts

116. The potential environmental impacts of the proposed CSP project were examined and screened during the IEE preparation. The relative significance of potential impacts from the project activities was identified. More detailed assessments were performed for major, critical, and specific impacts. Applicable and specific requirements by the PRC EIA regulations and ADB SPS; and experiences from existing CSP projects around the world were considered carefully in assessing the environmental impacts.

117. The results of the screening process showed that during the construction phase, the major negative environmental impacts are associated with potential soil erosion, construction noise and fugitive dust. During the operation phase, the major negative environmental impact is the potential risks from HTF leakage, waste water, some pollutant emissions from the nature gas combustion that is needed for HTF and molten salt heating, insulation, and start-up.

118. The impacts were grouped under three general categories: physical, biological and socio-economic. Impacts before construction and during construction and operation phases were considered separately. Potential impacts from the project were considered under the following categories: (i) direct impacts—directly due to the project; (ii) induced impacts—resulting from activities arising from the project, but not directly attributable to it; and (iii) cumulative impacts—which in combination would exert significant additional influences.

C. Potential Impacts before Construction

119. **Land acquisition and ethnic minority.** The project will acquire 246 hectares (3,690 mu) of semi-arid unused land from 153 persons of 31 households from the Mongolian ethnicity in Taositu village of Xuji township in Delingha city. The acquired land is within a jointly contracted grazing land of 136,827 mu of the affected village. The land use right was contracted to 31 households of the affected village in 1984 for 50 years (1984–2034).The land to be acquired accounts only for 0.73% of the total land (3,690 mu out of a total 507,556 mu) and only 2.7% of the jointly contracted land (3,690 mu out of 136,827 mu) of the 31 affected households. There is no shelter or structure in the land acquisition area. Therefore, there will be no loss of crops, trees, and fixed assets. Overall, there will be no economic or physical displacement resulting from land acquisition, as the amount of land lost has no impact on their current grassland areas for herding.

120. **Loss of cultural heritage and protected species.** No cultural heritage or archaeological sites are recorded on the project's land that will temporarily or permanently be lost because the project is located on barren land. No rare and endangered species will

[9] On average, the standard coal consumption per unit electricity from coal-fired power plants across China was 355 g/kWh.

be directly impacted by the project according to the domestic EIA report. The water supply pipeline from the municipal water supply plant has been laid to the boundary of the project site while the natural gas pipe has been constructed to about 500m away to the site. However, construction activities may have the potential disturbance of unknown underground cultural relics, although none have been identified in the project site. In such case, special attention will be paid and strict procedures will be established so that underground cultural sites can be protected if they are discovered during construction. The mitigation measures will be (i) immediate suspension of construction activities if any archaeological or other cultural relics are encountered, (ii) promptly notify local relic management authorities, and (iii) the construction activities will resume only after thorough investigation and with the permission of the appropriate authorities.

121. **Electromagnetic field.** The 8.5 km of 110 kV transmission line will generate electromagnetic field. They must be carefully evaluated during the design and comply with conditions specified in EIA approval.

122. **Mitigation measures during detailed engineering design.** Mitigation measures during detailed engineering designs to minimize the direct and induced impacts are as follows:

(i) **Monitoring of land acquisition process.** The combined land acquisition and ethnic minority development plan[10] was prepared in accordance with relevant law in the PRC and ADB's Safeguard Policy Statement (2009), and posted on ADB's website in December 2012. Each household will be compensated with CNY167,552 by giving up the semi-arid unused land which is equivalent to three times of the annual average net household income (CNY54,837 in 2011). Since there will be no economic or physical displacement resulting from land acquisition, the compensation will be a significant benefit for the affected households. In addition to compensation, the affected people are entitled to receive (i) employment opportunities during construction and operation of the project, (ii) portable solar photovoltaic power generation sets, (iii) high insulation yurt (nomad tent), and (iv) trainings on employment skills and grassland management. Semiannual reports will be required during implementation which the first report will be due after land transfer. Thereafter, two annual monitoring reports will be prepared to evaluate the impacts of the project on the livelihoods and lifestyles of the affected village and ensure there are no remaining issues. If issues should arise, remedial measures should be prepared and agreed with ADB and implemented prior to project completion.

(ii) **Design and bidding documents.** Environmental mitigation measures indicated in this IEE, the EMP and the domestic EIA will form part of the design document and bidding documents, and will be included in contracts for civil constructions and equipment installations. All contractors will be required to strictly comply with the EMP.

(iii) **Environmental management training.** Environmental specialists including environmental consultants and/or experts/officials from local EPB will be invited to provide training in implementation and supervision of environmental mitigation measures, and environmentally friendly construction methods to contractors and construction supervision companies (CSCs).

(iv) **Environmental monitoring.** The environmental monitoring program will be incorporated into the design to ensure that environmental impacts are closely monitored and activities of the project construction and operating are closely

[10] China Guangdong Nuclear Solar Energy Development Co. Ltd. December 2012. *Land Acquisition and Ethnic Minority Development Plan* for Qinghai Delingha Concentrated Solar Thermal Plant Project. Delingha.

supervised against the PRC environmental laws, regulations and standards, ADB's SPS, as well as the EMP, and approved domestic EIA.

(v) **Electromagnetic protection.** Anticorona, noise-reduction and electromagnetic protection measures must be taken during the detailed design to make sure that (a) 0.5 megahertz radio interference is less than 46 decibel (microvolt/meter) within the 20-meter boundary from the substation and transmission lines, (b) the power frequency electric field will be less than 4 kilovolt/meter in good weather, and (c) the power frequency magnetic field will be less than 0.1 milliteslas outside the boundary and on the ground under transmission line.

(vi) **Fire hazards.** A fire hazards protection system will be incorporated in the design of the project.

D. Impacts and Mitigation Measures during Construction

1. Environmental Management at Construction Sites

123. To ensure that contractor is able to implement the mitigation measures within the construction site during constructions, the IA will put in place the following arrangements (i) environmental mitigation measures and management requirements will be included in all contracts with contractors and CSCs; and (ii) approved spoil disposal sites, material haulage routes, borrow pit locations and waste disposal arrangements will be defined in the contracts as appropriate. Following the award of contracts of construction and construction supervision, the contractor and the CSC will prepare a Construction Site Environmental Management Plan and an Environmental Supervision Plan respectively, including an emergency preparedness and response plan for construction emergencies and a site environmental health and safety plan, for approval by the local EPB and the IA.

124. During construction, the assigned environmental management officer of the IA and an environmental supervision engineer from CSC under the guidance of the local EPB and environmental consultants, are responsible for enhancing site supervision, and management, so as to identify problems and solve the problems in a timely manner. Environmental training, especially related to environmental management of mitigation measures included in the EMP should be conducted. The contractor will take reasonable measures to minimize the impact of construction activities on the environment.

2. Impacts on Topography and Soil

125. **Impact on geology.** Potential impacts on geology and topography are most likely to occur in the project as a result of (i) land leveling, (ii) excavation and filling activities for foundations of the structures in the CSP, and (iii) spoil disposal and earth borrowing, which will cause topographical changes and visual problems unless properly controlled.

126. **Impacts on soil.** The project could affect the soil in the construction area through erosion and contamination. Soil erosion will occur during construction when surface soil and vegetation are disturbed. The primary areas of potentially increased soil erosion include foundation construction of troughs and storage tanks and other structures in the CSP plant. Soil contamination may result from the inappropriate transfer, storage, and disposal of petroleum products, chemicals, hazardous materials, liquids, and solid waste during construction.

127. **Soil erosion and contamination.** Moderate soil erosion levels are expected during construction when surface desert vegetation and soil are damaged or disturbed. Soil erosion can also occur after completion of construction in areas if site restoration is inadequate. The most vulnerable soil erosion areas in the construction site include excavation sites, leveling

sites, spoil sites, temporary construction sites, and other areas where surface soil is disturbed.

128. The construction activities may generate surplus spoil even after maximizing reuse of spoil on-site. The construction itself can utilize most of excavated and leveled-out earth and spoil generated during construction, and the rest spoil and construction wastes will be transported to a designated spoil landfill site for final disposal. The temporary spoil disposal sites must be identified, designed, and operated to minimize impacts. Temporary spoil disposal sites will be identified during detailed designs for the project and defined in the construction contractors' tender documents. The temporary spoil disposal site will be restored at the conclusion of disposal activity. The final height and shape of each temporary disposal area will be determined by geological survey during the detailed design and will be based upon the resting stability of local spoil material and the surrounding topography.

129. Major mitigation measures for control of soil erosion, soil contamination, and other geologic hazards due to construction activities are as follows:

(i) Minimize active open excavation areas during trenching activities and use appropriate compaction techniques for the construction;
(ii) The contractor should, prior to the commencement of earthworks, determine the average depth of topsoil. The full depth of topsoil should be stripped from areas affected by construction and related activities prior to the commencement of major earthworks including the building footprints, working areas and storage areas. Topsoil will be reused where possible to rehabilitate disturbed areas.
(iii) Care will be taken not to mix topsoil and subsoil during stripping.
(iv) Removed topsoil should be transported to a designated landfill site or used onsite for landscaping as required.
(v) Ensure that the minimum area of soil is exposed to potential erosion at any one time.
(vi) Limit construction and material handling activities during periods of rains and high winds.
(vii) Assess and estimate storm water runoff and prepare a storm water drainage system accordingly to minimize soil erosion.
(viii) Build a temporary detention pond to control topsoil runoff.
(ix) Stabilize all earthwork disturbance areas within 14 days after earthwork.
(x) Plant native trees and grass in the CSP plant to control soil erosion and properly slop or re-vegetate disturbed surfaces.
(xi) Properly store petroleum products, chemicals and hazardous materials on impermeable surface.
(xii) Use best management practices to prevent spill of oil and chemical to avoid pollution.
(xiii) Any planned paving or vegetating of the area will be done as soon as the materials are removed to protect and stabilize the soil.
(xiv) Appropriately set up temporary construction camps and storage areas to minimize land area required and impact on soil erosion;
(xv) Build concrete dikes with sealed surfaces underneath storage tanks containing HTF and hazardous materials. The dike walls must be high enough to contain 110% of the total volume of the storage tanks.
(xvi) Contaminated soil by HTF and/or other hazardous chemicals must be contained and disposed off-site by a third party with proper certification.
(xvii) Remove all construction wastes from the site and transport them to a designated spoil landfill site in Delingha for final disposal.
(xviii) Provide spill cleanup measures and equipment at the construction site.
(xix) Contractors will be required to develop contingency plans for control of oil and other dangerous substances to prevent soil contamination.

3. Impacts on Hydrology and Water Quality

130. **Surface and ground water contamination.** There are no surface water bodies around the construction site. The nearest surface water is Bayin River, which is about 5 km away from the project site. However, inappropriate transportation of petroleum products and hazardous materials, or accidental spills, disposal of domestic wastewater from construction camps, and wash-down water from construction equipment and vehicles may contaminate surface water or groundwater resources. Contractors will be required to store all toxic, hazardous or harmful construction materials including petroleum products in a place with impermeable surfaces and to manage them in such a way to prevent spillage or leakage during storage and transportation.

131. **Construction wastewater.** Wastewater produced during construction may come from washing aggregates, pouring and curing concrete, and oil-containing wastewater from machinery repairs. The peak work force is estimated at 80 workers. The daily wastewater discharge from labor camps will be 64 t/d during peak construction period according to the EIA.

132. **Mitigation measures for waste water.** To avoid surface and groundwater pollution, the following mitigation measures will be taken:

(i) Areas where construction equipment is being washed will be equipped with water collection basins and sediment traps.
(ii) Wastewater from construction activities will be collected in sedimentation tanks, retention ponds, and filter tanks to remove silts and oil.
(iii) Make sure the storm water channels or natural water path ways are not blocked.
(iv) The construction wastewater, after sedimentation, will be used as the spraying water for fugitive dust control on the construction site.
(v) Adequate sanitary facilities and ablutions must be provided for construction workers.
(vi) The domestic sewer from workers camp, after septic treatment, will be utilized for watering vegetation, both planted and natural.

4. Noise

133. **Noise Intensity.** A significant increase in noise is expected during construction, due to various construction and transport activities. Construction activities will involve excavators, bulldozers, concrete-mixing plants, loader, land scraper, rollers, and other heavy machinery. Noise during pipeline construction will be generated by trench excavators, rollers and other compaction machine. Though noise levels may be severe, the noise will be temporary and localized. The major construction machinery noise testing values are shown in **Table 5-1.**

Table 5-1: Values of Construction Machinery Noise

No.	Machine Type	Average sound level at 5m distance from machine dB (A)
1	Excavator	84
2	Bulldozer	86
3	Concrete mixer	87
4	Loader	90
5	Road roller	86
6	Land scraper	90

dB (A) = decibel.
Source: Specifications for EIA of Highway (JTJ005-96).

134. **Methodology for prediction of noise values during construction.** Construction equipment noise source is considered as a point sound source, and the predictive mode is as follows:

$$L_i = L_0 - 20 \lg \frac{R_i}{R_0} - \Delta L$$

Where, L_i and L_0 are equipment noise sound levels at R_i and R_0, respectively, ΔL is additional decrement produced by barriers, vegetation and air.

135. As for the impact of multiple construction machineries on a certain location, sound level superposition is needed using the following formula:

$$L = 10 \lg \Sigma 10^{0.1 \times L_i}$$

136. **Prediction results.** Noise levels at different distances are gained after calculating the impact scope of equipment noise during construction as defined in **Table 5-2**. The PRC "Standard of Noise Limits for Construction Sites" (GB12523—90) specifies the noise limit Class II area as 70 dB (A) during daytime and 55 dB (A) during nighttime. The standard compliance noise impact scope (m) of different machineries is listed in **Table 5-3**.

Table 5-2: Noise Values of Construction Machineries dB (A)

Machinery Name	Distance to Machinery									
	5 m	10 m	20 m	40 m	50 m	60 m	80 m	100 m	150 m	300 m
Excavator	84	78	72	66	64	62	60	58	54	48
Bulldozer	86	80	74	68	66	64	62	60	56	50
Land scraper	90	84	78	72	70	68	66	64	60	54
Loader	90	84	78	72	70	68	66	64	60	54
Roller	86	80	74	68	66	64	62	60	56	50
Concrete-mixer	87	81	75	69	67	65	63	61	57	51

dB (A) = decibel, m = meter.

Source: TA consultant.

Table 5-3: Standard Noise Limits and Impact Scopes for Construction Equipment

Construction Stage	Construction Machinery	Standard (dB)[11]		Standard Impact Distance (m)	
		Daytime	Nighttime	Daytime	Nighttime
Earth and Stone Work	Excavator	75	55	15	150
	Bulldozer	75	55	18	180
	Land scraper	75	55	29	290
	Scraper loader	75	55	29	290
Structure	Road roller	70	55	32	180
	Truck	70	55	67	266
	Vibrator	70	55	53	224
	Dump truck	70	55	20	112
	Concrete Mixer	70	55	29	200
	Asphalt concrete paver	70	55	29	160

dB (A) = decibel.

[11] Standard of Noise limits for Construction Sites (GB 12523-90).

Source: The PRC Standard of Noise Limits for Construction Sites (GB12523-2011).

137. The noise impact distances to be kept during construction for compliance with the PRC Standard of Noise Limits for Construction Sites (GB12523-2011) are ranging from 15 to 126 m during the day and 112 to 300 m at night. As the nearest residence area is about 3.35 km away from the project site and the environmental sensitive receivers like schools and hospitals are far away from the construction site, noise impacts will be mainly on the construction workers who operate the equipment.

138. **Mitigation measures for noise impact.** A systematic approach towards mitigation of construction noise will be followed to reduce noise levels to acceptable levels. The noise control strategy includes two major methods of source control and path control. Source control is the first choice because it is, in general, the most effective form of noise control by eliminating a noise source. Source control, which limits noise generation or restricts allowable types or operating times of heavy equipment, is also the easiest to monitor.

139. These mitigation measures are essential for the construction activities to meet the domestic construction site noise standards and to protect the workers and people at sensitive receptors:

(i) Ensure that noise levels from equipment and machinery conform to the PRC standard GB12523-90, and properly maintain construction vehicles and machineries to minimize noise.
(ii) Locate sites for rock crushing, concrete-mixing, and similar activities at least 1 km away from sensitive areas.
(iii) Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum.
(iv) Place temporary signs or noise barriers around noise sources during construction, if necessary.
(v) Provide noise personnel protective equipment (PPE) to workers.
(vi) Vehicles transporting construction materials or wastes will slow down and stop honking when passing through or nearby environmentally sensitive locations, such as residential communities, schools and hospitals.
(vii) Construction activities, and particularly the noisy ones, are to be contained to reasonable hours during the day and early evening.

5. Vibration impact and mitigation measures

140. Significant vibrations are expected during construction for the foundations of power generation unit, trough and storage tanks, cable trench compaction, and others. On the construction site, different degrees of mechanical vibration will occur during the project construction procedures. Such vibration is sudden, impassive, and discontinuous, and is likely to create annoyance to anyone nearby. Main construction machineries include vibrating road rollers, land scrapers, loaders, stone crashers and spreading machines, among which the impacts of bridge pile drivers and vibrating road rollers are the highest. Mitigation measures specified in the EMP include prohibition of pilling and compaction operations at night, which will effectively reduce the vibration impact to acceptable levels.

6. Air Quality

141. **Pollution sources.** Anticipated sources of air pollution from construction activities include (i) dust generated from earth excavation, filling, loading, hauling and unloading; (ii) dust generated from disturbed and uncovered construction areas, especially in windy days; (iii) dust generated by the movement of vehicles and heavy machinery on unpaved access and haul roads; (iv) dust from aggregate preparation and concrete-mixing; and (v) emission from construction vehicles (gaseous CO, HC and NO_2) and heavy diesel machineries and

equipment.

142. **Mitigation measures** to reduce air quality impact during construction period are as follows:

(i) Spray water on construction sites and earth/material handling routes where fugitive dust is being generated.
(ii) Keep transport vehicles at low speed in the construction site to reduce the fugitive dust.
(iii) Stop the construction activities during strong windy days.
(iv) Cover materials during truck transportation of fine materials to avoid spillage or fugitive dust generation.
(v) Excavations and other clearing activities must only be done during agreed working times and permitting weather conditions to avoid drifting of sand and dust into neighboring areas.
(vi) Store petroleum or other harmful materials in appropriate places and cover to minimize fugitive dust and emission.
(vii) Provide regular maintenance to vehicles in order to limit gaseous emissions (to be done off-site).
(viii) Ensure vehicle emissions are in compliance with PRC standards GB18352-2005, GB17691-2005, GB11340-2005, GB2847-2005, and GB18285-2005.
(ix) Maintain vehicles and construction machineries to a high standard to ensure efficient operating and fuel-burning and compliance with the PRC emission standards.

7. Solid waste

143. **Solid waste and mitigation measures.** Construction wastes could have adverse impacts on the surrounding environment if not properly managed. Construction wastes that cannot be recycled and reused will be collected on site and not be discarded in a way that will damage immediate environment. It's estimated that an average of 0.5 kg/day per worker of garbage will be generated from the construction camps. Inappropriate waste storage and disposal could affect soil, groundwater, and surface water resources, and hence, public health and sanitation. **Mitigation measures** are as follows:

(i) Establish temporary storage for solid wastes away from water bodies or other environmental sensitive areas, and regularly haul solid waste to an approved and designed landfill in Delingha;
(ii) All rubble must either be used on site as part of the existing development, or must be taken off the reserve and disposed off at the landfill facility in Delingha.
(iii) Rubble must not be dumped on site but must be placed within a bin for regular removal.
(iv) Provide appropriate waste storage containers at construction sites.
(v) Recycle the construction waste and excavating waste as much as possible and the rest construction waste will be transported to an approved landfill.
(vi) Hire a qualify contractor to remove all non-hazardous wastes from site to approved waste disposal site, according to appropriate domestic procedures.
(vii) Hold contractors responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that remain on the site after construction.
(viii) Strictly prohibit any waste incineration at or near construction site

8. Other hazardous and polluting materials

144. **Other hazardous and polluting materials.** A construction material handling and disposal protocol that includes spill emergency response will be prepared and implemented

by contractors. As for hazardous materials, a licensed company will be hired to handle, transport, and dispose of these materials. The following **mitigation measures** will be taken to prevent soil, and surface and groundwater contamination from harmful materials:

(i) Prepare and implement a protocol for the handling and disposal of hazardous materials during construction including a spill prevention and emergency plan.
(ii) Build storage facilities for fuels, oil, chemicals and other hazardous materials will be within secured areas on impermeable surfaces, and provided with dikes.
(iii) Vehicles and equipment will be properly staged in designated areas to prevent contamination of soil and surface water from chemicals and other hazardous materials.
(iv) Vehicle, machinery and equipment maintenance and refueling will be properly carried out so that spilled materials do not seep into the soil.
(v) Oil traps will be provided for service areas and parking areas; and fuel storage and refilling areas will be located at least 300 m from drainage structures and important water bodies.
(vi) Suppliers of chemicals and hazardous materials must hold proper licenses. They shall follow proper protocol for transferring fuel and the Operation Procedures for Transportation, Loading and Unloading of Dangerous or Harmful Goods of JT 3145-91.

9. Impacts to Biological Resources

145. **Potential impacts on flora and fauna.** Since construction activities will be on the wasteland, there are no rare, threatened, or endangered species within the construction boundaries. The potential impacts of the project on flora and fauna include the removal of vegetation and disruption of the ecosystem during construction. In particular, the construction activities will alter the original landscape and vegetation of limited area.

146. **Mitigation measures** will include the following activities:

(i) Preserve existing vegetation where no construction activity is planned, or temporarily preserve vegetation where activity is planned for a later date.
(ii) The construction activities will be implemented within the land acquisition scope, minimize the damage to the nearby land.
(iii) Properly backfill, compact, and re-vegetate piping/cable trenches after construction.
(iv) Remove shrubs only as a last resort if they impinge directly on permanent structures.
(v) All natural areas impacted during construction must be rehabilitated with locally indigenous grasses.
(vi) Construction activities must be planned carefully so as not to interfere with the calving and lambing season for most animal species.
(vii) Enhance awareness on protection of and prohibition to hunt wild animals, construction workers are forbidden to hunt wild animals in the construction and surrounding areas, in accordance with PRC's Law on Wildlife Protection.
(viii) Identify, demarcate and protect sites where small animals, reptiles, and birds of common species live.
(ix) Vegetate the CSP plant wherever possible.

10. Impacts on Socioeconomic Resources

147. **Workers living conditions and other social issue.** A mix of local workforce and workers from other regions will be hired during the construction phase. Temporary workers' quarters will be built and be properly managed to maintain safe and clean living environment for workers. Considering estimated numbers of workers to be hired from outside the region,

no serious social conflict would occur between these workers and locals.

148. **Community disturbance and safety.** Since the project is located about 7 kilometers (km) away from urban Delingha city and the nearest human settlement is 3.5km away from the project site, it is not expected to have any impact on community disturbance and safety such as traffic congestion, public safety from construction activities and heavy vehicles and machinery traffic and unexpected interruptions in other municipal services and utilities because of damage to pipelines for water supply, drainage, heating supply, and gas, as well as to underground power cables and communication cables (including optical fiber cables). However, the contractors will be required to implement safety measures around the construction sites to protect the public, including warning signs to alert the public to potential safety hazards, and barriers to prevent public access to construction sites. Heavy machinery will not be used at night.

149. **Risks to occupational health and safety.** Intensive use of heavy construction machinery, tools, and materials may cause physical hazards to workers, which could be caused by noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, chemical hazards such as toxic fumes and vapors, and others.

150. **Mitigation measures.** Contractors will implement adequate precautions to protect the health and safety of their workers. The occupational health and safety risks will be managed by applying measures in the following order of preference: avoiding, controlling, minimizing hazards, and providing adequate protective equipment. The contractors will undertake the following activities:

(i) **Environmental, health and safety officer.** An environmental, health and safety officer will be appointed by each contractor to implement and supervise the environmental, health, and safety management plan.

(ii) **Environmental, health and safety management plan.** Each contractor will prepare such a plan for the construction works on the basis of the EMP.

E. Impacts and Mitigation Measures during Operation

151. The project may cause some adverse environmental impacts during operation. The potential impacts include air pollution from natural gas combustion, noise from the pumps and blowers, waste water pollution, solid waste pollution, soil contamination from HTF leak, fire hazards, and others.

1. Air Pollutant Emissions

152. As the CSP uses steam turbine to generate electricity, no emissions are associated with the steam turbine. Emissions of air pollutants in the project are associated with the use of natural gas heater for start-up, HTF temperature control and freezing protection during bad weather. Natural gas combustion will produce emissions of some pollutants such as CO_2 and NO_2. Since natural gas only contains trace amount of sulfur, SO_2 emission is negligible.

153. The fugitive dust will be generated by strong wind and affect local air quality. The mitigation measures are following:

(i) Use recycled water to the plant area to suppress dust emission;

(ii) Use mirror washing water to suppress duct from solar collection field.

2. Water Pollution

154. **Wastewater from the CSP during operation**. There will be wastewater generated

from the CSP plant, including domestic wastewater, site drainage, wash water for the mirrors, and wastewater from water purifying system. Inappropriate management of wastewater has the potential to negatively impact local surface and groundwater quality.

155. **Wash water for mirror cleaning.** The mirrors of parabolic troughs needs regular cleaning depending on the level of dust accumulation, which is essential to maintain high efficiency of the CSP system. According to the FSR, the washing frequency of mirrors is expected to be about six times per year, and 8 tons of water will be used each time. The wastewater will be collected, and reused for the greening or dust suppression within the plant site after sedimentation.

156. **Wastewater from water purifying system.** The wastewater quality from the purifying system includes inorganic salt. The concentrations are shown in **Table 5-4**.

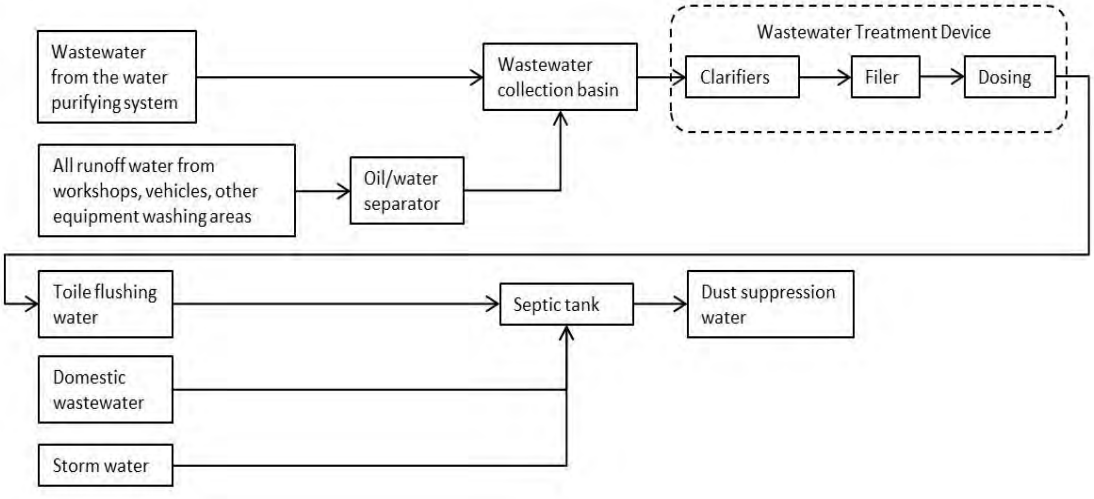
Table 5-4: Water Quality of the wastewater from the Purifying System

Substance	Concentration (mg/L)	Level B Standard (CJ343-2010) (mg/L)
Dissolved solid	1384	2000
Chloride	206	600
Sulfate	111.2	600

mg/L = milligram per liter.
Source: EIA report.

157. A wastewater treatment system will be constructed designed at the project site. The sewage discharge flow is shown in the **Figure 5-1**. The producing wastewater would be treated by the WWT devices, and the treated water will be used as toilet flushing to decrease the amount of domestic water usage. The domestic sewage water is treated by Biocontact Oxidation Process in septic tank, and the output water is used for dust suppression.

Figure 5-1: Sewage discharge flow



Source:TA consultants

158. **Other mitigation measures.** To mitigate potential impacts, the following measures will be taken:

(i) Wastewater from the water purifying system will be sent to the onsite wastewater treatment plant (WWTP).

(ii) Wastewater collected from other parts of the CSP plant will also be sent to the onsite WWTP.
(iii) Treated water from WWTP will be used for watering plants and dust suppression onsite.
(iv) All runoff water from workshops, vehicles washing areas and other equipment must will be collected and send to the onsite WWTP for treatment.
(v) Ensure that solid waste collection and sanitation is managed effectively in order to avoid any chances of ground and surface water pollution;
(vi) Oil contaminated water will be directed to the WWTP, which is equipped with an oil/water separator
(vii) All vehicle loading/unloading points will be within a bounded area to minimize the potential for spills to enter the storm water;
(viii) Any run-off that is discharged from the site must be uncontaminated and meet standards for discharge.

3. Noise

159. The noise impact during operation is mainly from the equipment of the CSP plant, such as steam generator system, power generation equipment, additional heating, transformer, pumps, and cooling equipment. As for the mitigation measures, the latest technology incorporating maximum noise mitigating measures for the CSP plant components will be used All plant and equipment, including vehicles will be properly maintained in order to minimize noise. Also, personal noise protective equipment will be provided to the workers who are likely to be exposed to high noise level environment.

4. HTF

160. According the FSR for the project, the HTF (73.5% diphenyl ether and 26.5% biphenyl) and natural gas have risks to workers in case of accidental release. HTF handling needs special care to protect workers and environment. HTF leakage may cause soil and water pollution and human health problems. And HTF waste is hazardous waste and cause environmental pollution if not treated properly. To mitigate potential risks from HTF, the following measures will be taken:

(i) HTF will be transported in spill proof container.
(ii) HTF will be stored in designated areas with impermeable surfaces and protective dikes.
(iii) HTF waste should be stored using spill proof tanks and treated as hazardous material.
(iv) Fire protection and control procedures will be implemented in HTF storage, heat conversion, and HTF expansion areas.
(v) HTF system is equipped with automatic pressure monitoring devices. HTF leakage will be automatically detected and alarmed in the control system.
(vi) The ullage system should be operated at all time when the plant is in operation.
(vii) Concrete dikes with enough capacities should be built around the ullage system and other HTF tanks, such as HTF expansion tank, to contain HTF in case of accident.
(viii) Emergency response plan for HTF leakage will be developed and performed by properly trained staffs.
(ix) Fire protection system is in place in order to quickly respond to the leakage.
(x) Contaminated soil from HTF will be temporarily stored onsite with impermeable surface.
(xi) HTF waste should be stored using spill proof tanks and treated as hazardous material.

(xii) An identified and certified 3rd party hazardous waste management entity will be contracted before the operation of the plant and they will be responsible for the transportation and treatment of the HTF waste according application laws and regulations of the PRC.

5. Other Chemicals and Hazardous Materials

161. All toxic, hazardous, and harmful materials including petroleum products, solvents and chemicals used for water purification, nitrogen as asphyxiant during purging, and mirror cleaning additives will have impacts on humans and the environment. A special care will be taken to mitigate negative impacts from those harmful materials. The mitigation measures are:

(i) All toxic, hazardous, and harmful materials must be transported in spill proof tanks with filling hoses and nozzles in working order, and stored in designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems.
(ii) Material safety data sheets (MSDSs) will be posted for all hazardous materials.
(iii) Oil absorbents will be readily accessible in marked containers.
(iv) Good housekeeping procedures will be established to avoid the risk of spills.
(v) Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility.
(vi) Identify and maintain a register of all activities that involve the handling of potentially hazardous substances, as well as devise and supervise the implementation of protocols for the handling of these substances. This will include all fuels, oils, grease, lubricants, and other chemicals.
(vii) Workers should be properly trained before handling hazardous wastes and have the requisite PPE.
(viii) Store hazardous waste temporarily in closed containers away from direct sunlight, wind, water and rain in secure designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained.
(ix) Oil sludge will be collected and disposed by licensed contractors as a needed basis.
(x) Separate hazardous waste from general waste and all hazardous waste will be contracted to the identified and certified contractor for transporting and disposal.
(xi) Ensure that care is taken at all times to ensure the impact of spillage of oils and other hazardous substances to be limited, and it will be cleaned up immediately.

6. Occupational health and safety

162. Accidental release of HTF, other chemicals, and hazardous materials may present health and safety risks to workers. Natural gas and other flammable gas like nitrogen gas have fire hazards and the molten salt may cause burn hazards to workers.

163. **Mitigation measures.** To mitigate potential health and safety risks, the following measures will be taken:

(i) Occupational heat and safety procedures, including fire prevention and control, will be developed and workers will be trained regularly.
(ii) The general arrangement is designed in strict compliance with relevant standards, featuring fire compartments based on fire-resisting levels of process units and buildings to satisfy requirement on fire-prevention space.

(iii) Storage tank area is surrounded by ring-shaped fire passages for fire-fighting vehicles. Fire compartments are set up based on the fire risk and fire-resisting buildings/structures, including fire-proof doors and windows.
(iv) A fire-alarm system will be installed and tested regularly to make sure if functions properly.
(v) The process control system contains an out-of-limit alarm to ensure all hazardous materials under safety control at all time.
(vi) PPE, including goggles, gloves, safety shoes, will be provided to workers.
(vii) Naked fire, hot surface, electric sparks, electrostatic spark and ignition sources like impulsive force and friction shall be strictly controlled, especially near HTF, nitrogen gas and natural gas.
(viii) Control measures shall also be strictly taken to ensure the discharge, exhaust and safety relief of flammable fuels in an enclosed system.
(ix) The fire monitoring system will be installed to ensure safety in production and operation and provide early warning to plant personnel.
(x) Important monitoring areas must have a combustible gas test detector of catalytic combustion kind which are able to make an acousto-optic alarm on the site, and a poisonous gas test detector of electrochemistry kind capable of making an acousto-optic alarm on the site.
(xi) Unauthorized personnel should not be around the molten salt storage tanks.
(xii) Authorized personnel must have PPE at all times to prevent burn hazards.

7. Emergency Response Plan

164. The emergency response plan will be established to prevent those risks from HTF, chemical and natural gas during the operation of the CSP plant. The plan will be in accordance with National Environmental Emergency Plan (24 January 2006) and relevant laws, regulations and standards. Major element of the emergency response plan is presented in **Table A-6** of **Appendix 1**.

VI. ALTERNATIVE ANALYSIS

165. According to the ADB SPS requirements, an analysis of project alternatives was conducted to determine the best way of achieving project objectives while minimizing environmental and social impacts by the project. Alternative methods of delivering the required service and alternative project designs were considered during the analysis.

A. No Project Alternative

166. The electrical power demand in PRC in general and in Qinghai province in particular has been increasing due the growth of economic activities. In 2012, the total electrical power consumption in Qinghai province was 60,200 GWh, an increase of 7.4% over 2011.[12]

167. Coal has provided 70% of the primary energy consumed and nearly 75% of electricity generation in the PRC. This high proportion of fossil fuel consumption, driven by the increasing demand for energy to support rapid economic growth in the last three decades, has raised serious environmental concerns. A way to mitigate this is to increasing the share of renewable energy in the overall energy supply.

168. If the CSP project is not implemented, a traditional coal-fired power plant would be built to meet the increasing demand for electricity in Qinghai. The rapid expansion in coal-fired power plants in the PRC has caused large increase in CO_2, the major greenhouse gas (GHG) responsible for climate change. The project will improve air quality and significantly

[12] 2012 Qinghai Electrical Power Summary, NDRC News Release on 5 February 2013.

reduce coal consumption and GHG emission.

B. Alternative Methods of Generating Power

169. There are different methods to generate electric power, including by coal-fired thermal power plant, natural gas power plant, wind power, biomass, geothermal, nuclear, solar, and etc.

1. Coal-fired Power Plant

170. The overwhelming dominant method for electrical power generation in the PRC is from coal-fired power plants, which generate more than 70% of all electrical power generated in the PRC. In Qinghai province, hydro power is the main electrical power production and followed by coal-fired power plants. Even though the pollutants emissions per unit of power generation have significantly reduced over the last three decades in the PRC due to energy efficiency improvements and pollution controls, coal-fired power plants are still the main stationary sources of air pollutants.

2. Natural Gas Power Plant

171. Natural gas production and consumption has increased significantly in the last decade. In the PRC, natural gas is mainly used in residential, public service, chemical industry, industrial sector, transportation and power sector. Chinese natural gas consumption in 2011 has already increased fourfold from 2000 levels and reached 130 billion m^3, making it the fourth largest gas market in the world. In its current 12th Five-Year Plan (2011 to 2015), the PRC government plans to double the share of natural gas in the primary energy consumption and reach consumption levels up to 260 billion m^3 by 2015.

172. Modern power plants can be built to combust natural gas as the primary fuel. Natural gas is also considered as a clean fossil fuel as less pollutants and GHG are generated from electrical power plants using natural gas comparing to using coal. The need to curb coal demand growth to reduce air pollution and improve air quality in big cities is as present and pressing as ever, and natural gas offers at least part of a solution. Natural gas is not widely used for power generation as it is much more expensive than coal, the main competitor to gas in the power sector.

3. Wind Power

173. Wind energy is kinetic energy of wind exploited for electricity generation in wind turbines. Wind power experienced dramatic growth since the turn of the 21st century. Global installed capacity at the end of 2011 was around 238 GW, up from 18 GW at the end of the year 2000.[13] Around 41 GW was added in 2011 alone. Over the last couple of years, wind's centre of growth moved from Europe and North America to Asia, which emerged as the global leader. China became the global leader in terms of total installed capacity in a very short time, overtaking the United States in 2010.

174. Hesitance of wind energy development in Qinghai province is due to over investments in other wind rich province such as Inner Mongolia Autonomous Region. Also, the nature of wind energy is intermittence of power generation based on the wind availability which creates concerns about the impacts on stability of power system. Therefore, it is recommended to develop more solar-based power generation system in Qinghai province taking advantage of rich solar resource.

[13] IEA website http://www.iea.org/topics/windpower/

4. Geothermal Power

175. Geothermal energy can be utilized for space heating or electrical power generation and it is used more for heating. The global capacity of geothermal power plants is approximately 9 GW, with an annual electricity generation of less than 1% of the global electricity demand. Geothermal heating plants have a global capacity of approximately 18,000 MW thermal and mostly shallow geothermal resources. The future of geothermal energy will be the development of enhanced geothermal systems to exploit deep geothermal resources, which could expand the potential of geothermal energy considerably.

176. Large-scale geothermal power development is currently limited to tectonically active regions such as areas near plate boundaries, rift zones, and mantle plumes or hot spots. These active, high heat-flow areas include countries around the 'Ring of Fire' (Indonesia, The Philippines, Japan, New Zealand, Central America, and the West Coast of the United States) and rift zones such as Iceland and East Africa. These areas are the most promising for geothermal development. If technological breakthroughs made new geothermal power technologies available, then geothermal power might expand to other regions. Qinghai does not have adequate geothermal resources for power generation.

5. Biomass for Power

177. Power generation and CHP based on biomass and on biomass co-firing in coal-fired power plants, are growing. The capacity of biomass CHP plants varies considerably. Biogas anaerobic digesters are usually associated to gas-fired engines for heat and power generation with electrical capacity up to a few MW. Biomass-fired power plants and CHP plants have capacities ranging from a few MW up to 350 MW. Small and medium-size CHP plants are usually sourced with locally available biomass. Large CHP plants and coal/biomass co-firing power plants require biomass sourcing from a wide region and/or imported wood or forestry residues.

178. Biomass-based CHP or power generation is widely used in regions that have ample fuel wood resources, forestry or agricultural residues. Biomass use in CHP plants may compete with other, non-energy uses of agricultural residues such as straw, or with wood processing industry (i.e., pulp and paper) in the case of forestry residues. On a global scale, biomass supplies more than 1% of the electricity demand. Biomass is also used in CHP plants. Qinghai has rather limited biomass fuel resources and thus it is not feasible to used biomass fuel for power generation.

6. Nuclear

179. Nuclear energy can be used generate electrical power. The power generation from nuclear power plants represents 1.3% of the total power generation in the PRC in 2012. Nuclear power plants are typically near large water bodies as they need large amount of water for cooling. Most areas of Qinghai are arid or semi-arid and it is not suitable for nuclear power plant. Current Qinghai does not have any nuclear power plant in the province.

7. Photovoltaic Solar Power

180. Solar photovoltaic (PV) cells convert sunlight directly into electricity. Currently, crystalline silicon (c-Si) and the so-called thin-film (TF) technologies dominate the global PV market. In a c-Si PV system slices (wafers) of solar-grade (high purity) silicon are made into cells that are assembled into modules and electrically connected. TF PV technology consists of thin layers of semiconducting material deposited onto inexpensive, large-size substrates such as glass, polymer or metal. Crystalline silicon PV is the oldest and currently dominant PV technology with approximately 85%–90% of the PV market share. Compared with c-Si-

based PV systems, the production of TF PV system is less energy-intensive and requires significantly less active (semiconducting) material. TF solar PV is therefore generally cheaper, though less efficient and requires substantially more surface area for the same power output, than c-Si-based systems.

181. PV power has an enormous energy potential and is usually seen as an environmentally benign technology. Over the years many countries have implemented specific policies and incentives to support solar PV deployment. This has led to a rapid increase in the total installed capacity of PV from 1.4 GW in 2000 to around 100 GW at the end of 2012, with about 30 GW of capacity installed per year in 2011 and 2012. The associated industrial learning and market competition have resulted in very significant and rapid cost reductions for solar PV systems. Continued cost reductions for solar PV systems are an essential requirement for accelerating the attainment of grid-parity of electricity generated using on-grid solar PV systems. In countries with good solar resources and high electricity tariffs, residential solar PV systems have already reached parity with electricity retail prices, whilst in general PV is now fully competitive with power generated from diesel-based systems.

182. Solar PV, as a variable renewable electricity source, can be readily integrated into existing grids up to a penetration level of about 20% depending on the configuration of the existing electricity generation mix and demand profiles. Increasing the integration of a high level of variable renewable power from PV systems into electricity grids requires re-thinking of grid readiness with regards to connectivity, and energy storage solutions.

8. Concentrating Solar Power

183. The concept of concentrating solar power (CSP) is to use devices to concentrate energy from the sun's rays to heat a receiver to high temperatures. This heat is transformed first into mechanical energy (by turbines or other engines) and then into electricity. CSP can provide low-carbon, renewable energy resources in countries or regions with strong sunshine and clear skies measured in DNI. Given the arid/semi-arid nature of environments that are well-suited for CSP, a key challenge is accessing the cooling water needed for CSP plants. Dry or hybrid dry/wet cooling can be used in areas with limited water resources.

184. CSP uses renewable solar resource to generate electricity while producing very low levels of greenhouse-gas emissions. Thus, it has strong potential to be a key technology for mitigating climate change. Unlike solar PV technologies, CSP has an inherent capacity to store heat energy for later conversion to electricity. When combined with thermal storage capacity, CSP plants can continue to produce electricity even when clouds block the sun or after sundown. CSP plants can also be equipped with backup power from combustible fuels, such as natural gas. These factors give CSP the ability to provide reliable electricity that can be dispatched to the grid when needed, including after sunset to match late evening peak demand or even around the clock to meet base-load demand.

185. CSP technology has been proven commercially in USA and Spain with a good track record. The first commercial plants began operating in California, United States from 1984 to 1991, spurred by federal and state tax incentives and mandatory long-term power purchase contracts. A drop in fossil fuel prices then led the federal and state governments to discontinue the policy framework that had supported the advancement of CSP. In 2006, the market reemerged in Spain and the United States, again in response to government measures such as feed-in tariffs and policies obliging utilities to obtain some share of power from renewable, and from large solar in particular.

186. There is no commercial scale CSP facility in the PRC. To diversity the energy supply and reduce the energy dependency to coal-fired power plants, the PRC government has

decided to support the project and demonstrate the CSP technology in Qinghai province, one of the idea places for CSP plant in the PRC. Experience learned from this demonstration project will be very valuable to develop plans on further promoting this very promising and renewable technology in wide areas.

C. Alternative Project Design

1. Alternative Locations

187. The sunlight hits the Earth's surface both directly and indirectly, through numerous reflections and deviations in the atmosphere. The main differences in the direct sunlight available from place to place arise from the composition of the atmosphere and the weather. The solar energy that CSP plants use is measured as DNI, which is the energy received on a surface tracked perpendicular to the sun's rays.

188. DNI measures provide only a first approximation of a CSP plant's electrical output potential. In practice, what matters most is the variation in sunlight over the course of a day: below a certain threshold of daily direct sunlight, CSP plants have no net production, due to constant heat losses in the solar field.

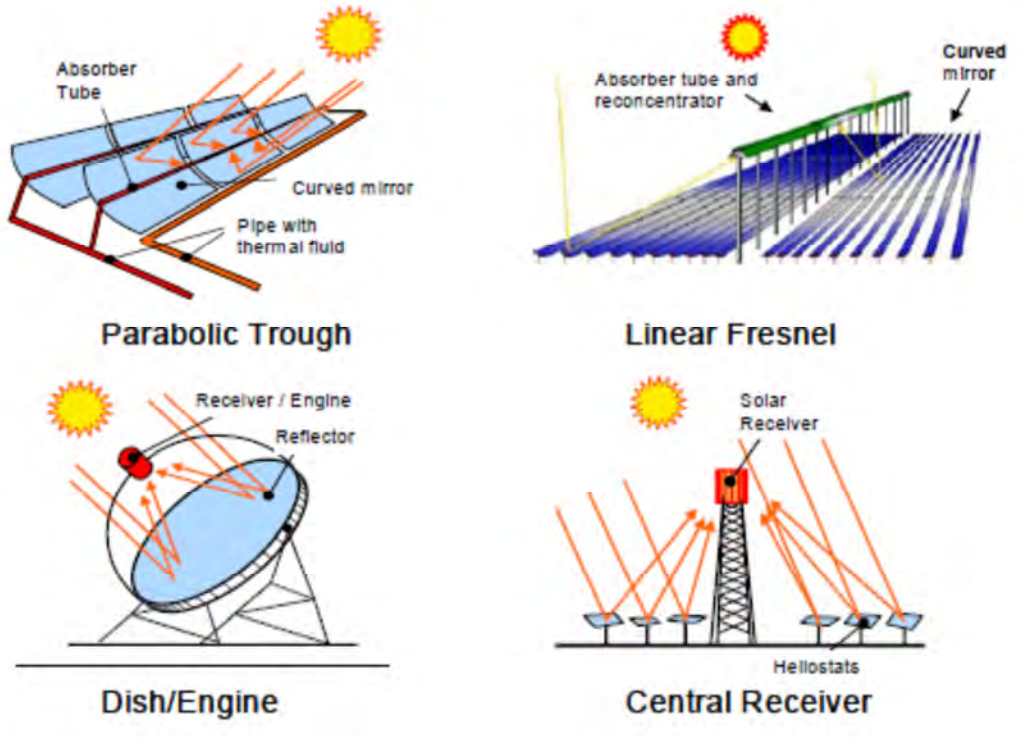
189. Good DNI is usually found in arid and semi-arid areas with reliably clear skies, which typically lay at latitudes from 15° to 40° North or South of the equator. DNI is also significantly better at higher altitudes, where absorption and scattering of sunlight are much lower. Thus, the most favorable areas for CSP resource are in the western part of China.

190. Main parameters used for selected a site for CSP plant including DNI level, availability of water, grid connection, availability of large land, terrain and location, availability of natural gas, infrastructures, social and environmental impacts. The EA and IA evaluated different locations of high DNIs for the project. Qinghai is one of the highest DNI solar energy in the PRC and Delingha is one of the best places in Qinghai for a CSP plant.

2. Alternative Technology and Design

191. There are four main CSP technologies, which can be categorized by the way they focus the sun's rays and the technology used to receive the sun's energy and they are parabolic troughs, linear fresnel reflectors, parabolic dishes and solar towers.

Figure 6-1: Illustration of Four Main CSP Technologies



Source:TA consultants

(1) Parabolic Troughs

192. Parabolic trough systems consist of parallel rows of mirrors (reflectors) curved in one dimension to focus the sun's rays. The mirror arrays can be more than 100 m long with the curved surface 5 m to 6 m across. Carbon steel pipes (absorber tubes) with a selective coating serve as the heat collectors. The coating is designed to allow pipes to absorb high levels of solar radiation while emitting very little infra-red radiation. The pipes are insulated in an evacuated glass envelope. The reflectors and the absorber tubes move in tandem with the sun as it crosses the sky.

193. All parabolic trough plants currently in commercial operation rely on synthetic oil as the fluid that transfers heat (the heat transfer fluid or HTF) from collector pipes to heat exchangers, where water is preheated, evaporated and then superheated to steam. The superheated steam goes through a turbine, which drives a generator to produce electricity. After being cooled and condensed, the water returns to the heat exchangers.

194. Parabolic troughs are the most mature of the CSP technologies and form the bulk of current commercial plants.

(2) Linear Fresnel Reflectors

195. Linear Fresnel reflectors (LFRs) approximate the parabolic shape of trough systems but use long rows of flat or slightly curved mirrors to reflect the sun's rays onto a downward-facing linear, fixed receiver. A more recent design, known as compact LFRs, uses two parallel receivers for each row of mirrors and thus needs less land than parabolic troughs to produce a given output.

196. The main advantage of LFR systems is that their simple design of flexibly bent

mirrors and fixed receivers requires lower investment costs and facilitates direct steam generation (DSG), thereby eliminating the need for heat transfer fluids and heat exchangers. LFR plants are, however, less efficient than troughs in converting solar energy to electricity and it is more difficult to incorporate storage capacity into their design.

(3) Solar Towers

197. Solar towers, also known as central receiver systems (CRS), use hundreds or thousands of small reflectors (called heliostats) to concentrate the sun's rays on a central receiver placed atop a fixed tower. Some commercial tower plants now in operation use DSG in the receiver; others use molten salts as both the heat transfer fluid and storage medium.

198. The concentrating power of the tower concept achieves very high temperatures, thereby increasing the efficiency at which heat is converted into electricity and reducing the cost of thermal storage. In addition, the concept is flexible and designers can choose from a wide variety of heliostats, receivers, transfer fluids and power blocks. However, there is no commercial scale application at this moment.

(4) Parabolic Dishes

199. Parabolic dishes concentrate the sun rays at a focal point propped above the center of the dish. The entire apparatus tracks the sun, with the dish and receiver moving in tandem. Most dishes have an independent engine/generator (such as a Stirling machine or a micro-turbine) at the focal point. This design eliminates the need for a heat transfer fluid and for cooling water.

200. Parabolic dishes offer a reasonable solar-to-electric conversion performance of any CSP system. It has several other features including compact size, absence of cooling water, and low compatibility with thermal storage and hybridization and it competes with PV modules, especially concentrating PV.

201. Parabolic dishes are limited in size (typically tens of kW or smaller) and each produces electricity independently, which means that hundreds or thousands of them would need to be co-located to create a large-scale plant.

3. Conclusion

202. To demonstrate the CSP technology, evaluate the performance of the CSP plant in the PRC and achieve the optimal operating efficiency, the most common CSP technology, parabolic trough CSP with thermal storage, has been selected for this project. Based on the overall alternative analysis, the project has selected a suitable location and with the right choice of technologies. The selected alternative design option will minimize the potential impact of the project to the environment.

VII. INFORMATION DISCLOSURE AND PUBLIC CONSULTATIONS

A. PRC and ADB Requirements for Public Consultation

203. **The PRC requirements.** Relevant provisions in the PRC *Environmental Impact Assessment Law* (2003) and the *Regulations on the Administration of Construction Project Environmental Protection* (No. 253 Order of the State Council, 1998) require that an EIA study for a construction project shall solicit opinions from affected residents, as well as other organizations and stakeholders concerned. However, the requirements for public consultation are different from various sectors and projects. For an environmental Category A project (such as a coal-fired power plant), full EIA reports are required including two rounds of public consultations, while for a Category B project (such as a solar or wind power project), only a simplified tabular EIA is required without requirement for any public consultation.

204. **ADB Requirements.** ADB SPS has specific requirements for public consultation. In order to make key documents widely available to the general public, ADB's SPS requires submission of a finalized EIA for Category A projects, and a final IEE for Category B projects to ADB for posting on ADB website. ADB SPS requires that borrowers take a proactive disclosure approach and provide relevant information from environmental assessment documentation directly to affected peoples and stakeholders. The SPS also requires that the borrower carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation. Meaningful consultation goes beyond information disclosure. It involves two-way communication between the borrower and the affected communities and stakeholders, and active participation of affected communities and stakeholders in project design and implementation.

B. Information Disclosure

205. Information disclosure involves delivering information about a proposed project to the general public and to affected communities and other stakeholders, beginning early in the project cycle and continuing throughout the life of the project. Information disclosure is intended to facilitate constructive engagement with affected communities and stakeholders over the life of the project.

206. Information disclosure and public consultations were conducted in the project city of Delingha during the course of domestic EIA preparation in accordance with the *PRC Guidelines for Public Consultation for EIA (2006)*. The information disclosure and consultations included (i) questionnaire survey, and (ii) website information disclosure. The project information, its potential environmental impacts as well as mitigation measures are and will be disclosed as follows:

(i) The domestic EIA Report of the project is available for review in the project city EPB;
(ii) This English IEE will be available for review at ADB's website at www.adb.org before the project is considered by the ADB Board;
(iii) Copies of the full EIA report will be made available upon request; and
(iv) All semiannual environmental progress and performance reports will be available at ADB's website during the implementation of the project.

C. Public Consultations during Project Preparation

207. **The first round public consultation** In order to engage the stakeholders and get their feedbacks on the proposed project, the questionnaire survey method was used to get the public opinion on the project and its environmental impact. The survey was conducted during 5 December 2012 to 30 January 2013. In total 50 participated were involved in the

survey. The profiles of the participants are summarized in **Table 7-1** while the results of the survey are presented in **Table 7-2**.

Table 7-1: Profile of Survey Participants

No. of People Surveyed	50	No. of Male	30
Questionnaire return rate	100%	No. of Female	20

	Age				Education				Total
	Under 18	18～30	31～50	Above 50	Primary school	High school	College	University and above	
No.	0	38	12	0	1	15	10	24	50
Percent		76%	24%		2%	30%	20%	48%	100 %

	Occupation										
	Government employee	Worker	Farmer	Small business owner	Staff member	Soldier	Teacher	Retiree	Student	Other	Total
No.	3	5	1	8	16	2	6	1	2	6	50
Percent	6%	10%	2%	16%	32%	4%	12%	2%	4%	12%	100 %

Source: TA consultants.

Table 7-2: Summary of Questionnaire Survey Results

No.	Survey Question	Answers to Question		No. of people	Percentage
1	Do you know this project?	Yes		44	88%
		No		6	12%
2	What is the main environmental impact of this project in your opinion?	Air pollution		7	14%
		Water pollution		24	48%
		Noise pollution		5	10%
		Ecological damage		22	44%
3	What do you think about the influences of this project on local economy?	Improve the local employment		34	68%
		Enhance the development of local economy		37	74%
		Improve the living standard of residents		13	26%
		Other		1	2%
4	Do you support this project?	Yes		36	72%
		No		2	4%
		a.	Result in pollution and damage to the environment	1	2%
		b.	Cannot solve the problem of labor force		
		c.	Cannot improve the living standard of residents		
		No opinion		11	22%
5	Are you satisfied with the current environment	Satisfied		34	68%
		Unsatisfied		5	10%

No.	Survey Question	Answers to Question	No. of people	Percentage
	conditions in the project area?	No opinion	11	22%
6	Do you think your living and working environment will be improved after the completion of this project?	Yes	33	66%
		No	5	10%
		Do not know	12	24%
7	Do you think this project is beneficial to the improvement of local air quality?	Yes, it is beneficial	27	54%
		No, it is harmful	4	8%
		No influence	19	38%
8	Do you think this project will contribute to the development of energy-saving, emission-reduction and low carbon economy?	Yes	42	84%
		No		
		No influence	8	16%

Source: Implementing agency's survey questionnaire.

208. It can be seen from **Table 7-1** that the survey covered an age range from 18 to 50, with 60% being male and the rest being female. More than half participants have an education level of college and above (68%). The occupation of the participants is quite diversified, representing the opinion of most kinds of stakeholders.

209. The participants provided answers to almost all questions in the survey questionnaire, with only a very few left in blank. According to **Table 7-2**, most of the participants (88%) know the proposed project, indicating that the information of the project has been well disseminated. When the participants were asked to identify the main environmental impact, about half participants (48%) are concerned about water pollution, closely followed by ecological damage (44%). The concerns about air pollution and noise pollution are mild (14% and 10%, respectively). About the influence on the local economy, most participants believe that the project will enhance the local economic development (74%) and local employment (68%). Most of the participants (72%) support the construction of the project while only 4% is not in favor of the project. About 68% participants are satisfied with the current environmental conditions in the local area. The similar proportion of the participants (66%) think the project will further improve the local living and working environment, and about half participants believe the project will improve the local air quality. Most (84%) participants think the construction of this project will contribute to the development of energy-saving, emission-reduction and low carbon economy.

210. The questionnaire also includes three questions soliciting free answers, regarding the impact of the project construction on the local ecologic environment and acoustic environment as well as the other suggestions and requirements on the project construction. The special concerns about the impact on the ecologic environment include that the local plants may be seriously damaged, and the wastewater produced during the operation may cause impact on the local ecologic environment. There is no special concern about the noise pollution. The participants raised some suggestions and requirements on the project construction, which include that (i) the local fauna and flora need to be well protected, (ii) afforestation is desired to rehabilitate the construction area, (iii) adequate security measures for the power plant should be adopted to reduce or prevent the damage to surrounding users by fire accidents, (iv) the proper wastes disposal program should be in place, (v) the local employment can be facilitated by the project, (vi) the energy conservation and emission reduction should be implemented and achieved, vii) the consumables should be recycled as much as possible, and (viii) more similar projects should be implemented.

211. Only two people out of all people surveyed did not support the project. One of them was due to lack of understanding of the project scope, its impact and mitigation measures. The other one did not support the project based on the assumption that the project will not improve the standard of living of local residents. After follow up with them and explain the mitigation measures that will be implemented, these two stakeholders changed their minds and will support the project.

212. **The second round public consultation** A public consultation announcement for the second round was published on the official website of Delingha City Government for 10 days from 7 March 2013, as shown below in **Figure 7-1**. The bulletin briefly introduced the project owner, purpose, scope, location, content, investment, construction unit, EIA unit, working procedure and main contents of the EIA, and the methods for raising public opinion. No one showed up for the public consultation meeting. No comment from the public was received regarding the proposed project during the web information disclosure period or afterwards.

Figure 7-1: Publication of the Project EIA Information (1)

VIII. GRIEVANCE REDRESS MECHANISM

A. Introduction

213. Residents and/or organizations affected by the project activities were encouraged to participate in assessing the project and provide comments to the domestic EIAs, the IEE and the EMP. However, other environmental issues and concerns may develop during both construction and operation periods of the project. In order to address complaints if or when they arise, a project-level grievance redress mechanism (GRM) has been developed in order to solve problems timely and effectively, as well as ensuring that the project will be implemented smoothly and successfully. Grievances and complaints of potentially affected people and organizations will be recorded, addressed and solved completely and quickly through the mechanism.

214. The project GRM includes a procedure for receiving grievances, recording/ documenting key information, and evaluating and responding to the complainants in a reasonable period of time. Any concerns raised through the GRM will need to be addressed promptly and transparently.

B. ADB's GRM Requirements

215. The ADB's SPS requires the IA to establish a GRM to receive and facilitate resolution of affected person's concerns and complaints about the project's environmental performance during construction as well as operation phase of the project. The GRM should be scaled to the risks and adverse impacts of the project; should address affected people's concerns and complaints promptly, using an understandable and transparent process; should be readily accessible to all sections of the community at no cost and without retribution; and, should not impede access to the PRC's judicial or administrative remedies.

C. Current Practice in the PRC

216. At the national level, a framework to address grievance has been established. The State Council issued Decree No. 431 *Regulations on Letters and Visits* in January 2005 and it codifies a complaint mechanism at all levels of government, and safeguards the complainants from any retaliation. In 2007 the Ministry of Environment issued Decree No. 34 *Environmental Letters and Visits System,* which provides specific guidelines to establish a system and address environmental complaints.

217. Currently, when residents or organizations are negatively affected by project activities, such as noise, dust or safety issues caused by construction activities, they may complain to the contractors and the project implementing agency by themselves or through their community organizations, or complain directly to local EPBs before they take any legal action that is typically considered as a last option. In the case of issues occurring during the construction period, they can complain to the contractors first if the construction activities are the source of the problem. If the contractors' responses cannot resolve the issues or if the contractors do not respond to the complaints, the affected person may contact municipal EPBs or the district/county EPBs, who will record the complaints and then visit the sites to investigate and obtain the contractors' side of the story. Sometimes, the two sides might contradict, each defending its own argument. In such cases, the local EPBs will need to consult with the contractor or the environmental supervision engineer to acquire relevant project information and collect data. This kind of fact-finding or site investigation is usually time-consuming, thus delaying the implementation of appropriate mediation measures. The major weaknesses of the current system in the PRC are: (i) lack of a specialized unit to address grievances on a project level; and (ii) no specific timeframe for actions and responses to be undertaken to resolve the complaints. These weaknesses have been

addressed in the project GRM.

D. Proposed Project GRM

218. In consultation with the EA and IA, it was agreed that the implementing agency will establish a Project Public Complaints Unit (PPCU). The PPCU will be coordinated by at least two staff members. The contact persons for the different GRM entry points (residential community leaders, neighborhood organizations, local authorities, district EPB, and contractors, operators) will be defined prior to construction. Organizational charts of the GRM, including the contact persons of the entry points and the PPCU, will be disclosed at every construction site. Phone numbers, addresses, and email addresses of all access points and the PPCU will be disclosed to the public through the project city's website and/or on information boards at each construction site. The project will provide training to the members of the PPCU and the contact persons of the GRM entry points to ensure that responsibilities and procedures are clear. The concept of the proposed project GRM is shown in **Figure 8-1**.

E. Grievance Types and Eligibility Assessment

219. Public grievances addressed by the project GRM will most likely relate to environmental issues encountered during the construction and operation phases, as comprehensive consultations with potentially affected people that were conducted during project preparation confirmed their basic support of the project. Grievances may include vehicle operation and transportation of heavy equipment and materials; fugitive dust emissions and construction noise; soil erosion and haphazard disposal of waste materials in inappropriate places; and safety measures for the protection of the general public and construction workers. Construction-related grievances can be numerous, and managing them is the contractor's responsibility under its contract with the IA. Operation related grievances may occur due to complaints about plant's environmental performance.

220. Each complaint will be assessed following a well-established procedure. Once a complaint is received and filed, the PPCU will identify if the complaint is eligible. Eligible complaints include those where (i) the complaint pertains to the project, and (ii) the complaint falls within the scope of environmental issues that the GRM is authorized to address. Ineligible complaints include those where (i) the complaint is clearly not project-related, (ii) the nature of the issue is outside the mandate of the environment GRM (such as issues related to resettlement, allegations of fraud or corruption), and (iii) other company or community procedures are more appropriate to address the issue. If the complaint is rejected, the complainant will be informed of the decision and the reasons for the rejection.

221. It's very important that all complains are recorded in a systematic fashion by the PPCU. Effective tracking and documentation will accomplish the following objectives:

(i) The PPCU will be responsible for the classification. The level of severity guides requirements for alerting senior management and determines the seniority of management oversight needed;
(ii) Provide assurance that a specific person is responsible for overseeing each grievance—from receipt and registration to implementation;
(iii) Promote timely resolution;
(iv) Inform all concerned (the complainant and appropriate Project personnel) about the status of the case and progress being made toward resolution;
(v) Document the responses and outcome(s) to promote fairness and consistency;
(vi) Provide a record of settlements and help develop standards and criteria for use in the resolution of comparable issues in the future;

(vii) Monitor the implementation of any settlement to ensure that it is timely and comprehensive; and
(viii) Assess the effectiveness of the process and action(s) to resolve complaints.

F. GRM Steps and Timeframe

222. A fundamental goal of the GRM is to solve problems early at the lowest level. Therefore, the IA, through the person assigned to receive, record and document grievances, will attempt to address grievances at the first instance and in a pro-active manner to preclude elevating grievances to higher level. Procedures and timeframes for the grievance redress process are described as follows (also see **Figure 8-1**):

Step 1: If a concern arises, the affected person tries to resolve the issue of concern directly with the contractor/operator and/or the project manager. The contractor/operator and/or the project manager shall provide a response within seven working days. If the concern is resolved successfully, no further follow-up is required. Yet, the contractor/operator and/or the project manager shall record any complaint and actions taken to resolve the issues and report the results to ADB residence mission office in the PRC;

Step 2: If no solution is found, the PPCU must properly assess the eligibility of the complaint, identify a solution, give a clear reply within 14 working days, and timely convey to the complainant and to the implementing agency, or contractor the suggested solution. The contractor, during construction, and the implementing agency, during operation, shall implement the redress solution and convey the outcome to the PPCU within seven working days;

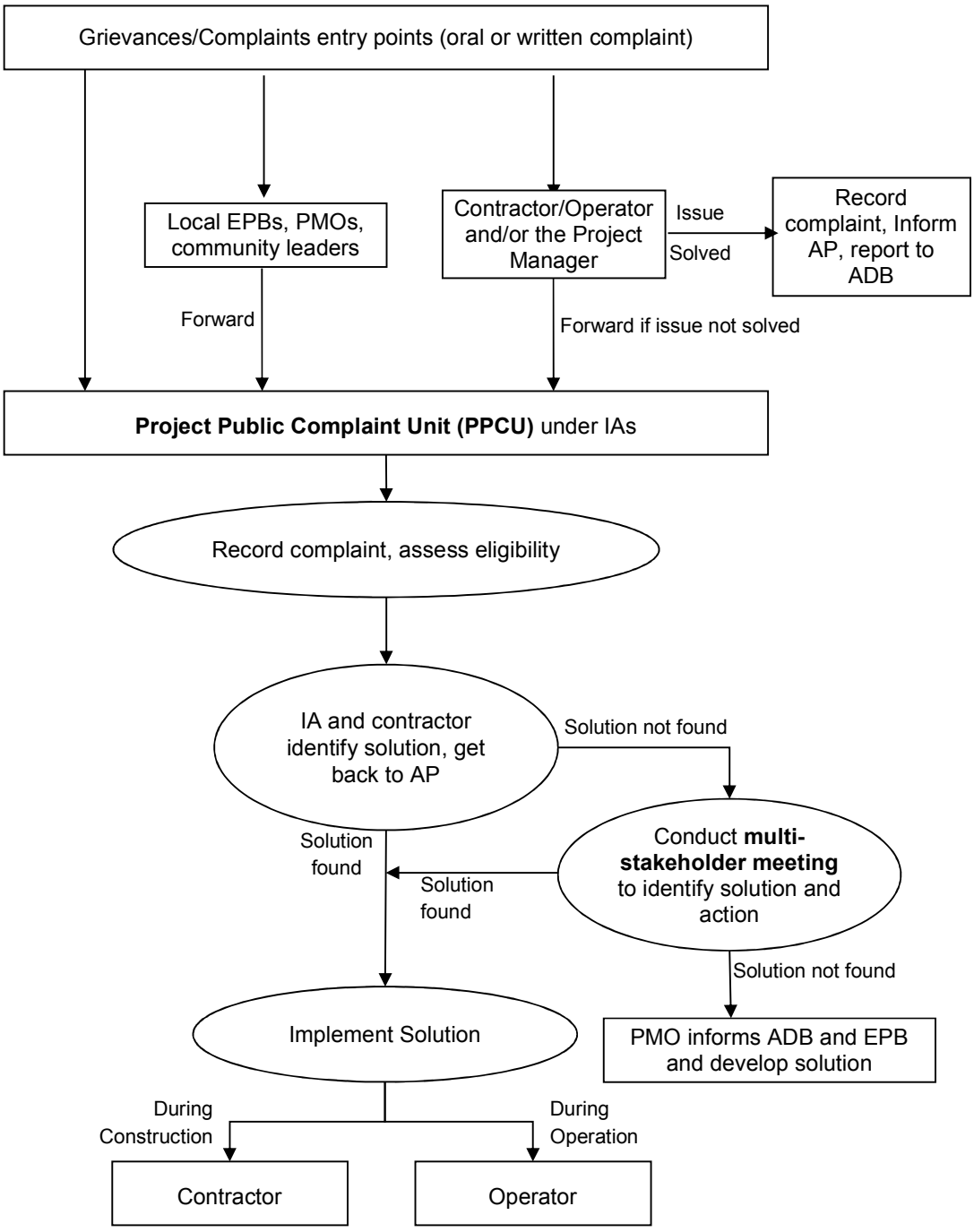
Step 3: If no solution is identified by the PPCU or if the complainant is not satisfied with the suggested solution under Step 2, the PPCU will organize, within two weeks, a multi-stakeholder hearing (meeting) where all relevant stakeholders, including the complainant, the IA, contractor/operator, and local EPB will be invited. The meeting will aim to find in a solution acceptable to all, and identify responsibilities and an action plan. The contractor during construction and the IA during operation will implement the agreed-upon redress solution and convey the outcome to the PPCU within seven working days;

Step 4: If the multi-stakeholder hearing process is not successful, the PPCU, through the IA, will inform the EA and provincial EPB accordingly. The EA with the consultation from the EPB and ADB will deliver alternative approaches to resolve the issues.

223. The PPCU as well as the local EPB will accept the complaints and grievances lodged by the affected persons free of charge. Any costs incurred should be covered by contractor or the IA or from the contingency of the contract.

224. A summary of GRM activities will be reported by the IA in the annual project progress reports and sent to ADB. The GRM will be operational during the entire construction phase and during the operations until the project completion.

Figure 8-1: Project-Level GRM



ADB = Asian Development Bank, AP = affected person, EA = executing agency, EPB = environmental protection bureau, IA = implementation agency.
Source:TA consultants

IX. CONCLUSIONS

225. The proposed CSP project in Delingha City, Qinghai Province, is one of the kind demonstration renewable energy project in the PRC. It will bring positive environmental benefits locally as well as globally by generating electrical power with zero emission solar energy and clean natural gas instead of by traditional coal-fired power plants. The project will save 70,000 tons of standard coal or 122,554 tons of raw coal annually. The associated annual avoided emission of CO_2 154,446 tons.

226. The project (i) selected an appropriate technology to reduce the emission of pollutants, (ii) identified negative environment impacts and appropriately established mitigation measures, (iii) received public support from the majority of project beneficiaries and affected people, (iv) established an effective project GRM, (v) prepared a comprehensive EMP, (vi) assessed the capacity of the executing agency and the implementing agency to implement the EMP, and (vii) included a project component to strengthen their capacity during project implementation.

227. Any adverse environmental impacts associated with the project will be prevented, reduced, minimized, or otherwise compensated. The EMP has been established to ensure the environmental performance of the project and it includes (i) environmental management and supervision structure, (ii) environmental mitigation and monitoring plans, (iii) institutional strengthening and personnel training. With the implementation of the mitigation measures defined in the EMP, the adverse impacts will be reduced to acceptable levels.

ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

1. The objectives of the EMP are to ensure implementation of (i) identified mitigation and management measures to avoid, reduce, mitigate, and compensate for anticipated adverse environment impacts, and (ii) monitoring and reporting against the performance indicators, while ensuring that the project complies with the PRC's environmental laws, standards and regulations and to ADB's Safeguard Policy Statement (2009). Organizational responsibilities and budgets are clearly identified for execution, monitoring and reporting.

B. Implementation Arrangements

2. This project is construction of a concentrating solar thermal plant in Delingha, Qinghai Province, the People's Republic of China (PRC). China General Nuclear Power Holding Co., Ltd. (CGN) is the executing agency (EA) for the project. A project leading group was established under the CGN and is responsible for directing the project and providing policy guidance during project implementation. China General Nuclear Delingha Solar Energy Co., Ltd. (CGN-DSE) is the implementation agency (IA).

3. The EA holds the final responsibility of EMP implementation and EMP reporting. It will provide guidance to the IA, coordinate with other governmental agencies as necessary, and submit EMP monitoring reports to ADB semi-annually during construction and annually during operation of the project.

4. The IA is responsible for implementing the EMP, which will nominate a qualified environmental manager to undertake effective environmental management activities specified in the EMP. The IA will form an environmental management unit (EMU), which consists of a leader and an appropriate number of staff to coordinate environmental issues with the contractor, CSC and CGN. The EMU will be supported by environment consultants and supervised by the local EPB.[14] The IA is responsible for implementing mitigation measures and EMP monitoring. The IA will prepare and submit the EMP monitoring reports to the EA who will review the reports and submit them to ADB.

5. Environmental engineers of a construction supervision company (CSC) contracted by IA will be responsible for the daily internal inspection, monitoring, and evaluation of mitigation measures at the construction site. Contractors are responsible for implementing relevant mitigation measures during construction specified in the EMP supported by the CSC.

6. The local EPB and Environment Monitoring Station (EMS) under the EPB will ensure in compliance with the PRC's environmental standards and regulations through regular and random environmental compliance monitoring and inspection during construction and operation. The EMS will conduct environmental compliance monitoring and inspection at least semiannually on behalf of the EPB.

7. ADB is responsible for reviewing the overall environmental performance of the project. ADB will also disclose the EMP monitoring reports on its website. ADB will review the semiannual and annual EMP performance reports submitted by the EA, and conduct due diligence of environment issues during the project review missions. If the EA and IA fail to meet safeguards requirements described in the EMP, ADB will seek corrective measures and advise the EA and IA on items in need of follow-up actions. The institutions and their responsibilities are summarized in **Table A-1.**

[14] Haixi Prefecture's EPB

Table A-1: Summary of Institutions and Responsibilities for EMP

Name of Institution	Responsibilities
EA (CGN)	Hold a final responsibility on the overall implementation of the EMP and EMP monitoring; Provide advice and guidance to the IA; Review EMP monitoring reports and submit them to ADB.
Project Leading Group	Direct the project and provide guidance during project implementation; Review project implementation progress and take additional measures if necessary.
IA	Establish EMU; Provide supervision to contractor and CSC, and submit monthly report to the EA on the implementation of the EMP; Work with design institutes and the tendering company in preparing bidding documents to ensure environmental protection provisions are included in them; Submit semiannual EMP monitoring reports to the EA and ADB; Hire environmental consultants.
ADB	Review the overall environmental performance of the project; Review the EMP monitoring reports and disclose the project monitoring reports on its website; conduct due diligence of environment issues during the project review missions.
Contractor	Responsible for implementing mitigation measures on a daily basis according the contract conditions.
CSC	Responsible for the daily inspection, monitoring, and evaluation of the implementation of EMP mitigation measures at construction site.
Environmental consultant	Provide technical assistance to the EA and the IA for implementing the EMP; Provide training to the staff of the CGN, IA, contractor and CSC; and Assist the IA in preparing semiannual and annual environmental reports.
Local EPB	Inspect the facilities during construction and operation to ensure compliance with the PRC requirements; Enforce applicable environmental laws and regulations.
Local EMS	Conduct environmental compliance monitoring according to the PRC requirement.

ADB = Asian Development Bank, CGN = China General Nuclear Power Group, CSC = construction supervision company, EA = executing agency, EMP = environmental management plan, EPB = Environmental Protection Bureau, IA = implementing agency.

8. **Institutional Strengthening and Capacity Building.** During the project implementation, experts from local EPB and environmental consultants will provide series of trainings to strengthen the capacity of the EA and IA for EMP implementation. The training topics, contents, estimated budgets and number of participants are listed in **Table A-2**. Environmental consultants will be responsible for developing training materials and providing training along with technical experts.

Table A-2: Institutional Strengthening and Training Program

Training	Attendees	Trainers	Contents	Times	Period (days)	Number of Person	Budget (CNY 1,000)	Source of fund
ADB's and PRC's environmental laws, regulations and policies	IA, contractors	Environmental consultant	ADB's safeguard policy statement Project applicable PRC's environmental laws, policies, standards and regulations International environmental management practice in civil constructions	2	1	10	10	Included in the IA's operating budget
Grievance Redress Mechanism	IA, Local EPB, residential communities, and Stakeholders	Environmental consultant	GRM structure, responsibilities, and timeframe Types of grievances and eligibility assessment	2	1	10	10	
Implementation of environment monitoring plan	IA, contractor, CSC	Environmental consultant	Impacts and mitigation measures during construction and operation Monitoring and auditing mechanism Reporting requirements Corrective actions for EMP	4	1	15	30	
International good practices of operating CSP plant	IA	Environmental consultant	Environmental, health and safety issues associated with CSP and best practices of operation and maintenance of CSP and new solar energy technologies	2	2	10	20	
		Total		**10**	**5**	**45**	**70**	

ADB = Asian Development Bank, CSC = construction supervision company, GRM = grievance redress mechanism, IA = implementing agency, PRC = People's Republic of China.
Source: TA consultants.

C. Potential Impacts and Mitigation Measures

9. The potential impacts of the project during construction and operation are identified and appropriate mitigation measures have been developed (see Chapter V of the IEE for details). The effectiveness of mitigation measures will be evaluated through environmental inspections and EMP monitoring. Detailed impacts mitigation measures are presented in **Table A-6.**

D. Environment Monitoring Plan

10. An environment monitoring plan is developed to monitor the environmental impacts of the project (see **Appendix 2**). The EMP monitoring plan covers air, wastewater, solid waste, and noise parameters during construction as well as operation of the project. Monitor frequencies, responsible parties and estimated costs are identified in the plan.

11. The contractor and CSC will be responsible for onsite routine environmental inspection during construction. The IA will be responsible for supervising the contractor with the assistance from an environmental consultant. The IA will be responsible for ensuring environmental mitigation measures indicated in the EMP to be properly implemented. The IA will be responsible for performing EMP monitoring during construction and operation.

12. The local EMS will also conduct compliance monitoring during both construction and operation to assess whether the project complies with applicable regulations and requirements specified in the domestic EIA report approved by the Qinghai EPB.

13. **Standard Monitoring Methods.** The monitoring methods, detection limits, and the standard code for each monitoring parameter are shown in **Table A-3.** The data and results of environmental inspection and monitoring activities will be used to assess: (i) the extent and severity of actual environmental impacts against the predicted impacts and baseline data collected before the project implementation, (ii) performance or effectiveness of environmental mitigation measures or compliance with pertinent environmental rules and regulations, (iii) trends in impacts, (iv) overall effectiveness of EMP implementation, and (v) the need for additional mitigation measures and corrective actions if non-compliance is observed.

Table A-3: Monitoring Parameters and Methods

Media	Monitoring Parameter	Method (Standard No.)	Standard Limit
Air	TSP (mg/m^3)	Gravimetric (GB/T15432-1995)	0.30[15]
	PM_{10} (mg/m^3)	Gravimetric with specific sampler (HJ/T93-2003)	0.15
	NO_x (mg/m^3)	Saltzman Method (GB/T15435-1995)	0.12
Noise	Equivalent Continuous A Sound (Leq)	Acoustimeter Method (GB12524-90)	60 (day)/ 50 (night)
Surface water	pH value	Glass electrode method (GB6920-86)	6-9[16]
	COD_{Mn} (mg/L)	Permanganate index (GB11914-	6

[15] All the air parameters are Grade II ambient air standards (daily average).
[16] All the water parameters are Grade III standards.

Media	Monitoring Parameter	Method (Standard No.)	Standard Limit
		89)	
	Petroleum (mg/L)	Infrared spectra photograph (GB/T16488-1996)	0.05
	SS (mg/L)	Gravimetric method (GB11901-89)	250
	Total coliforms (no./L)	Membrane filter (GB/T575.12-2006)	10,000

COD = chemical oxygen demand, mg/L = milligram per liter, mg/m^3 = milligram per cubic meter, PM_{10} = particulate matter smaller than 10 micrometers, SS = suspended solid, TSP = total suspended particulate.
Source: PRC standards.

14. **Quality assurance (QA) and quality control (QC) of monitoring.** To ensure monitoring accuracy and data integrity, the QA and QC procedures must be established and implemented by the EMS in accordance with the following regulations:

(i) Regulations of QA/AC Management for Environmental Monitoring (SEPA, July 2006);
(ii) QA/QC Manual for Environmental Water Monitoring, the State Environmental Monitoring Center, 2001; and
(iii) QA/QC Manual for Environmental Air Monitoring, the State Environmental Monitoring Center, 2001.

E. Reporting Requirements

15. The IA will submit the monthly, semiannual, and annual environment monitoring reports to CGN, who will review and submit EMP monitoring reports to ADB semiannually during construction and annually during operation.

16. The IA will conduct required monitoring according the EMP environmental monitoring plan and submit the monitoring results to the EA. A consolidated EMP monitoring report will be prepared by IA with the assistance from an environmental consultant and submit the report to ADB.

17. No later than two months after completion of the construction work, the IA shall collect data from the contractor and CSC, and submit construction completion report to CGN and the local EPB in order to comply with the PRC regulations. Within two months after project completion, an environmental acceptance report of the project will be prepared by the local EMS and reviewed for approval by the local EPB. ADB can request the IA for a copy of the construction completion report and environmental acceptance report for the project record.

18. The environmental reporting requirements during the implementation of the project are summarized in the **Table A-4**.

Table A-4: Reporting Requirements

Report	Prepared by	Submitted to	Frequency
A. Construction Phase			
Monthly environment monitoring report	IA supported by Contractor, CSC	CGN	Monthly
EMP monitoring report	IA prepares and submits to CGN; CGN reviews and submits	ADB	Semiannually
B. Operation Phase			
Project EMP monitoring report	IA	CGN	Annually
EMP monitoring report	IA prepares and submits to CGN; CGN reviews and submits	ADB	Annually

ADB = Asian Development Bank, CGN = China General Nuclear Power Group, CSC = construction supervision company, IA = implementing agency.

F. Performance Indicators

19. Performance indicators (**Table A-5**) have been developed to assess the implementation of the EMP. These indicators will be used to evaluate the effectiveness of environmental management.

Table A-5: Performance Indicators

No.	Description	Indicators
1	Staffing	(i) Qualified environment officer is assigned in CGN and CGN-DSE before project implementation (ii) EMU is established with appropriate number of staff in the IA before project implementation
2	Budgeting	(i) Environment mitigation cost during construction and operation is sufficiently and timely allocated (ii) Environment monitoring cost is sufficiently and timely allocated (iii) Budget for capacity building is sufficiently and timely allocated
3	Monitoring	(i) Requirement of environmental inspection and monitoring during construction period is included in the contracts between the IA and CSC (ii) Compliance monitoring for the PRC requirements is conducted by the local EMS. (iii) EMP monitoring is conducted by contractors, CSC, and IA, as scheduled.
4	Supervision	(i) IA supervises environmental inspection and monitoring done by contractors and CSC (ii) ADB mission will review EMP implementation on a regular base during the project implementation period
5	Reporting	(i) Monthly environment monitoring reports prepared by the IA and CSC are submitted to CGN.

No.	Description	Indicators
		(ii) Semiannual (during construction period) and annual (during operation) EMP monitoring reports prepared by the IA are submitted to ADB through CGN's review. (iii) Construction completion report prepared by the IA is submitted to CGN and local EPB. (iv) Environment acceptance report prepared by the local EPB is submitted to the IA/CGN within two months after project completion.
6	Capacity building	(i) Training on ADB safeguard policy is provided to CGN and the IA at the beginning of project implementation (ii) Training on GRM is provided at least once during the project implementation (iii) Training on EMP and best environmental practices of CSP operation and maintenance is provided during the project implementation
7	Grievance Redress Mechanism	(i) PPCU is established in the IA before project implementation (ii) Contact persons of PPCU are assigned and disclosed to the public before construction (iii) Complains are recorded and processed within the set time framework in the GRM of this IEE.
8	Compliance with the PRC standards	Comply with the PRC's environmental laws and regulations and meet all the required standards.

ADB = Asian Development Bank, CGN = China General Nuclear Power Group, EPB = environmental protection bureau, GRM = grievance redress mechanism, IEE = initial environmental examination, PPCU = project public complaints unit.

G. Estimated Budget for Mitigation and Monitoring

20. The estimated budgets for environmental mitigation and monitoring are summarized as follows. Mitigation cost during construction is estimated at CNY7.85 million or $1.3 million, and annual operating cost is CNY3.68 million or $594,000.

21. Monitoring cost during construction is estimated at CNY225,000 or $35,000, while the estimated annual monitoring cost during operation is CNY570,000 or $92,000, respectively. The estimated budget for capacity building is CNY70,000 or $11,000.

H. Mechanisms for Feedback and Adjustment

22. Based on environmental inspection and monitoring results, the local EPB will decide whether (i) further mitigation measures are required as corrective actions, or (ii) some improvements are required for environmental management practices.

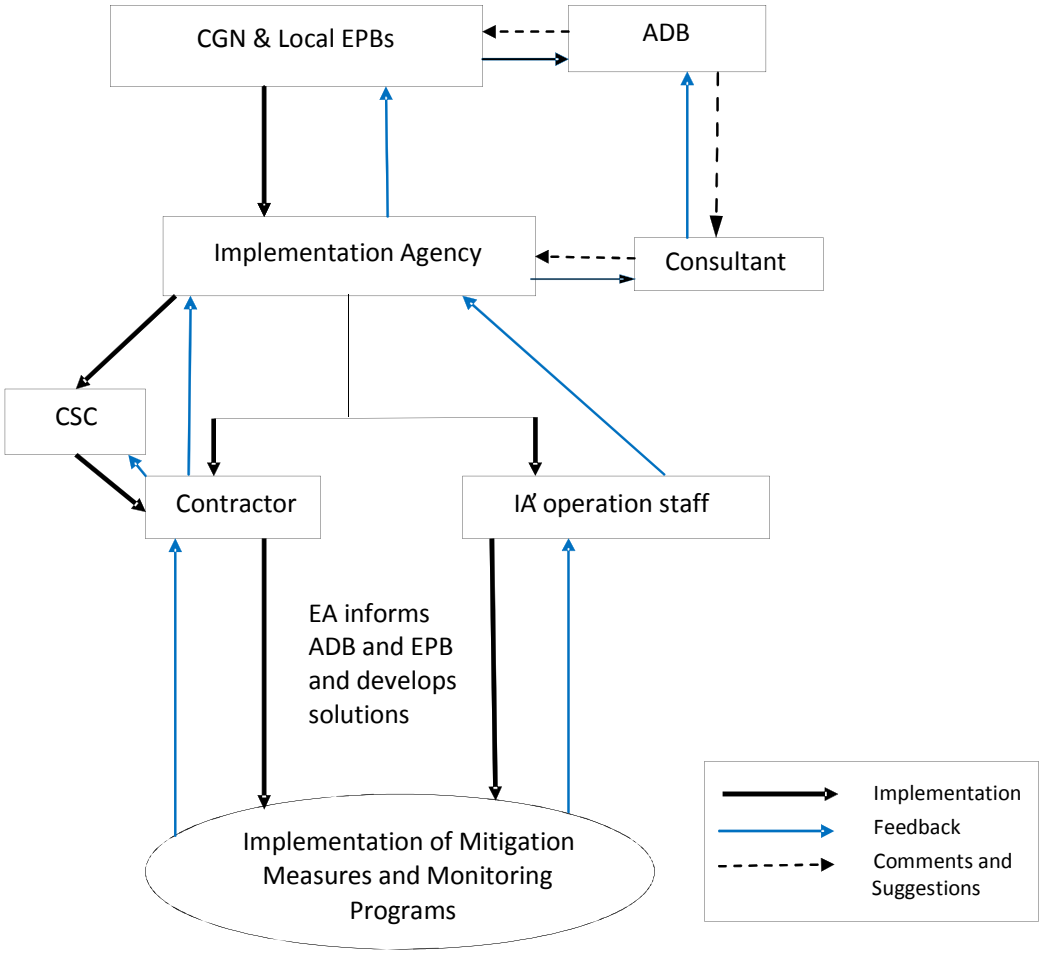
23. The effectiveness of mitigation measures and monitoring plans will be evaluated through a feedback reporting system. The EA will assess the results of EMP and then propose any changes to the EMP monitoring and mitigation plan, if necessary. However, any major adjustments will be subject to ADB review and approval.

24. If, during inspection, substantial deviation from the EMP is observed or any changes are made to the project that may cause substantial adverse environmental impacts or

significant increase in the number of affected people, then CGN must consult with the local EPB and ADB. ADB may pursue additional environmental assessment and, if necessary, further public consultation. The EMP can be revised based on the changes of the project activities and the revised EMP will be passed to CGN, the IA, CSC, and the contractor(s) for implementation.

25. Any proposed changes in the EMP should be sent to ADB's review and approval. The revised EMP with ADB confirmation is subject to reposting on the ADB's website as the ADB public communications policy requires. The mechanism for feedback and adjustment of the EMP is shown in **Figure A-1**.

Figure A-1: Mechanism for Feedback and Adjustment of EMP



ADB = Asian Development Bank, CGN = China General Nuclear Power Group, CSC = construction supervision company, EPB = Environmental Protection Bureau, IA = implementing agency.
Source:TA consultants

Table A-6: Environment Impacts and Mitigation Measures

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
A. Pre-construction Phase						
Design Mitigation facilities and measures	Land acquisition	The combined land acquisition and ethnic minority development plan was prepared in accordance with relevant law in the PRC and ADB's SPS. Each household will be compensated with the amount that is equivalent to three times of the annual average net household income. In addition to compensation, the affected people are entitled to receive (i) employment opportunities during construction and operation of the project, (ii) portable solar photovoltaic power generation sets, (iii) high insulation yurt (nomad tent), and (iv) trainings on employment skills and grassland management.	IA	CGN	5,194	
	Project's site and routes selection	The site of CSP plant and the layout will be reconfirmed to avoid or minimize potential adverse impacts on the surrounding environments and communities.	DI and IA	CGN		Included in design contract
	Including mitigation measures and monitoring program in engineering designs	Environmental mitigation measures identified in the IEE and the domestic EIA will be incorporated in the engineering design document and bidding document for the project, and will be included in contract documents for civil constructions and equipment installations. All contractors shall be required to strictly comply with the EMP.	DI	CGN, IA, local EPB		Included in design contract
		EMP monitoring will be incorporated into the engineering design to ensure that environmental impacts are closely monitored.				
	Fire hazards	Fire protection system will be incorporated in the design of the project.	DI and IA	Local EPB, CGN		Included in design contract

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
Bidding and Contracting	Bidding and contract document preparation	Incorporate environmental mitigation measures indicated in the EMP in bidding documents and construction contracts for the project.	DI and IA	CGN, Local EPB		Included in design contract
Grievance Redress Mechanism	Establishment of operational GRM	Establish a Project Public Complaints Unit (PPCU) in IA's office; provide training for PPCU members and GRM access points; Disclose the PPCU's phone number, fax, address, and email to the public.	IA	CGN, Local EPB		Included in IA's operation budget
Training	Training for the site staff to prevent polluting environment	Provide environmental awareness and capacity training for construction staff, concerning the prevention of accidental spillage of hazardous chemicals and oil; pollution of water resources (both surface and groundwater), air pollution and litter control and potential identification of archaeological artifacts.				
		Project Manager shall ensure that the training and capabilities of the Contractor's site staff are adequate to carry out the designated tasks.	IA and CSC	CGN, Local EPB		Included in contractor's budget
		No operator shall be permitted to operate critical mechanical equipment without having proper certification.				
		Staff should be educated as to the need to refrain from indiscriminate waste disposal and/or pollution of local soil and water resources and receive the necessary safety training.				
Subtotal of Pre-Construction Phase					**5,194**	
B. Construction Phase						
Soil	Soil erosion and contamination due to construction	Minimize active open excavation areas during trenching activities and use appropriate compaction techniques for the construction;	Contractors, CSCs	IA, Local EPB, IA	350	Included in construction contract

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
	activities	The contractor should, prior to the commencement of earthworks, determine the average depth of topsoil. The full depth of topsoil should be stripped from areas affected by construction and related activities prior to the commencement of major earthworks including the building footprints, working areas and storage areas. Topsoil will be reused where possible to rehabilitate disturbed areas. Care will be taken not to mix topsoil and subsoil during stripping. Removed topsoil should be transported to a designated landfill site or used onsite for landscaping as required. Ensure that the minimum area of soil is exposed to potential erosion at any one time. Limit construction and material handling activities during periods of rains and high winds. Assess and estimate storm water runoff and prepare a storm water drainage system accordingly to minimize soil erosion. Build a temporary detention pond to control topsoil runoff. Stabilize all earthwork disturbance areas within 14 days after earthwork. Plant native trees and grass in the CSP plant to control soil erosion and properly slop or re-vegetate disturbed surfaces. Properly store petroleum products, chemicals and hazardous materials on impermeable surface.				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		Use best management practices to prevent spill of oil and chemical to avoid pollution. Any planned paving or vegetating of the area will be done as soon as the materials are removed to protect and stabilize the soil.				
		Appropriately set up temporary construction camps and storage areas to minimize land area required and impact on soil erosion; Build concrete dikes with sealed surfaces underneath storage tanks containing HTF and hazardous materials. The dike walls must be high enough to contain 110% of the total volume of the storage tanks. Contaminated soil by HTF and/or other hazardous chemicals must be contained and disposed off-site by a third party with proper certification. Remove all construction wastes from the site and transport them to designated spoil disposal site in Delingha. Provide spill cleanup measures and equipment at the construction site. Contractors will be required to develop contingency plans for control of oil and other dangerous substances to prevent soil contamination.				
Wastewater	Surface and groundwater contamination from construction	Areas where construction equipment is being washed will be equipped with water collection basins and sediment traps.	Contractors, CSC	IA, Local EPB, CGN	240	Included in construction contracts

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
	wastewater, and domestic water	Wastewater from construction activities will be collected in sedimentation tanks, retention ponds, and filter tanks to remove silts and oil. Make sure the storm water channels or natural water path ways are not blocked. The construction wastewater, after sedimentation, will be used as the spraying water for fugitive dust control on the construction site. Adequate sanitary facilities and ablutions must be provided for construction workers. The domestic wastewater from workers camp, after septic treatment, will be utilized for watering vegetation, both planted and natural.				
Noise	Noise from construction, machinery operation, and transportation activities	Ensure that noise levels from equipment and machinery conform to the PRC standard of GB12523-90, and properly maintain construction vehicles and machineries to minimize noise. Locate sites for rock crushing, concrete-mixing, and similar activities at least 1 km away from sensitive areas. Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum. Place temporary signs or noise barriers around noise sources during construction, if necessary. Vehicles transporting construction materials or wastes shall slow down and stop honking when passing through or nearby environmentally sensitive locations, such as residential communities, schools	Contractors, CSC	IA, local EPB	300	Included in construction contracts

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		and hospitals. Construction activities, and particularly the noisy ones, are to be contained to reasonable hours during the day and early evening. Provide noise personnel protective equipment (PPE) to workers.				
Vibration	Vibration generating by compacting and rolling	Prohibit pilling and compaction operations at night	Contractors, CSC	IA and local EPB		Included in construction contracts
Ambient Air	Fugitive dust generated by construction activities worsens ambient air quality	Spray water on construction sites and earth/material handling routes where fugitive dust is being generated. Keep transport vehicles at low speed in the construction site to reduce fugitive dust generation. Stop the construction activities during strong windy days. Cover materials during truck transportation, in particular, the fine material, to avoid spillage or dust generation Excavations and other clearing activities must only be done during agreed working times and permitting weather conditions to avoid drifting of sand and dust into neighboring areas.	Contractors, CSC	IA, local EPB	100	Included in construction contract
	Air emission from vehicles and construction equipment	Store petroleum or other harmful materials in appropriate places and cover to minimize fugitive dust and emission.	Contractors, CSC	IA, Local EPB	120	Included in construction contract

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
Solid Waste	Solid waste from construction activities	Establish temporary storage for solid wastes away from water bodies or other environmental sensitive areas, and regularly haul solid waste to an approved and designed landfill in Delingha; All rubble must either be used on site as part of the existing development, or must be taken off the reserve and disposed off at the landfill facility in Delingha. Rubble must not be dumped on site but must be placed within a bin for regular removal. Provide appropriate waste storage containers at construction sites. Recycle the construction waste and excavating waste as much as possible and the rest construction waste will be transported to an approved landfill. Hire a qualify contractor to remove all non-hazardous wastes from site to approved waste disposal site, according to appropriate domestic procedures. Hold contractors responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that remain on the site after construction. Strictly prohibit any waste incineration at or near construction site.	Contractors, CSC	IA, Local EPB	300	Included in construction contract
Chemicals and Hazardous	Hazardous and polluting materials	Prepare and implement a protocol for the handling and disposal of hazardous materials during	Contractors, CSC	IA, Local EPB	150	Included in construction contract

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
Material	from construction activities	construction including a spill prevention and emergency plan. Build storage facilities for fuels, oil, chemicals and other hazardous materials will be within secured areas on impermeable surfaces, and provided with dikes. Vehicles and equipment will be properly staged in designated areas to prevent contamination of soil and surface water from chemicals and other hazardous materials. Vehicle, machinery and equipment maintenance and refueling will be properly carried out so that spilled materials do not seep into the soil. Oil traps will be provided for service areas and parking areas; and fuel storage and refilling areas will be located at least 300 m from drainage structures and important water bodies. Suppliers of chemicals and hazardous materials must hold proper licenses. They shall follow proper protocol for transferring fuel and the Operation Procedures for Transportation, Loading and Unloading of Dangerous or Harmful Goods of JT 3145-91.				
Flora and Fauna	Protection of vegetation, re-vegetation of disturbed areas; planting and	Preserve existing vegetation where no construction activity is planned, or temporarily preserve vegetation where activity is planned for a later date. The construction activities will be implemented within the land acquisition scope, minimize the damage to the nearby land.	Contractors, CSC	IA, Local EPB	70	Included in construction contract

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
	compensatory planting trees and grass	Properly backfill, compact, and re-vegetate piping/cable trenches after construction. Remove shrubs only as a last resort if they impinge directly on permanent structures. All natural areas impacted during construction must be rehabilitated with locally indigenous grasses. Construction activities must be planned carefully so as not to interfere with the calving and lambing season for most animal species. Enhance awareness on protection of and prohibition to hunt wild animals, construction workers are forbidden to hunt wild animals in the construction and surrounding areas, in accordance with PRC's Law on Wildlife Protection. Identify, demarcate and protect sites where small animals, reptiles, and birds of common species live.				
	Greening facilities for the plant site	Vegetate the CSP plant wherever possible.	Contractors, CSC	IA	5,800	Included in construction contract
Community Disturbance and Safety	Public safety around the construction site	Implement safety measures around the construction sites to protect the public, including warning signs to alert the public to potential safety hazards, and barriers to prevent public access to construction sites.	Contractors, CSC	IA, Local Public Transportation Bureau	240	Included in construction contract
Occupational health and safety	Health damage and accidents during construction activities	Identify and minimize the causes of potential hazards to workers. Implement safety measures and work procedures and provide first aid facility onsite. Workers should be thoroughly trained on	Contractors, CSC	IA, Local EPB, CGN	200	Included in construction contract

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		occupational health and safety during construction, especially for using potentially dangerous equipment. Provide preventive and protective measures, including modification, substitution, or elimination of hazardous conditions. Contractors must ensure that all equipment is maintained in a safe operating condition. The Contractors will take all the necessary precautions against the spreading of disease. Material stockpiles or stacks, such as, pipes must be stable and well secured to avoid collapse and possible injury to site workers. Provide appropriate personal protective equipment (PPE) to workers to minimize risks, including ear protection, hard hats and safety boots. Post adequate signage in risk areas. Provide procedures for limiting exposure to high noise or heat working environments in compliance with PRC noise standards for construction sites (GB12523-2011). Provide training to workers on the storage, handling and disposal of hazardous wastes. Provide emergency prevention, preparedness, and response arrangements and training to workers. Hold safety meetings with staff before each shift.				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
Physical Cultural Resources	Relics may be damaged if proper precaution is not taken.	Establish and conduct chance-find procedures for physical cultural resources Relics destroying, damaging, defacing, concealing or otherwise interfering will be strictly prohibited in accordance with PRC regulations. If a new site is unearthed, work should be stopped immediately and the IA and local cultural relic bureau will be promptly notified; construction will resume only after a thorough investigation and with the permission of the appropriate authority.	Contractors, CSC	IA and CGN	30	In case of cultural relic discovered, the direct cost for compensation to contractor will be covered by special fund for cultural relic protection
Subtotal of Construction Phase					**7,850**	
C. Operation Phase						
Dust	Fugitive dust will be generated by strong wind and affect local air quality	Use recycled water to the plant area to suppress dust emission. Use mirror washing water to suppress dust from solar collection field.	IA	Local EPB	20	Included in the IA's operating budget
Noise	Noise from steam generator system, power generation equipment, additional heating, pump and cooling equipment may impact workers' hearing	Implement restricted access, and provide PPEs such as earmuffs and earplugs to personnel who work in high noise generating areas. The latest technology incorporating maximum noise mitigating measures for the CSP plant components will be used. All plant and equipment, including vehicles, will be properly maintained in order to minimize noise generation.	IA	Local EPB	10	Include in the IA's operation budget
Solid Wastes	Waste generated	No permanent on-site solid waste disposal will be	IA	Local EPB	500	Included in IA's

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
	from the CSP plant and worker	allowed. All structures and/or components replaced during maintenance activities are recycled as much as possible. None-recyclable parts will be disposed at an designated waste disposal site in Delingha. General waste will be recycled if possible or disposed properly to an appropriate designated landfill facility. All wastes will be routinely collected by appropriately licensed waste management companies for reuse, recycling or final disposal in a licensed waste facility. Waste handling, collection and disposal operations are managed and controlled by a waste management contractor No burning of wastes will be permitted at the plant site.				operation budget
HTF	HTF handling needs special care to protect workers and environment	HTF will be transported in spill proof container. HTF will be stored in designated areas with impermeable surfaces and protective dikes. Fire protection and control procedures will be implemented in HTF storage area.	IA	Local EPB	50	Included in IA's operation budget
	HTF leakage may cause soil and water pollution and human health problems.	HTF system is equipped with automatic pressure monitoring devices. HTF leakage will be automatically detected and alarmed in the control system. The ullage system should be operated at all time when the plant is in operation.	IA	Local EPB	100	Included in IA's operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		Concrete dikes with enough capacities should be built around the ullage system and other HTF tanks, such as HTF expansion tank, to contain HTF in case of accident. Emergency response plan for HTF leakage will be developed and performed by properly trained staffs. Fire protection system is in place in order to quickly respond to the leakage.				
	HTF waste is hazardous waste and cause environmental pollution if not treated properly.	Contaminated soil from HTF will be temporarily stored onsite with impermeable surface. HTF waste should be stored using spill proof tanks and treated as hazardous material. An identified and certified 3rd party hazardous waste management entity will be contracted before the operation of the plant and they will be responsible for the transportation and treatment of the HTF waste according application laws and regulations of the PRC.	IA	Local EPB	250	Included in IA's operation budget
Chemicals and Hazardous Materials	Hazardous materials or chemicals can lead to soil and water pollution and risks to human health.	All toxic, hazardous, or harmful materials including petroleum products, solvents and chemicals used for water treatment must be transported in spill proof tanks with filling hoses and nozzles in working order, and stored in designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems. Material safety data sheets (MSDSs) will be posted for all hazardous materials.	IA	Local EPB	150	Included in IA's operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
	Hazardous waste may cause pollution to environment and health issues to workers.	Oil absorbents will be readily accessible in marked containers. Good housekeeping procedures will be established to avoid the risk of spills. Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility. Identify and maintain a register of all activities that involve the handling of potentially hazardous substances, as well as devise and supervise the implementation of protocols for the handling of these substances. This will include all fuels, oils, grease, lubricants, and other chemicals. Workers should be properly trained before handling hazardous wastes and have the requisite PPE. Store hazardous waste temporarily in closed containers away from direct sunlight, wind, water and rain in secure designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained. Oil sludge will be collected and disposed by licensed contractors on as needed basis. Separate hazardous waste from general waste and all hazardous waste will be contracted to the identified and certified contractor for transporting and disposal.				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		Ensure that care is taken at all times to ensure the impact of spillage of oils and other hazardous substances to be limited, and it will be cleaned up immediately.				
Wastewater	Water pollution and reuse in CSP	Wastewater from the chemical treatment facility will be pre-treated before discharging to the onsite wastewater treatment plant (WWTP) for further treatment. Wastewater collected from other parts of the CSP plant will also be sent to the onsite WWTP. Treated water from WWTP will be used for watering plants and dust suppression onsite. All runoff water from workshops, vehicles washing areas and other equipment will be collected and send to the onsite WWTP for treatment. Ensure that solid waste collection and sanitation is managed effectively in order to avoid any chances of ground and surface water pollution. Oil contaminated water will be directed to the WWTP, which is equipped with an oil/water separator. All vehicle loading/unloading points will be within a bounded area to minimize the potential impact of spills to pollute water. Any run-off that is discharged from the site must be uncontaminated and meet standards for discharge.	IA	Local EPB	1050	IA's operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
Occupational health and safety	HTF may present health and safety risks to workers in case of accidental release	Occupational heat and safety procedures, including fire prevention and control, will be developed and workers will be trained regularly. The general arrangement is designed in strict compliance with relevant standards, featuring fire compartments based on fire-resisting levels of process units and buildings to satisfy requirement on fire-prevention space. Storage tank area is surrounded by ring-shaped fire passages for fire-fighting vehicles. Fire compartments are set up based on the fire risk and fire-resisting buildings/structures, including fire-proof doors and windows. A fire-alarm system will be installed and tested regularly to make sure if functions properly. The process control system contains an out-of-limit alarm to ensure all hazardous materials under safety control at all time. PPE, including goggles, gloves, safety shoes, will be provided to workers.	IA	Local EPB, local LB, local fire station	1,620	IA's operation budget
	Natural gas and other flammable gas are fire hazards	Naked fire, hot surface, electric sparks, electrostatic spark and ignition sources like impulsive force and friction shall be strictly controlled, especially near HTF, nitrogen gas and natural gas. Control measures will also be strictly taken to ensure the discharge, exhaust and safety relief of flammable fuels in an enclosed system. The fire monitoring system will be installed to ensure safety in production and operation and provide early				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		warning to plant personnel. Important monitoring areas must have a combustible gas test detector of catalytic combustion kind which are able to make an acousto-optic alarm, and a poisonous gas test detector of electrochemistry kind capable of making an acousto-optic alarm.				
	Molten salt tanks are very hot and it may present some burn hazardous to workers	Unauthorized personnel should not be around the molten salt storage tanks. Authorized personnel must have PPE at all times to prevent burn hazards.				
Emergency Response Plan	HTF, other hazardous chemicals, and gas may create health risks to worker and pollute the environment	An emergency response plan will be prepared before the plant is operational and the plan must meet the requirements according to National Environmental Emergency Plan (24 January 2006) and relevant laws, regulations and standards. Procedures for responding to different types of emergency situations will be identified in the response plan. Emergency exercises will be conducted and they should include different emergency scenarios. **Training requirements.** Appropriate operating and maintenance employees will be trained to ensure that they are knowledgeable of the requirements of the written emergency response procedures. Training will be provided as follows: (i) Initial training to all employees before the CSP plant is put in operation; (ii) When new equipment, materials, or processes are introduced.	IA	Local EPB and Local Fire Department	100	Included in IA's operating budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		(iii) When emergency response procedures have been updated or revised. **Annual emergency simulation.** Exercise of simulated emergencies will be conducted at least annually. Simulated emergencies exercises should be documented. **Receiving notification of a possible emergency.** When a supervisor receives a report of a possible emergency situation, he/she should obtain at least the following information from the reporting person: (i) Name of person reporting emergency; (ii) Nature of Emergency - leak, fire, interruption of service if leak, place where odor is present, how long has odor been noticed. (iii) Details of emergency: location, amount, how long has the odor been noticed, what actions have been taken, etc. (iv) Leaks or other emergencies require prompt investigation. **Immediate on-site action.** The first responder will assess the nature of the report. This assessment should include the status of the emergency, an estimation of how the incident might progress, and an evaluation of the manpower, equipment, and materials needed to adequately cope with the situation. If there is a strong odor or any measurable reading of gas detected inside a structure, (i) Clear the building of all occupants;				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		(ii) Eliminate potential ignition sources. (iii) Localize or isolate the problem and shut off gas as needed. (iv) Determine the extent of the hazardous area and establish a restricted area. The responding supervisor shall determine the extent of the emergency and inform the dispatcher of the condition at the site. If emergency procedures are put into effect, the supervisor should select a location and establish an emergency command post. The responding supervisor will assign one person to remain at the command post to maintain communications until the emergency is over. When necessary, the command post will be coordinated with the local emergency responders. When local emergency responders are involved, they will be in charge of incident. The responding supervisor will make himself known to fire and/or police department officials, or other authority having jurisdiction, and will remain with them during the emergency. All employees reporting to the scene of the emergency will report to the command post for identification and instructions. Key personnel will be alerted, and it will be their				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Budget (CNY in 1,000)	Source of Funds
			Implemented by	Supervised by		
		responsibility to keep the emergency personnel under their supervision informed and available for emergency call out. When a system failure cannot be made safely by normal procedures, emergency shutdown procedures should be implemented. Reduce system pressure or segmenting a section before repair procedures are implemented. Well trained and qualified personnel will be dispatched to monitor system pressure and repair work. **Communication with Public Officials.** When an emergency resulting in a hazard to the public safety occurs, the local fire department, police, the city medical emergency center and other relevant public officials should be notified. An emergency call list will be prepared and make it available at the plant control room.				
Subtotal of Part C (per year)					**3,680**	

DI = design institute, EIA = environment impact assessment, EMP = environment monitoring plan, EMS = environment monitoring station, EPB = environment protection bureau, GRM = grievance redress mechanism, CSP = concentrated solar thermal plant, IA = implementing agency, km = kilometer, LB = labor bureau, m = meter, mg = milligram, m^3 = square meter, PRC = the People's Republic of China, SO_2 = sulfur dioxide.

Source: Domestic EIA report and TA consultants estimate.

Table A-7: ENVIRONMENTAL MONITORING PLAN

Subject	Parameter	Location	Frequency	Implemented by	Supervised by	Estimated Cost (CNY 1,000)	Source of Fund
A. Construction Phase							
Wastewater generated from construction	Inspection of wastewater mitigation measures (water collection basins and sediment traps, etc.)	The construction site	Waste water effluent sites, Daily	Contractors, CSC,	IA and CGN	30	Included in CSC's Contract
	pH, SS, oil	The construction site	One sampling each day each time, monthly	Local EMS	IA, Local EPB	10	Included in construction Contract
Ambient air	Ambient air monitoring; Inspection of dust mitigation measures (water spraying, cover transport vehicles, etc); and Inspection of maintenance and condition of vehicles and construction equipment.	The construction site and nearby areas	Monthly; Daily when there are construction activities.	IA, Contractors, CSCs	IA, Local EPB	130	Included in CSC's contract
Noise	Leq dB(A)	All sensitive receivers nearby construction site	Monthly: a day each time and two samples; once during daytime, once during nighttime.	IA, Contractors, CSCs	Local EPB	15	Included in construction contract
Construction spoil disposal	Spoil waste	Construction waste disposal sites.	At the onset of construction; Once a year; and once after completion of spoil disposal	Local EPB	CGN	40	Included in construction Contract
Subtotal						**225**	

Subject	Parameter	Location	Frequency	Implemented by	Supervised by	Estimated Cost (CNY 1,000)	Source of Fund
B. Operation Phase (solid waste)							
Noise from CSP	Leq dB(A)	1m outside of the CSPs' boundary	Monthly	IA	Local EPB, CGN	30	Included in IA's operation budgets
Wastewater and sludge from CSP[a]	Quantity generated and discharged, SS, BOD	Discharging point	Monthly	IA	Local EPB, CGN	35	Included in IA's operation budgets
Solid waste	Solid waste generated from the plant	Waste disposal site	Monthly	IA	Local EPB	5	Included in IA's operation budgets
Leakage of hazardous Materials and Wastes	Leakage of the HTF and natural gas	CSP	Real time control	IA	Local fire station, local EPB, CGN	500	Included in IA's operation budgets
Subtotal (Annual cost)						**570**	
Total						**795**	

CNY = Chinese yuan, CSC = construction supervision company, CSP = concentrated solar thermal plant, dB = decibel, EMS = environment monitoring station, EPB = environment protection bureau, IA = implementing agency, Leq = equivalent continuous noise level, NO_2 = nitrogen dioxide, pH = potential hydrogen, PM = particulate matter, SO_2 = sulfur dioxide.

[a] During the detailed engineer designing phase, all the features of the wastewater facility will be confirmed. Based on the confirmation, the monitoring location and frequency will be reviewed and revised if necessary.

Source: Domestic environment assessment report and TA consultants estimate.