Initial Environmental Examination

Project Number: 37697

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Mongolia: Darkhan Wastewater Management Improvement Project

Prepared by Ministry of Construction and Urban Development of Mongolia for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 11 August 2014)

Currency unit	–	Mongolian Tughrik (MNT)
MNT1.00	=	$0.0005
$1.00	=	MNT1,877

ABBREVIATIONS

ADB	–	Asian Development Bank
AP	–	Affected Person
BOD	–	Biological Oxygen Demand
EA	–	Executing Agency
EHSO	–	Environmental Health and Safety Officer
EMP	–	Environmental Management Plan
EIA	–	Environmental Impact Assessment
ESS	–	Environmental and Social Specialist
GHG	–	Greenhouse Gas
GOM	–	Government of Mongolia
GRM	–	Grievance Redress Mechanism
HSMP	–	Health and Safety Management Plan
IEE	–	Initial Environmental Examination
IFAS	–	Integrated Fixed-film Activated Sludge
IWRMP	–	Integrated Water Resource Management Plan
MEGD	–	Ministry of Environment and Green Development
MCUD	–	Ministry of Construction and Urban Development
MNS	–	Mongolian National Standard
MoMo	–	Integrated Water Resources Management for Central Asia: Model Region Mongolia
NGO	–	Non-Governmental Organization
NO2	–	Nitrogen Dioxide
PCB	–	Polychlorinated Biphenyl
PCU	–	Public Complaints Unit
PIU	–	Project Implementation Unit
PM	–	Particulate Matter
PMU	–	Project Management Unit
POP	–	Persistent Organic Pollutants
PPE	–	Personal Protective Equipment
PSC	–	Project Steering Committee
RCAG	–	Research Center of Astronomy and Geophysics of the Mongolian Academy of Sciences
SE	–	Supervising Engineer
SOx	–	Sulphur Oxides
SO2	–	Sulphur Dioxide
SPS	–	ADB Safeguard Policy Statement

UNEP	–	United Nations Environment Program
UNFCCC	–	United Nations Framework Convention on Climate Change
WCS	–	World Conservation Society
WFPF	–	Water Financing Partnership Facility
WHO	–	World Health Organization
WWF	–	World Wildlife Fund

WEIGHTS AND MEASURES

^{o}C	–	degree celsius
dB	–	decibel
km	–	kilometer
KWh		Kilowatt hour
m	–	meter

NOTES

In the report, "$" refers to US dollars.

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I. EXECUTIVE SUMMARY

A. Introduction and Purpose

1. This Initial Environmental Examination (IEE) has been prepared for the proposed Darkhan Wastewater Management Improvement Project, Mongolia (the project). The project targets environmentally sustainable urban development and improved living standards in Darkhan City, Mongolia. The project will contribute to a more balanced national urban system and strengthened urban-rural relationships through contribution to the development of a second tier city in the country. The project will support improvement of the city's wastewater management, its central wastewater treatment plant (WWTP), sewer system, and pumping stations. The project will support institutional development, training, project management support and policy dialogue including on water and wastewater tariff, and on sanitation.

2. Darkhan Uul-Aimag has a registered population of 92,000 and an urban population in Darkhan City (Darkhan Soum) of 72,000, of which estimated 40% live in ger areas. The city is located 220 kilometers (km) north of Ulaanbaatar and 130 km south of the Russian border. Darkhan enjoys favorable conditions for farming and is rich in mineral deposits. It was founded as an industrial hub in 1961, and situates at the Trans-Mongolian rail line and an ADB supported road that connects Ulaanbaatar with Darkhan and the Lake Baikal region. Few industrial investments were made in recent years. To strengthen development of secondary cities and to mitigate migration to Ulaanbaatar, where almost half of the country's population resides, in 2012 the government identified Darkhan to become a national model city for urban sustainability and liveability with a vision of "smart and green city" by 2028 and funded an Urban Development Master Plan, now under preparation. [1] Improvements of existing urban districts and ger areas are planned, as well as urban expansion in the form of new industrial and residential areas, strengthened academic institutions, and expanded and new public parks and environmental protection zones. By 2020, the registered population in Darkhan Soum is estimated to grow to 83,000 with 75% living in formalized and fully serviced residential districts. These industrial and residential developments will cause significant increase in demand for urban services, including piped water supply, resulting in increased wastewater flow.[2] Investment in infrastructure is needed to meet this present and future demand from improved and expanded urban services and to support clustering of new businesses and industries.

3. The city's wastewater treatment plant (WWTP) and sanitary sewer system and pumping stations, were built in 1965 and partially updated and expanded in 1987, and are in urgent need of rehabilitation, repair and/or replacement. The WWTP was significantly overdesigned with a capacity of 50,000 cubic meters per day (m^3/d) and was never fully utilized. It currently operates at 8,000 to 10,000 m3/d (summer and winter) with peak flows of 12,000 m^3/d. Many components are under-utilized or unused and dilapidated, with some operating units in a state of serious disrepair. The pumping stations and some of the sewer mains are in urgent need of replacement or repair. Sanitation in *ger* areas is currently in the form of on-plot pit latrines causing soil and groundwater pollution. Wastewater is not collected in *ger* areas and plans for incremental extension of the network are being prepared for domestic financing. The WWTP treats domestic sewage together with non-toxic industrial wastewater and some industrial pre-treatment plants remove toxic elements (i.e., from sheepskin processing, approximately 5% of total industrial wastewater flow). Breakdowns of the current system cause untreated wastewater to discharge into the Kharaa River.

[1] The terms of reference for the urban development master were approved by the State Secretary of MCUD, and are presented in Appendix 6.
[2] Industrial development projections are presented in para. 48.

4. Darkhan's centralized water supply system was recently improved and service in *ger* areas is through water kiosks, some of which are connected to the central water supply, and in some areas, kiosks are replenished by trucks. Improvement of water supply and sanitation and incremental expansion of the centralized pipe networks into *ger* areas are under preparation under a technical assistance project by the Cities Development Initiative for Asia (CDIA).

5. The proposed project is aligned with the *Government Action Plan* (2012–2016) which includes objectives of (i) improving centralized wastewater systems in *aimag* centers, (ii) enforcing the Law on Water Supply and Sewer Use (2011), and (iii) supporting the expansion of industrial development in Darkhan. The project is aligned with ADB's Strategy 2020 with its objective of inclusive economic and environmentally sustainable growth, and the project follows ADB's Urban Operational Plan[3] aiming at inclusive, green, and competitive cities. The project supports ADB's Mongolia country partnership strategy, 2012–2016. Lessons learned will be considered from previous and ongoing ADB urban and water sector projects in Mongolia.

B. Project Impact, Outcome, and Outputs

6. The project impact will be improved urban living conditions and improved environment in Darkhan City and the Kharaa River basin. The project outcome will be improved wastewater collection and treatment for domestic and industrial users in Darkhan City. The indicative outputs include:

(1) **Output 1:** Modern central wastewater treatment plant (WWTP) with a total treatment capacity of 20,000 m^3/d through structural renovation and partially new construction, and full new equipment installation with a new, efficient treatment process meeting national effluent standards constructed and operating in Darkhan;

(2) **Output 2:** Improved wastewater collection system with 1,800 meters of replaced sewer lines, and two structurally renovated, newly equipped pumping stations operating in Darkhan;

(3) **Output 3:** Institutional development, training, and sector policy dialogue to increase institutional capacity in utility project management, planning, procurement, implementation, operation, monitoring and improved efficiency of utility service provision.

C. Environmental Due Diligence, anticipated impacts, mitigation measures

7. **Categorization, due diligence.** The Project was classified as category B for environment by the Asian Development Bank (ADB). An initial environmental examination (IEE), including an environmental management plan (EMP), was prepared by the TA consultant on behalf of the Ministry of Construction and Urban Development (MCUD), the Executing Agency (EA) for the project. The EMP is presented in **Appendix EMP** of this IEE, and in Attachment 1 of the project administration manual (PAM).

8. Domestically, the project was subject to general environmental impact assessment (GEIA) by the Ministry of Environment and Green Development (MEGD). The GEIA conclusion has required the preparation of a detailed EIA (DEIA). The DEIA was prepared by a licensed EIA institute (Environ LLC), and submitted to MEGD for review and approval. The DEIA was approved by MEGD in June 2014.

9. **Anticipated environmental benefits and impacts.** The project will have substantial

[3] ADB. 2013. Urban Operational Plan 2012–2020.

environmental and socioeconomic benefits. The strengthening of Darkhan's municipal wastewater collection and treatment capacity will provide protection and improvement to Kharaa River's water environment, which is key to the sustainability of Darkhan's socio-economic development. The wastewater treatment plant will remove significant amounts of pollutants, including COD (3,000 tons per year); BOD (1,700 tons per year); nitrogen (330 tons per year); and phosphorous (42 tons per year). Findings of the IEE and DEIA show that the project does not have any predicted significant, long term or irreversible impacts on the physical, biological or socio-economic environment. The project will have short-term impacts during construction which can be mitigated to an acceptable level through mitigation measures which seek to reduce the potential for harm to the environment and human health. Dust and noise generated by sewer line rehabilitation activities will be a nuisance to nearby residents. Discharge of wastewater from construction sites could potentially pollute the Kharaa River. Mitigation measures defined in the EMP relate primarily to implementing good construction practice as well as meeting the particular needs of the project area through consultation with affected people:

(1) The impacts on soil will be mitigated through a number of measures which will control the impacts in relation to (a) soil erosion, through managing slopes, cut faces and re-vegetation; (b) soil contamination through managing use and storage of potentially polluting materials; (c) borrow pits through appropriate siting and restoration.

(2) Mitigation measures to protect sensitive receptors from air emissions and dust include (a) management of stockpiles to reduce dust; (b) good construction site practices to suppress dust; (c) covering materials during transport; and (d) siting plant for production of concrete or pavement surfaces away from receptors.

(3) Potential impacts on surface and groundwater resources may occur through accidental release of pollutants. Since the project will rehabilitate some of the existing structures of the WWTP, a key issue during construction is the sequencing of construction works to ensure continuous treatment of inflowing wastewater. Mitigation measures include (a) adequate WWTP capacity to be maintained at all times; (b) controlled storage and management of all chemicals and wastes, and (c) spill management plan to be developed.

(4) The potential impacts arising from solid waste production and disposal will be mitigated through a number of activities including (a) application of the waste hierarchy at all times; and (b) appropriate storage and containment of wastes including potential PCB wastes and PCB containing equipment which may be present in old transformers in the pumping stations. This will require a specific PCB assessment and management plan.

(5) The potential noise impacts will be mitigated through measures which include (a) source control; (b) siting noise generating activities such as concrete mixing away from receptors; and (c) operating within reasonable times and in consultation with affected people.

(6) In order to minimize the risk to community health and safety at construction sites, the focus will be on clear signage, using machinery only in day light and where possible keeping members of the public out of construction areas.

(7) The civil works contractors will implement adequate precautions to protect the occupational health and safety of construction workers and will appoint an Environment Health and Safety Officer (EHSO) to develop, implement and supervise a Health and Safety Management Plan (HSMP), as well as ensure that the requirements of the EMP are implemented.

(8) Potential short-term traffic disturbance around the important market area in Old Darkhan will be

mitigated through consulting with relevant *aimag* officers on the timing of the road excavation, and signage to warn motorists of when the road closures may be needed.

10. During operation, no significant environmental impact is anticipated. Comprehensive training and appropriate technological design will contribute significantly to reducing operational risks of the project. Prior to commissioning of the WWTP, a series of tests will be conducted to ensure proper functioning of the WWTP and ability to achieve Mongolian discharge standard. A SCADA system including wastewater quality monitoring devices for real-time monitoring of key parameters (COD, TP, NH_4-N) will be installed at the WWTP. Odor and noise generating facilities will be equipped with containment facilities. Daily check, repair and maintenance procedures will be instituted for all wastewater treatment facilities/equipment. In order to avoid pipe freezing and bursting, the depth of the pipe will be determined by a cold weather engineering specialist. Us Suvag as WWTP operator will regularly inspect the pipes and ensure the packed earth is in good condition. WWTP sludge will be dewatered through filter press, and disposed of in existing on-site sludge drying beds (60-ha storage capacity, see Figure III-3), to be partly rehabilitated under the project. An emergency preparedness and response plan will be formulated and put in place before the WWTP becomes operational. The emergency preparedness and response plan will address, among other things, training, resources, responsibilities, communication, procedures, and other aspects required to respond effectively to emergencies associated with the risk of accidental discharges. The discharge of treated effluent will have no significant impact on the water quality of the Kharaa River.

11. **EMP implementation responsibilities.** The EMP specifies the roles and responsibilities of key project stakeholders (including MCUD, the PMU, Us Suvag LLC, Darkhan-Uul aimag, the PIU, MEGD, State Professional Inspection Agency, contractors, and loan implementation environment consultants) in overall environmental management:

(1) MCUD as executing agency has the overall responsibility for compliance with safeguards plans. A <u>project management unit (PMU) within MCUD</u> will manage the procurement process, including but not limited to: (i) updating the IEE and EMP after detailed design (as needed), including submission to ADB for clearance and web-disclosure; (ii) overseeing incorporation of EMP recommendations into the bidding documents; (iii) ensuring the procurement of environmentally responsible contractors; (iv) ensuring that DEIA approval by MEGD has been secured prior to the awarding of civil works contract.

(2) The PMU will procure the services of <u>loan implementation environment consultants (LIEC)</u> to provide support in (i) project preparation including updating the project EMP; (ii) training; (iii) regular environmental quality monitoring (air, surface and ground water, and noise) in compliance with the monitoring plan; (iv) annual project EMP progress reporting; and (v) identifying environment-related implementation issues and necessary corrective actions.

(3) A project implementing unit (PIU) will be established under Darkhan Uul-Aimag Government (DAG, the Implementing Agency) to handle day-to-day activities under the project. The PIU will be staffed with at least one safeguard staff (PIU-SS). Under the guidance of the LIEC, the PIU-SS will be responsible for the supervision of the implementation of the EMP, including (but not limited to) (i) setting up and coordinating the grievance redress mechanism (GRM, see below); (ii) monitoring contractors to ensure adherence to the project EMP and the contractor EMPs; (iii) preparing quarterly reports on project EMP implementation to the PMU; (iv) coordinating consultation with local stakeholders as required, informing them of imminent construction works, updating them on the latest project development activities, GRM, etc.; and (v) coordinating the conduct of periodic environment monitoring by licensed monitoring entities, as defined in the monitoring program.

(4) Civil works contractors (3 contracts) will be required to formulate contractor EMPs with complete management systems for adverse impacts, e.g., dust control, noise control, traffic management, addressing as minimum the requirements of the EMP (Appendix EMP) and the DEIA. The contractor EMPs will be renewed on a yearly basis, submitted to PIU and PMU for review, and to MEGD for approval. To ensure that the contractors comply with the EMP provisions, the PMU will prepare and provide the following specification clauses for incorporation into the bidding procedures: (i) a list of environmental management requirements to be budgeted by the bidders in their proposals; (ii) environmental clauses for contractual terms and conditions; and (iii) the full project EMP and DEIA in Mongolian.

D. Consultation, information disclosure, grievance redress mechanism (GRM)

12. **Environmental grievance redress mechanism.** Environment safeguards related complaints or disputes will be handled in accordance with the grievance redress mechanism (GRM) established for the project. The PIU will coordinate the environment GRM, with support of the LIEC. The GRM is defined in the EMP, and links to the social safeguards GRM.

13. **Consultation, information disclosure.** The stakeholder consultation process conducted during the development of the IEE, particularly with Darkhan *aimag* and Us Suvag, demonstrated that the project has local support as it will result in benefits in terms of the long term environmental and social sustainability of Darkhan's WWTP. In compliance with ADB's Safeguard Policy Statement (2009), environmental information related to the Project was and/or will be disclosed as follows: (i) this initial environmental examination (IEE) is disclosed on ADB's project website (www.adb.org), and is available for consultation in the PIU's and PMU's office; (ii) the detailed environmental impact assessment (DEIA) approved by the Ministry of Environment and Green Development (MEGD) is disclosed on the MEGD website; and (iii) annual reports on project's compliance with the EMP will be available at www.adb.org.

E. Risks and assurances

14. Risks and risk mitigating measures have been identified in the risk assessment and risk management plan. One of the risks is damage to the wastewater treatment process from the discharge of potentially toxic wastewater from new industries that will locate in Darkhan. To mitigate the risk, the Government will ensure to enforce the order No a/11/05/A/18 of January 10 1997 which prescribes the "Allowable limits of industrial wastewater composition before letting effluents into the central wastewater system". Further, the project will support the government with policy mechanisms to enable industries with the development of their wastewater pre-treatment facilities i.e. through tax incentives. The project will also support Darkhan Us Suvag with (i) developing mechanisms to effectively monitor industrial wastewater composition before it enters the public sewer system; (ii) strengthening emergency measures to ensure toxic flows are retained and/or diverted so they do not enter the sewer system[4]; and (iii) advising existing and new industries on optimal technology solutions for their respective industrial processes in case of potential toxic effluents.

15. The Government, MCUD and Darkhan-Uul Aimag government have assured ADB that implementation of the project shall conform to all applicable ADB policies including those concerning anticorruption measures, safeguards, procurement, consulting services, and disbursement as described in detail in the project administration manual and in the draft loan agreement. In addition to

[4] The current system includes an overflow from PS1 conveying wastewater via an existing channel to a large fly ash containment pond. The emergency system, including online monitoring of industrial wastewaters, will be strengthened through the MoMo Phase III project, to be financed by the German Government in 2015, and through project output 3 (project implementation support, institutional advice for setting industrial wastewater monitoring online monitoring).

these standard assurances, the Government has agreed with ADB on a series of assurances, defined in the draft project agreement (and listed in conclusion chapter).

F. Structure of the Initial Environment Examination (IEE)

16. This IEE report is structured as follows:

(1) *Executive Summary* – outlines important facts, major findings, and recommended actions of this IEE;

(2) *Policy, Legal, and Administrative Framework* – presents the national and local legal and institutional framework within which the IEE is carried out. It describes the environmental categorization by ADB and MEDG;

(3) *Description of the Project* – provides a detailed description of the project, including project location and components and implementation schedule;

(4) *Description of the Environment (Baseline Data)* – defines relevant physical, biological, and socioeconomic conditions within the project area. ADB SPS (2009) requires environmental assessments to address induced impacts and risks to (i) physical; (ii) biological; (iii) socioeconomic including physical cultural resources in the context of the project's area of influence; and (v) potential trans-boundary and global impacts, including climate change;

(5) *Anticipated Environmental Impacts and Mitigation Measures* – predicts and assesses the project's likely positive and negative direct and indirect impacts to physical, biological, socioeconomic, and physical cultural resources in the project's area of influence; identifies mitigation measures and any residual negative impacts that cannot be mitigated;

(6) *Analysis of Alternatives* – examines alternatives to the proposed project site, technology, design, and operation, including the no project alternative;

(7) *Information Disclosure, Consultation, and Participation* – describes the process undertaken during project design and preparation for engaging stakeholders, including information disclosure and consultation with affected people and other stakeholders and addressing the comments raised in consultation;

(8) *Grievance Redress Mechanism (GRM)* – presents the GRM established to handle grievances and complaints arising during project implementation. It defines GRM entry points, timeframe and institutional responsibilities within the GRM.

(9) *Environmental Management Plan (EMP)* – defines the mitigation measures, performance indicators, environmental monitoring requirements, institutional responsibilities, training activities related to environmental management, reporting requirements, and a mechanism for feedback and adjustment.

(10) *Conclusion and Recommendation* – summarizes the major environmental impacts and mitigation measures and concludes on the environmental soundness of the project.

(11) *Appendixes* – includes the EMP; a description of existing water supply, sewerage system, pumping stations, and wastewater treatment facility; a wastewater treatment plant reconstruction sequencing and design layout; an audit of Darkhan wastewater treatment

plant; details of pump station and sewer network rehabilitation requirements; and a wastewater treatment plant alternative analysis.

G. Conclusion

17. The IEE concludes that the project will not have any significant, long term or irreversible impacts on the physical, biological or socio-economic environment. The project will have short term impacts during construction which can be mitigated to an acceptable level through mitigation measures which seek to reduce the potential for harm to the environment and human health. These measures relate primarily to implementing good construction practice as well as meeting the particular needs of the project area through consultation with affected people. Good practice through comprehensive training and appropriate technological design will also contribute significantly to reducing the operational impacts of the project.

18. The project will have significant positive environmental benefits. It will lead to improved water quality in the Kharaa River as the effluent quality from the WWTP will be significantly improved over the long term. The use of modern technology and replacement of the outdated and broken equipment will lead to better wastewater and sludge management which will benefit the environment and the residents of the city. Category B for environment is confirmed. The project is feasible from an environment safeguards point of view.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Mongolia's Environmental Policy

19. **Policy framework.** Mongolia has enacted a comprehensive policy and legal framework for environmental management. It has policies, legislation and strategies in place to manage the protected estate, to satisfy its international obligations and to protect the quality of the environment for the health and well-being of its citizens. The hierarchy of policies and legislative provisions for environmental management in Mongolia comprises five layers ranging from the Constitution to international treaties, and to environment and resources protection laws. [5]

20. The main policy documents include the National Environmental Action Plan of 1996, updated in 2000; the State Policy for Ecology of 1997; the National Plan of Action to Combat Desertification, updated in 2010; the Biodiversity Conservation Action Plan of 1996 (now the Rare Animals Protection Plan of 2012); and the National Plan of Action for Protected Areas, all developed under the Ministry of Environment and Green Development (MEGD) auspices, as well as the Mongolian Action Programme for the 21st Century, developed by the National Council for Sustainable Development in 1996. The National Action Plan for Climate Change was added in 2000 and updated in 2011. Several program documents, e.g., the National Water Program (updated in 2011), National Forestry Program; Program of Protection of Air; Sustainable Development Education Program (2009-2019); Special Protected Areas; and Protection of Ozone Layer; were also completed at the turn of the decade. In addition, other guidance documents with important environmental repercussions were developed under the auspices of other ministries and these include the Roads Master Plan, the Power Sector Master Plan, the Tourism Master Plan, and the Renewable Energy Master Plan. Other documents, such as the annual Human Development Reports, have increasingly incorporated environmental aspects.[1]

21. The overarching policy on environmental resources and their protection is set out in the 1992 Constitution of Mongolia. Proceeding from, and conformable to, the Constitution, the Government of Mongolia (GoM) has enacted a series of environmental laws, regulations and standards. Among these, the Law on Environmental Protection and Law on Environmental Impact Assessment provide the core framework and general procedure and guidelines on environmental assessment.

5 Institutional Structures for Environmental Management in Mongolia. August 2008. UNDP.

Table II-1: Relevant Environmental Laws in Mongolia

Law	Year	Purpose
Law on Subsoil	1988	Regulates relations concerning the use & protection of subsoil in the interests of present and future generations.
Law on Special Protected Areas	1994 (2004)	Regulates relations concerning the use & taking of areas under special protection (natural conservation parks, natural complex areas, natural reserves & national monument areas).
Law on Land	1994 (2012)	Regulates the possession & use of land by a citizen, entity & organization, & other related issues. Articles 42/43 provide guide on removing possessed land & granting of compensation relative to removing.
Law on Environmental Protection	1995 (2012)	Regulates "relations between the state, citizens, economic entities & organizations in order to guarantee the human right to live in a healthy and safe environment, have ecologically balanced social and economic development, & for the protection of the environment for present & future generations, the proper use of natural resources & restoration of available resources". Its Article 7 requires the conduct of natural resource assessment & environmental impact assessment to preserve the natural state of the environment, and Article 10, the conduct of environmental monitoring on the state and changes of the environment.
Law on Air	2012	Regulates the protection of the atmosphere to provide environmental balance & for the sake of present & future generations. Allows Government to set standard limits to emissions from all sources. Provides for the regular monitoring of air pollution, hazardous impacts & changes in small air components such as ozone and hydrogen.
Law on Forests	2012	Regulates relations for protection, possession, sustainable use & reproduction of the forest in Mongolia. Defines prohibited activities in protected forest zones & their regimes & conditions when undertaking allowed activities in the utilization zone forests & their regimes.
Law on Natural Plants	1995	Regulates the protection, proper use, & restoration of natural plants other than forest & cultivated plants.
Water Law	2012	Regulates relations pertaining to the effective use, protection & restoration of water resources. Specifies regular monitoring of the levels of water resources, quality & pollution. Provides safeguards against water pollution.
Law on Water Pollution Fees	2012	Introduces fees payable for pollution of water resources
Law on Plant Protection	1996 (2007)	Regulates the inhibition, protection, inspection of pasturelands & plants.
Law on Buffer Zones	1997	Regulates the determination of special protected area buffer zones & the activities. Article 9 requires the conduct of detailed environmental assessment for the establishment of water reservoirs or construction of floodwalls or dams in buffer zones for special protected areas.

Law	Year	Purpose
Law on Environmental Impact Assessment	1998 (2012)	Regulates "relations concerning protection of the environment, prevention of ecological imbalance, the use of natural resources, assessment of the environmental impact and decision-making on the start of a project". It sets out the general requirements and procedures for project screening and conduct of environmental assessment and review.
Law on Sanitation	1998	Governs relationships concerning maintenance of sanitary conditions, defining the general requirements for sanitation in order to ensure the right of an individual to healthy & safe working & living conditions, ensuring normal sanitary conditions, & defining the rights & duties of individuals, economic entities & organizations with this respect.
Law on Protection of Cultural Heritage	2001	Regulates the collection, registration, research, classification, evaluation, preservation, protection, promotion, restoration, possession and usage of cultural heritage including tangible and intangible heritage.
Civil Code of Mongolia	2002	Its Article 502 stipulates the liability for damage to environment.
Law on Wastes	2012	Governs the collection, transportation, storage, & depositing in landfills of household & industrial waste, & re-using waste as a source of raw materials to eliminate hazardous impacts of household and industrial waste on public health & the environment. Undertakings that generate significant amount of wastes must dispose of the wastes in designated landfills that meet prescribed standards.
Law on Disaster Protection	2003 (2012)	Regulates matters relating to the principles & full powers of disaster protection organizations & agencies, their organization & activities, as well as the rights & duties of the State, local authorities, enterprises, entities & individuals in relation to disaster protection.
Law on soil protection and prevention from desertification	2012	Regulates matters related protection of soil deterioration, reclamation, and prevention from desertification
Law on fauna	2012	Regulates matters related protection of animals, growth and development, breeding, rational use of its resources.

Note: (year last amended)

22. **Water and wastewater sector strategy.** The laws of Mongolia which govern water use have been revised and consolidated, and new laws have been adopted over recent years. The Law of Mongolia on Water dated 22 April 2004 ("Old Water Law") has been replaced with a revised version of the Law of Mongolia on Water dated 17 May 2012 ("Water Law"). The Law of Mongolia on Fees for Use of Water and Minerals has been consolidated with other laws on the use of natural resources and is replaced with the Law of Mongolia on Natural Resources Use Fee dated 17 May 2012 ("Natural Resources Use Fee Law"). On 17 May 2012, the Law of Mongolia on Water Pollution Fees was newly adopted to introduce fees payable for pollution of water resources ("Water Pollution Fees Law"). [6]

23. The overall effect of these changes is that under the Water Law, the Government has the authority to determine the intrinsic environmental value of water resources for each region or river

[6] Based on: Revision of Environmental Laws in Mongolia and its impact on the mining sector, October 2012, Hogan Lovells, Ulaanbaatar.

basin. Currently, governmental resolution No. 302 dated 26 October 2011 sets out the intrinsic environmental value for each river basin in amounts ranging from MNT 800 to MNT 2651 per cubic metre for surface water, and MNT 1510 to MNT 9440 per cubic meter for sub-surface water (groundwater). The fee will be payable on a monthly basis and the user must also submit an annual report for water use fees.

24. In the wastewater sector, to implement the "polluter pays" principle in terms of water resources, the Water Pollution Fees Law introduces fees payable by entities and organizations that pollute water resources, and sets out the maximum and minimum amount of water pollution fees per polluting substance type.[7] The Government will set the specific fees payable in each water drainage basin taking into account the volume and quality of the water resources contained therein.

25. **Urban environmental policy and strategy.** There is no specific Government policy relating directly to urban environmental matters. The Government's overall policy for environmental protection, including the following of EIA procedures for public sector project proposals, provides the urban environmental protection framework.

26. The Government is promoting urban greening as part of the reforestation and green agenda of the Ministry for Environment and Green Development (MEGD). This builds on the statutory provisions within the urban planning laws of Mongolia which set out minimum requirements for public open space which are in turn reflected in the development tables accompanying each master plan (including the current Master plan for Darkhan). As with all ex-soviet countries, the guidelines for development set out very prescriptive requirements assigning areas in percentage terms – including those for green space. In this context, the Soum Government of Darkhan is proposing the establishment of an urban green zone between the built-up areas of Old and New Darkhan and the Kharaa River as part of its "smart and green city" concept.

27. **International conventions.** Mongolia is a party to the international environmental conventions and protocols. It has passed state laws that implement the terms of these international conventions, with provision that: "If an international treaty to which Mongolia is a party is inconsistent with this law then the provisions of the international treaty shall prevail".

Table II-2: Relevant International Environmental Conventions

International Convention / Protocol	Year of Party
World Heritage Convention	1990 (a)
United Nations Framework Convention on Climate Change	1993 (r)
Kyoto Protocol	1999 (a)
Convention on Biological Diversity	1993 (r)
United Nations Convention to Combat Desertification	1996 (r)
Vienna Convention for the Protection of the Ozone Layer	1996 (a)
Montreal Protocol on Substances That Deplete the Ozone Layer	1996 (a)
Washington Convention on International Trade in Endangered Species of Wild Fauna & Flora (CITES)	1996 (a)
Basel Convention on the Control of Transboundary Movements of the Hazardous Wastes and Their Disposal	1997 (a)

7 This sub-divides polluting load by: low density substance; organic substance; minerals; heavy metals; and toxic substances, but does not assign an acceptable value or fee rate for exceedence to each.

International Convention / Protocol	Year of Party
Ramsar Convention on Wetlands of International Importance	1998 (e)
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	2001 (r)
Stockholm Convention on Persistent Organic Pollutants	2004 (r)

Note: (a) accession; (e) entry into force; (r) ratification.

28. **Climate change policy.** Mongolia has joined 14 environment-related UN Conventions and Treaties, including the UN Framework Convention on Climate Change (UNFCCC). Nationally, the Mongolian Action Program for the 21st Century (MAP 21) includes considerations and recommendations related to climate change adaptation and the mitigation of Greenhouse gas (GHG) emissions. In order to comply with the obligations and commitments under the UNFCCC as well as to address challenges relevant to climate change, Mongolia has developed its National Action Program on Climate Change, which received Government approval in 2000 and was updated in 2010. The action program includes the national policy and strategy to tackle impacts of climate change and to mitigate GHG emissions. It also sets priorities for action and to integrate climate change concerns into other national and sectoral development plans. In order to fulfill the requirements of the National Program on Climate Change, an inter-disciplinary and inter-sectoral National Climate Committee has been established by the government and is led by MEGD. The Committee coordinates and guides national activities and measures aimed at adapting to climate change and mitigating GHG emissions.

29. Regarding *climate change mitigation*, the government has undertaken to mitigate GHG emissions through a range of strategies for sustainable development covering different sectors including energy, waste, transportation and agriculture. Of specific relevance to the project is the strategy for ' Improvement of energy efficiency in Industry'. Policy measures which will implement this strategy relate to (i) equipment efficiency improvements and good housekeeping; and (ii) technology changes.[8] The energy efficiency gains of the project are fully aligned to the policy.

30. Regarding *climate change adaptation*, the government has outlined strategies relating to the following sectors: animal husbandry, arable farming, water resources, human health, and forestry. Each sector has a number of strategies and policies and measures relating to the strategy. In the water resource sector, one of the strategies is ‘improved water resource management’ and the measure to implement it is ‘developing and implementing integrated river basin management policy and plans in the river basins and at national level, coping with desertification’. Another target area is the strategy for 'improved water quality' to be implemented through 'advancing the level of water purification and sewage water treatment plants in urban areas'. The project fully supports this policy measure.

B. Environmental Impact Assessment Requirements

31. The project is subject to the environmental safeguards requirements of both Mongolia and those of the ADB. These requirements are defined in the next two sections.

(1) Environmental Assessment Requirements of the ADB

32. Safeguard requirements for all projects funded by ADB are defined in ADB SPS (2009). SPS 2009 establishes an environmental review process to ensure that projects undertaken as part of programs funded through ADB loans are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and are not likely to cause significant environmental, health, or

[8] Mongolia’s Second National Communication on Climate Change

safety hazards. SPS 2009 is underpinned by the ADB Operations Manual, Bank Policy (OM F1, 2010). The policy promotes international good practice as reflected in internationally recognized standards such as the *World Bank Group's Environmental, Health and Safety Guidelines*[9].

33. SPS 2009 environmental assessment requirements specify that:

(i) At an early stage of project preparation, the borrower/client will identify potential direct, indirect, cumulative and induced environmental impacts on and risks to physical, biological, socioeconomic, and cultural resources and determine their significance and scope, in consultation with stakeholders, including affected people and concerned NGOs. If potentially adverse environmental impacts and risks are identified, the borrower/client will undertake an environmental assessment as early as possible in the project cycle. For projects with potentially significant adverse impacts that are diverse, irreversible, or unprecedented, the borrower/client will examine alternatives to the project's location, design, technology, and components that would avoid, and, if avoidance is not possible, minimize adverse environmental impacts and risks;
(ii) The assessment process will be based on current information, including an accurate project description, and appropriate environmental and social baseline data;
(iii) Impacts and risks will be analyzed in the context of the project's area of influence;
(iv) Environmental impacts and risks will be analyzed for all relevant stages of the project cycle, including preconstruction, construction, operations, decommissioning, and post-closure activities such as rehabilitation or restoration;
(v) The assessment will identify potential trans-boundary effects as well as global impacts; and
(vi) Depending on the significance of project impacts and risks, the assessment may comprise a full-scale environmental impact assessment (EIA) for category A projects, an initial environmental examination (IEE) or equivalent process for category B projects, or a desk review.

34. Other key requirements of SPS 2009 include:

(i) *Environmental Management Plan.* The borrower/client will prepare an environmental management plan (EMP) that addresses the potential impacts and risks identified by the environmental assessment.
(ii) *Consultation and Participation.* The borrower/client will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.
(iii) *Information disclosure.* The borrower/client will submit to ADB the following documents for disclosure on ADB's website: (i) a draft full EIA/IEE (including the draft EMP) at least 120 days prior to ADB Board consideration; (ii) the final EIA/IEE; (iii) a new or updated EIA/IEE and corrective action plan prepared during project implementation, if any; and (iv) semi-annual environmental monitoring reports.
(iv) *Grievance Redress Mechanism.* The borrower/client will establish a mechanism to receive and facilitate resolution of affected people's concerns, complaints, and grievances about the project's environmental performance.
(v) *Monitoring.* The borrower/client will monitor and measure the progress of implementation of the EMP.

[9] New Version of the "World Bank Group Environmental, Health, and Safety Guidelines", April 30, 2007, Washington, USA. http://www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

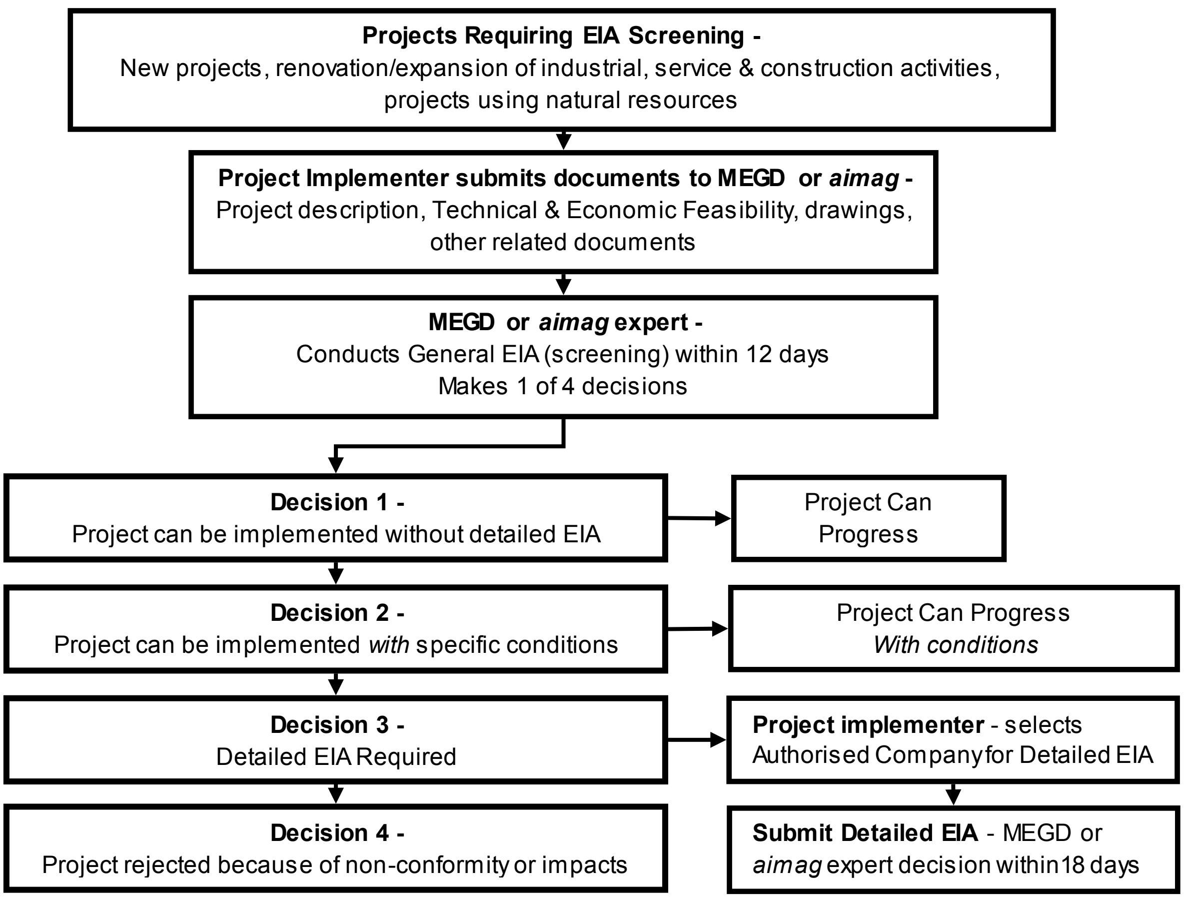
35. This IEE is intended to meet SPS 2009 requirements.

(2) Environmental Assessment Requirements of Mongolia

36. The EIA requirements of Mongolia are regulated by the Law on EIA (1998, amended 2002[10] and amended 2012). The terms of the law apply to all new projects, as well as rehabilitation and expansion of existing industrial, service or construction activities and projects that use natural resources.

37. The most recent amendment to the law was adopted in 2012 and was brought into force in 2013, implemented through a new Environmental Impact Assessment Regulation.[11] The purpose of the EIA law is environmental protection, the prevention of ecological imbalance, the regulation of natural resource use, the assessment of environmental impacts of projects and procedures for decision-making regarding the implementation of projects. The EIA process in Mongolia is summarized in **Figure II-1.**

Figure II-1: EIA Process in Mongolia



Source: Adapted from Vol. 1 (2001) Compendium of Laws: A Mongolian Citizens Reference Book

[10] Law of Mongolia on Environmental Impact Assessments (1998, amended in 2002). Unofficial translation available from http://cdm-mongolia.com.

[11] The new EIA Regulation revokes 2 Regulations and 1 Guideline document which do not meet the requirements of the EIA Law. The revoked legislation is: Regulation on the Environmental Impact Assessment Committee (2006); Guidelines on Formulating EPPs and EMPs (2000); and Regulation on Detailed EIA Appraisal (2006). These regulations are superseded by the EIA Law.

38. The type and size of the planned activity define responsibility as either MEGD or *aimag* (provincial) government. There are two types of EIA defined in the Law:

(i) **General EIA (screening)** - to initiate a General EIA, the project implementer submits to MEDG (or *aimag* government) a brief description of the project including feasibility study, technical details, drawings, and other information. The General EIA may lead to one of four conclusions: (i) no detailed EIA is necessary, (ii) the project may be completed pursuant to specific conditions, (iii) a Detailed EIA is necessary, or (iv) project cancellation. The General EIA is free and usually takes up to 12 days.

(ii) **Detailed EIA** – the scope is defined by the General EIA. The Detailed EIA report must be produced by a Mongolian company which is authorized by MEDG by means of a special procedure. The developer of the Detailed EIA should submit it to MEDG (or *aimag* government). An expert of the organization who was involved in conducting General EIA should make a review of the Detailed EIA within 18 days and present it to MEDG (or *aimag* government). Based on the conclusion of the expert, the MEDG (or *aimag* government) takes a decision about approval or disapproval of the project.

(iii) The Detailed EIA must contain the following chapters: (i) Environmental baseline data; (ii) Project alternatives; (iii) Recommendations for minimizing, mitigation and elimination of impacts; (iv) Analysis of extent and distribution of adverse impacts and their consequences; (v) Risk assessment; (vi) Environmental Protection Plan; (vii) Environmental Monitoring Program; and (viii) Opinions of residents on whether the project should be implemented.

C. Environmental, health and safety standards

39. Key standards applied in the DEIA and the IEE include the following: (i) the ambient water quality standard (MNS 4586:1998), Table II-3; (ii) Air quality general technical requirements (MNS 4585:2007), Table II-5; (iii) Groundwater quality standard (MNS 900:2005), and the WHO Guidelines for Drinking-water Quality, Fourth Edition (2011), Table II-4; (iv) Soil Quality, Soil Pollutant Elements and Substances Standard (MNS 5850:2008), Table II-6; (vi) Ambient Noise Standard (MNS 4585:2007), Table II-7; and (vii) the occupational health and safety standard (MNS 5002:2000). These standards are described below.

Table II-3: Ambient surface water quality standard MNS 4586:1998

Parameter	MNS 4586-98	
pH		6.5-8.5
DO	mgO/l	not less than 6&4 *
BOD	mgO/l	3
NH_4-N	mgN/l	0.5
NO_2-N	mgN/l	0.002
NO_3-N	mgN/l	9
PO_4-P	mgP/l	0.1
Cl	mg/l	300
F	mg/l	1.5
SO_4	mg/l	100
Mn	mg/l	0.1
Ni	mg/l	0.01
Cu	mg/l	0.01
Mo	mg/l	0.25
Cd	mg/l	0.005
Co	mg/l	0.01
Pb	mg/l	0.01
As	mg/l	0.01
Cr	mg/l	0.05
Cr^{6+}	mg/l	0.01
Zn	mg/l	0.01
Hg	mg/l	0.1
Oil	mg/l	0.05
Phenol	mg/l	0.001
Active and washing substances	mg/l	0.1
Benzapyren	Mkg/l	0.005

* DO >6 mgO/l for summer time and DO >4 mgO/l for winter time

Table II-4: Groundwater quality standard MNS 900:2005

Parameter	MNS 900:2005		WHO Guidelines for Drinking Water Quality, Fourth Edition. 2011	
Na^+	mg/l	200		None established
K^+	mg/l	200		None established
Ca^{2+}	mg/l	100		-
Mg^{2+}	mg/l	30		-
$S0_4^{2}$	mg/l	500		None established
HCO_3	mg/l	-		-
CO_3^{2}	mg/l	-		-
Cl	mg/l	350	mg/l	5
P	mg/l	0.7-1.5		-
Br		-		None established
Test, by mark	mg/l	2		-
Color	degree	20°		None proposed
Odor	mark	2		-
pH		6.5-8.5		None established
Electric Conductivity Y S/st		-		-
General Minerals		1000		-
Hardness	mg-eqv/l	7		None established
Acidity potential	mB			-
Solid remains	g/l	1		-
NH_4	mg/l	1.5		None established
NO_3	mg/l	50	mg/l	50
NO_2	mg/l	1	mg/l	3
PO_4	mg/l	3.5		-
As	mg/l	0.01	mg/l	0.01
Fe	mg/l	0.3		None established
Pb	mg/l	0.03	mg/l	0.01
Ni	mg/l	0.02	mg/l	0.07
Cr	mg/l	0.05	mg/l	0.05
Cu	mg/l	0.1	mg/l	2
Zn	mg/l	5		None established
Mn	mg/l	0.1		None established
Cd	mg/l	0.003	mg/l	0.003
Hg	mg/l	0.0005	mg/l	0.006
B	mg/l	0.5	mg/l	2.4
Ba	mg/l	0.7	mg/l	0.7
Mo	mg/l	0.07		None estabished
Se	mg/l	0.01	mg/l	0.04
E.coli or thermotolerant coliform bacteria		-		Must not be detectable in any 100 ml sample.

MNS 900:2005, Drinking Water Hygienic Requirement and Qualtity Control is the stadard used for groundwater supply, which is the source for drinking water supply in Mongolia.

Table II-5: Ambient air quality standard MNS 4585:2007

Parameter	MNS 4585:2007		EHS Guidelines. World Health Organization (WHO). Air Quality Guidelines Global Update, 2005)	
SO_2	24-hour	20	24-hour	125 (Interim target-1)
				50 (Interim target-2)
				20 (guideline)
	10 minute	500	10 minute	500 (guideline)
NO_2	1-year	30	1-year	40 (guideline)
	24-hour	40	24-hour	-
	20-min	85	1-hour	200 (guideline)
PM_{10}	1-year	50	1-year	70 (Interim target-1)
				50 (Interim target-2)
				30 (Interim target-3)
				20 (guideline)
	24-hour	100	24-hour	150 (Interim target-1)
				100 (Interim target-2)
				75 (Interim target-3)
				50 (guideline)
$PM_{2.5}$	1-year	25	1-year	35 (Interim target-1)
				25 (Interim target-2)
				15 (Interim target-3)
				10 (guideline)
	24-hour	50	24-hour	75 (Interim target-1)
				50 (Interim target-2)
				37.5 (Interim target-3)
				25 (guideline)
CO	Average in 1 hour	30g/m3	No standard	

Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines.

Table II-6: Soil quality standard MNS 5850:2008

Parameter	MNS 5850 :2008			
	Soil Mechanical Composition			Maximum Acceptable Amount
	Clay	Loamy	Sandy	
Pb	100	70	50	100
Cd	3	1.5	1	3
Hg	2	1	0.5	2
As	6	4	2	6
Cr	150	100	60	150
Cr^{6+}	4	3	2	4
Sn	50	40	30	50
Sr	800	700	600	800
V	150	130	100	150
Cu	100	80	60	100
Ni	150	100	60	150
Co	50	40	30	50
Zn	300	150	100	300
Mo	5	3	2	5
Se	10	8	6	10
B	25	20	15	25
F	200	150	100	200
CN	25	15	10	25

Table II-7: Ambient noise standard MNS 4585:2007

	Maximum allowable noise limit (hourly measurement), 1hr LA_{eq} in dB(A)	
Standard	**Day** (07:00-22:00)	**Night** (22:00-07:00)
IFC Guideline: Industrial/ Commercial	70	70
IFC Guideline: Residential/ Institutional/ Educational	55	45
MNS 4585:2007	60	45

Source: Oyu Tolgoi EIA 2012

40. Mongolian National Standard for Ambient Noise MNS 4585:2007 sets an allowable limit for noise in daytime at 60 dB, and night at 45 dB, with night being 10pm-6am according to the Act on Labor. These standards can be compared to the more detailed WHO guidelines which recommend that indoor noise levels should not exceed 30 dB (average equivalent over 8 hours LA_{eq}) and 45 dB (maximum for an individual noise event), and outdoor sound levels should not exceed 50 dB LA_{eq}. Comparison is made with IFC standards in Table II-7, which shows that IFC guidelines are slightly more stringent that the national standard for residential day time permissible levels.

41. The **standard for wastewater discharge** to water bodies (MNS 4943:2011) has been recently revised (2011) and now aligns quite closely with European Standards. It appears to be both consistent with international standards and appropriate for Mongolian conditions (Table II-8). The standard for wastewater discharge to a public sewer (Regulation number No a/11/05/A/18: Allowed Limits of Industrial Wastewater Composition Before Letting Effluents into the Central Wastewater Treatment Systems) is older (1997) and based on Russian standards (Table II-9).

Table II-8: Standard for wastewater discharge to water bodies (MNS 4943:2011)

№	Parameter	Measuring unit	Maximum allowance
1	Water temperature	C	20
2	Hydrogen ion activity (pH)	-	6-9
3	Odor	Sense	No bad smell
4	Suspended solids (SS)	mg/l	50
5	Biochemical Oxygen Demand (BOD)	mg/l	20
6	Chemical Oxygen Demand (COD)	mg/l	50
7	Permanganate	mg/l	20
8	Dissolved Salt	mg/l	100
9	Ammonia Nitrogen (NH4-N)	mg/l	6
10	Total Nitrogen (TN)	mg/l	15
11	Total Phosphorous (TP)	mg/l	1.5
12	Organic Phosphorous(DOP)	mg/l	0.2
13	Hydrogen Sulphide (H2S)	mg/l	1
14	Total Iron (Fe)	mg/l	1
15	Aluminum (Al)	mg/l	0.5
16	Manganese (MN)	mg/l	0.5
17	Total Chromium (Cr)	mg/l	03
18	Chromium+6 (Cr+6)	mg/l	Not specified
19	Total cyanide (CN)	mg/l	0.05
20	Free cyanide (CN)	mg/l	0.05
21	Copper (Cu)	mg/l	0.3
22	Boron (B)	mg/l	0.3
23	Lead (Pb)	mg/l	0.1
24	Zinc (Zn)	mg/l	1.0
25	Cadmium (Cd)	mg/l	0.03
26	Antimony (Sb)	mg/l	0.05
27	Mercury (Hg)	mg/l	0.01
28	Molybdenum (Mo)	mg/l	0.5
29	Total Arsenic (As)	mg/l	0.01
30	Nickel (Ni)	mg/l	0.2
31	Selenium (Se)	mg/l	0.02
32	Beryllium (Be)	mg/l	0.001
33	Cobalt (Co)	mg/l	0.02
34	Barium (Ba)	mg/l	1.5
35	Strontium (Sr)	mg/l	2
36	Vanadium (V)	mg/l	0.1
37	Uranium (U)	mg/l	0.05
38	Mineral oil	mg/l	1
39	Fat oil	mg/l	5
40	Surface active agents	mg/l	2.5
41	Fhenol (C5H2OH)	mg/l	0.05
42	Threchloretilen	mg/l	0.2
43	Tetrachloretilen	mg/l	0.1
44	Remained chlorine (Cl)	mg/l	1
45	Faecal coliforms	No/100ml	Not occurring in 1 ml.

Table II-9: Allowable limits of industrial wastewater composition before letting effluents into the public sewers and central wastewater treatment systems (Regulation No a/11/05/A/18)

№	Parameters	In UB	In other urban areas
1	Suspended solids (SS)	400.0	500.0
2	Biochemical Oxygen Demand (BOD)	200.0-400.0	250.0-500.0
3	Chemical Oxygen Demand (COD)	400.0-800.0	500.0-1000.0
4	Copper	0.5-1.0	0.5
5	Petroleum	0.07-0.1	5.0
6	Sulphate	1355.0-1500.0	1500.0
7	Sulphide	10.0	10.0
8	Nickel	0.5-0.65	0.65
9	Lead	0.07	0.1
10	Chromium+6	0.27-0.5	0.2-0.5
11	Total Chromium	2.5-5.0	2.5-5.0
12	Zinc	1.0	1.0
13	All types of washing chemicals	5.0-10.0	10.0-20.0
14	Phenol	0.5-1.0	1.0
15	Cadmium	0.032-0.1	0.1
16	Cyanide	0.08-1.5	0.1-1.5
17	Ammonia	10.0-15.0	10.0-20.0
18	Total Nitrogen	30	30
19	Hydrogen ion activity	6.5-8.5	6.5-8.5
20	Chlorine	900.0-1000.0	1000.0
21	Iron	0.27-1.0	0.5-1.0
22	Hydrogen ion	0.2	0.2
23	Synthetics	25.0	25.0
24	Sulphur paint	0.45	0.5
25	Water temperature	15-40C	30C
26	Arsenic	0.1	0.1
27	Mercury	0.005	0.005
28	Cobalt	0.1	0.1
29	Fat oil	10.0-25.0	15.0-25.0
30	Silver	2.0	2.0
31	Selenium	0.1	0.1
32	Organic phosphorous	0.4	0.4
33	Total hydrocarbon	0.04	0.04
34	Aluminum	0.5	0.5

42. **Occupational health and safety standard (MNS 5002:2000).** Article 16 of the National Constitution of Mongolia states that every employee has the right to 'suitable conditions of work'. The government adopted a National Program for Occupational Safety and Health Improvement in 2001 and national standards are also adopted such as the National Standard on Occupational Health and Safety MNS 5002:2000 which support the Occupational Safety and Health Law 2008 which sets out policies, rules and regulations on occupational safety and health, and the most common requirements for workplace safety.

III. DESCRIPTION OF THE PROJECT

A. Justification and Rationale

43. The project targets environmentally sustainable urban development and improved living standards in Darkhan City, Mongolia. The project will contribute to a more balanced national urban system and strengthened urban-rural relationships through contribution to the development of a second tier city in the country. The project will support improvement of the city's wastewater management, its central wastewater treatment plant (WWTP), sewer system, and pumping stations. The project will support institutional development, training, project management support and policy dialogue including on water and wastewater tariff, and on sanitation.

44. **Outdated wastewater treatment facility.** The city's wastewater treatment plant (WWTP) and sanitary sewer system and pumping stations, were built in 1965 and partially updated and expanded in 1987, and are in urgent need of rehabilitation, repair and/or replacement. Two out of three sedimentation tanks are no longer functioning leading to the primary sedimentation treatment being overloaded. Rusted bar screens allow the flow of debris into the system, and creates a risk to pipes and pumps. The WWTP was significantly overdesigned with a capacity of 50,000 cubic meters per day (m3/d) and was never fully utilized. It currently operates at 8,000 to 10,000 m3/d (summer and winter) with peak flows of 12,000 m3/d. Many components are under-utilized or unused and dilapidated, with some operating units in a state of serious disrepair.[12] In summer and autumn of 2012, regular aeration blackouts were observed which lasted in excess of a week.[13] This led to a loss of activated sludge and negatively influenced the treatment efficiency. The WWTP treats domestic sewage together with non-toxic industrial wastewater and some industrial pre-treatment plants remove toxic elements (i.e., from sheepskin processing). Breakdowns of the current system cause untreated wastewater to discharge into the Kharaa River.

45. **Sewer network, pumping stations in need of replacement.** The pumping stations and some of the sewer mains are in urgent need of replacement or repair. Us Suvag maintains that some 40% of the sewer network is in need of rehabilitation or replacement, and there is evidence of significant infiltration (and thus also exfiltration) from the sewer network. It is reported[14] that there is a significant increase in inflows to the WWTP during periods of intense rainfall, indicating significant ingress of storm water into the system. This suggests there is also significant ex-filtration which has the potential to pollute groundwater resources. Based on the differential between water consumption and sewage flows, there are estimates that infiltration of groundwater and surface water into the sewer system is of the order of 25%.[15]

46. **Low energy efficiency.** Inefficiencies in the treatment plant mean that energy is being wasted unnecessarily. The cost of energy for the WWTP is currently approximately 60% of Darkhan Us Suvag's annual budget. The current energy use[16] equates to approximately 1.3 KWh/m^3 which is considered inefficient by WWTP design experts. Although Mongolia is currently largely meeting its energy needs domestically, primarily through seven coal fired power plants, thirteen hydro power plants and small size solar and diesel generators, about 13% of electricity, mostly during peak demand, is

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[12] ADB. Application To Access Water Financing Partnership Facility (WFPF) Resources For Direct Charges, 2013.
[13] P2Mberlin. Terms of Reference: Main Trunk Sewer and Central Wastewater Treatment Plant for Darkhan, Mongolia, 2013
[14] Us Suvag flow records at the Central WWTP
[15] Source: Milojevic, Nikola, Klaus-Jochen Sympher, Matthias Schütz, and Martin Wolf, MoMo Technical Report No 6 Integrated Wastewater Management in Central Asia – MoMo Model Region, 2011
[16] Based on data for August 2013 from Darkhan Us Suvag

imported from Russia Federation. With the high increase of the final energy consumption in recent years and the projections for further increase, there are expectations that the future electricity demand will not be met with the existing generation capacity.[17] Therefore taking opportunities to reduce domestic energy consumption will be beneficial to Darkhan city's local energy demands.

47. **Increased pressure from urban development.** Darkhan Uul-Aimag has a registered population of 92,000 and an urban population in Darkhan City (Darkhan Soum) of 72,000, of which estimated 40% live in ger areas. The city is located 220 kilometers (km) north of Ulaanbaatar and 130 km south of the Russian border. Darkhan enjoys favorable conditions for farming and is rich in mineral deposits. It was founded as an industrial hub in 1961, and situates at the Trans-Mongolian rail line and an ADB supported road that connects Ulaanbaatar with Darkhan and the Lake Baikal region. To strengthen development of secondary cities and to mitigate migration to Ulaanbaatar, where almost half of the country's population resides, in 2012 the government identified Darkhan to become a national model city for urban sustainability and livability. Improvements of existing urban districts and *ger* areas are planned, as well as urban expansion in the form of new industrial and residential areas, strengthened academic institutions, and expanded and new public parks and environmental protection zones. By 2020, the registered population in Darkhan Soum is estimated to grow to 83,000 with 75% living in formalized and fully serviced residential districts. These industrial and residential developments will cause significant increase in demand for urban services, including piped water supply, resulting in increased wastewater flow. Investment in infrastructure is needed to meet this present and future demand from improved and expanded urban services and to support clustering of new businesses and industries.

48. **Increased industrial wastewater.** Darkhan city currently has a number of industries which produce wastewater requiring treatment. The level of industrial activity is projected to increase in Darkhan, meaning additional and effective wastewater treatment will be required. Discussions with the *aimag* Land Administration Department[18] confirmed that within the last five years, applications and approvals for both commercial and housing developments have rapidly increased. Although industrial wastewater is pre-treated by the key producer (tannery) before it enters the WWTP, it still requires further treatment in the WWTP before it can be discharged. Darkhan *Nekhii* is a well-known sheepskin tannery making products for domestic and export markets. In 2010, with funding from the Czech government, a pre-treatment plant opened for use by the tannery. Additional industries in Darkhan which produce wastewater include Darkhan Metallurgical Plant which produces steel products from reprocessing metal and steel scraps and has a production capacity of 100,000 tons per year. In addition, a new ore processing plant and wool processing factory were built in the industrial area in 2013, although not yet operational. Additional industries sited in the industrial area include meat processors, a flour mill, cement and brick factories, and a timber processing plant in Old Darkhan. An oil refining industry is also planned for the industrial area although the current status of this plan is unknown. This demonstrates that there is a likelihood that industrial wastewater volumes will increase in the future.[19]

49. **Kharaa River pollution control**. The main water body in the project area, the Kharaa River has elevated nitrogen and phosphorous levels as the removal of these contaminants from the WWTP is inefficient. Due to the dilution capacity and turnover processes in the river, the nutrient levels are moderate. This has led to limited detectable impact on the ecology of the river.[20] However it is possible that at times of low-flow and with an increase in housing and industry, the impacts on the river arising

[17] Energy Charter Secretariat, 2011 In-Depth Review of Energy Efficiency Policies and Programmes: Mongolia
[18] Mr Munkh-Erdene J, Head of Land Administration; Mr Olonbayar KH, Senior Land Officer, meeting 19/09/13
[19] Wastewater flow projections for the period 2015-2040, including industrial wastewater flows, are presented in Appendix 1.
[20] MoMo. 2009. Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo). Kharaa River Case Study Main Findings Summary Report.

from the current WWTP would become more significant and the environmental sustainability will be compromised. This is increasingly likely as the outdated wastewater treatment technology becomes progressively more unreliable with age. The development of an efficient and effective WWTP will ensure that in the future, those relying on the Kharaa River as a raw drinking water source are not affected by poor water quality. This includes nomadic herders who graze their livestock on the Kharaa River flood plain, and residents of *ger* areas in the flood plain.[21] The nomadic herders are generally the poorer members of the population, and as such, are less able to withstand health shocks which may be associated with health impacts from poor water quality.

50. **Fit with Mongolian policy**. The work is aligned with the Government's 2012–2016 Action Program, which includes objective of: (i) improving public utility services and networks in provincial centers; and (ii) supporting the significant expansion of industrial development in Darkhan city. The activity will further support the Ministry of Economic Development's strategy for the development of Darkhan as both an industrial center and as a "model city for urban livability" for Mongolia.

51. **Fit with ADB country partnership strategy**. The proposed intervention aligns with the ADB country partnership strategy, 2011–2015 for Mongolia, and is consistent with ADB's Water Operational Plan in Mongolia through its objectives of: (i) supporting innovative approaches to wastewater treatment technologies under Mongolian conditions; and (ii) supporting urban utilities sector reform and capacity development. It is in alignment with the impacts, outcomes and outputs supported by the country partnership strategy, and will contribute to the achievement of millennium development goal targets in providing improved access to satisfactory sanitation. Urban development was first included as a distinct sector in 1992 in the ADB Mongolia Country Strategy. However, the link between the urban sector and the overall country strategy was not strong. In an attempt to strengthen this strategic linkage, the 2004 country strategy and program sought to reorient the urban strategy toward the provision of those services fundamental to achieving MDG targets. The 2012-2016 Country Strategy continues on this trajectory with a strong emphasis on infrastructure and access to basic services. The Components which contribute to this goal and are included under this project are: (i) improved infrastructure planning; (ii) provision of physical infrastructure (including wastewater treatment): and (iii) institutional and service delivery reform and capacity development.

B. Project Impact, Outcome, and Outputs

52. The project impact will be improved urban living conditions and improved environment in Darkhan City and the Kharaa River basin. The project outcome will be improved wastewater collection and treatment for domestic and industrial users in Darkhan City. The indicative outputs include:

(1) **Output 1:** Modern central wastewater treatment plant (WWTP) with a total treatment capacity of 20,000 m^3/d through structural renovation and partially new construction, and full new equipment installation with a new, efficient treatment process meeting national effluent standards constructed and operating in Darkhan;

(2) **Output 2:** Improved wastewater collection system with 1,800 meters of replaced sewer lines, and two structurally renovated, newly equipped pumping stations operating in Darkhan;

(3) **Output 3:** Institutional development, training, and sector policy dialogue to increase institutional capacity in utility project management, planning, procurement, implementation, operation, monitoring and improved efficiency of utility service provision.

[21] Sigel K. 2010. Environmental sanitation in peri-urban ger areas in the city of Darkhan (Mongolia): A description of current status, practices, and perceptions.

53. The project is operating in the context of an existing sewerage network, wastewater treatment plant (WWTP) and industrial wastewater pre-treatment plant. The existing system (WWTP, sewer system, pumping stations) is described in **Appendix 1**. The current wastewater treatment plant adopts a conventional activated sludge process arrangement (Figure A1.4). The sewer network has of total length of 223.5 km made up of about 97 km of trunk main, 2 km of rising main, and the remainder in secondary sewers and connectors. The condition of the network is variable, as many of the pipes are almost 50 years old.[22] An industrial wastewater pre-treatment plant has been in operation in the industrial area in Old Darkhan since 2010. The main user of the treatment plant is the tannery; the plant precipitates chromium from tannery effluent which is then discharged to the sewer system for further treatment and the central WWTP. At the point of discharge to the WWTP, the water quality meets relevant Mongolian standards. This is confirmed by the *aimag* Environment Protection Agency and Us Suvag.

54. The project outputs and activities are described in more detail in the following sections.

C. Output 1: Modern wastewater treatment plant (WWTP)

55. Output 1 comprises a new wastewater treatment plant for Darkhan which will treat all wastewater from residential areas in New and Old Darkhan and all wastewater (pre-treated and un-treated) wastewater from the Darkhan industrial area. The planning horizon is 2040. The new WWTP will be constructed within the same footprint of the existing WWTP (see Figure III-2) except that it will occupy a smaller area, reusing only some of the structural elements of the existing plant. The WWTP is located in *bagh* 3 (sub-district). The current site is approximately 2.1 km x 0.64 km, with an area of approximately 136 ha. This is an adequate land area for Output 1. The new WWTP is designed to produce an effluent which complies with the newly established standard for wastewater discharge to water bodies (MNS 4943:2011)[23], and will have the following characteristics:

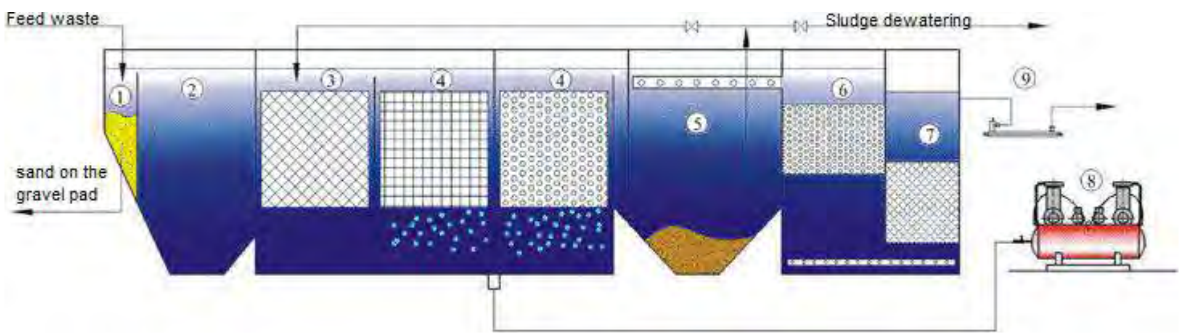
(1) 2 streams with a total treatment capacity of 16,000 m^3/d (plus a 8,000 m^3/d standby stream) (approximately 150,000 population equivalent at Darkhan flow rates)[24]; The wastewater treatment system will comprise: (i) rehabilitation of the existing inlet works and pump station and new preliminary treatment works (screening and sand, grit and grease removal); followed by (ii) primary settlement in the rehabilitated exiting primary clarifier (one of three); (iii) biological treatment in an integrated fixed film activated sludge bioreactor (IAFS) which will combine the features of activated sludge and fixed biofilm technologies in a series of reactor tanks fabricated from a single steam of the rehabilitated and reconstructed existing ASP biological reactor; and (iv) secondary settlement on one of the existing secondary clarifiers (rehabilitated); and then (v) ultra-violet disinfection[25] and discharge for effluent polishing in the rehabilitated maturation ponds; and finally (vi) discharge to the Kharaa river. The key steps in the IFAS plant are shown in Figure III-1. A photograph of the WWTP site is given in Figure III-4.

(2) A filter press will be introduced to reduce sludge volume prior to discharge to sludge drying

[22] A full inventory of sewer network pipes including age of pipes is presented in Appendix 4. The project will finance the replacement of 1,800m of bypass main and tertiary sewers identified as key priorities by the Darkhan Us Suvag.
[23] See Table II-8
[24] The capacity of the WWTP was established based on water demand and wastewater flow projections for the period 2015 - 2040, presented in Appendix 1.
[25] UV disinfection was selected for the following reasons: (i) there are significant concerns associated with chlorination including the production of potentially hazardous byproducts (chlorinated organic compounds), toxicity concerns from chlorine residual for the biota in receiving surface waters, and the potential hazards associated with handling the chlorine at the treatment plant; and (ii) unlike chlorine, UV does not pose disinfection byproducts, toxicity, or hazardous materials concerns.

beds (60ha storage capacity, see Figure III-3). The biological wastewater treatment process will produce a well-mineralized sludge which will be dewatered using the filter press from which it will be conveyed to the sludge drying beds. This can ultimately be reused as organic fertilizer.

(3) A layout for the proposed treatment configuration is provided at Figure III-3 which highlights in blue those elements which will be rehabilitated and transformed as an IFAS system. The arrangements for maintaining treatment capacity during rehabilitation and reconstruction of the new plant will involve temporary use of the other treatment units which are currently not utilized. The process and sequencing for this is provided at **Appendix 2**. Unused parts of the old WWTP (which will continue operation during project implementation) will be retained for possible future use in expansion, including the primary sedimentation tanks, aeration tanks, recycling sludge tanks, mechanic shop, and laboratory-office (Figure III-3).



Notes:
1. Vertical sand and grit removal channel
2. Equalization tank
3. Denitrification tank
4. Nitrification tank
5. Sludge settlement (thin layer module) secondary settlement
6. Primary bio reactor
7. Full treatment bio reactor
8. Aeration equipment
9. Disinfection through ultra-violet lamp

Source: ADB. Wastewater Management for Darkhan – Project Preparation, L2301-MON Interim Final Report

Figure III-1: IFAS Plant Technology

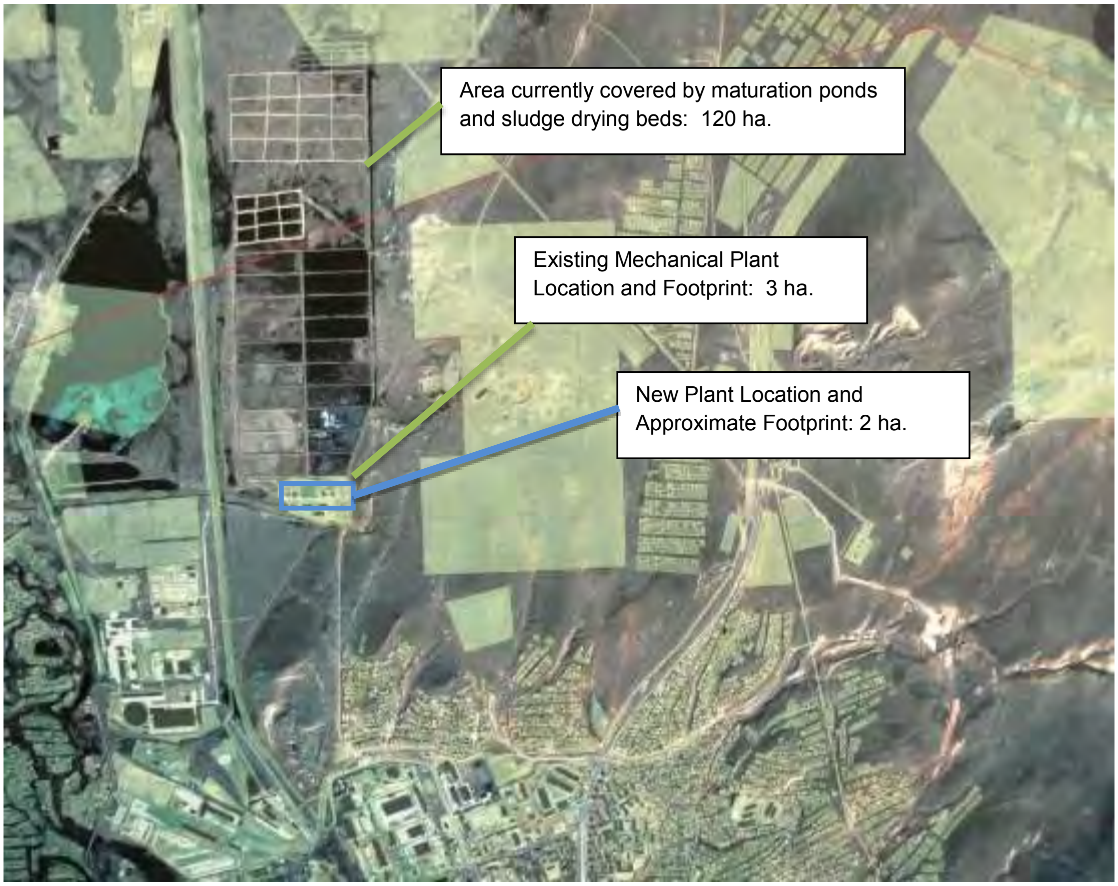


Figure III-2: Location and approximate footprint of proposed new WWTP

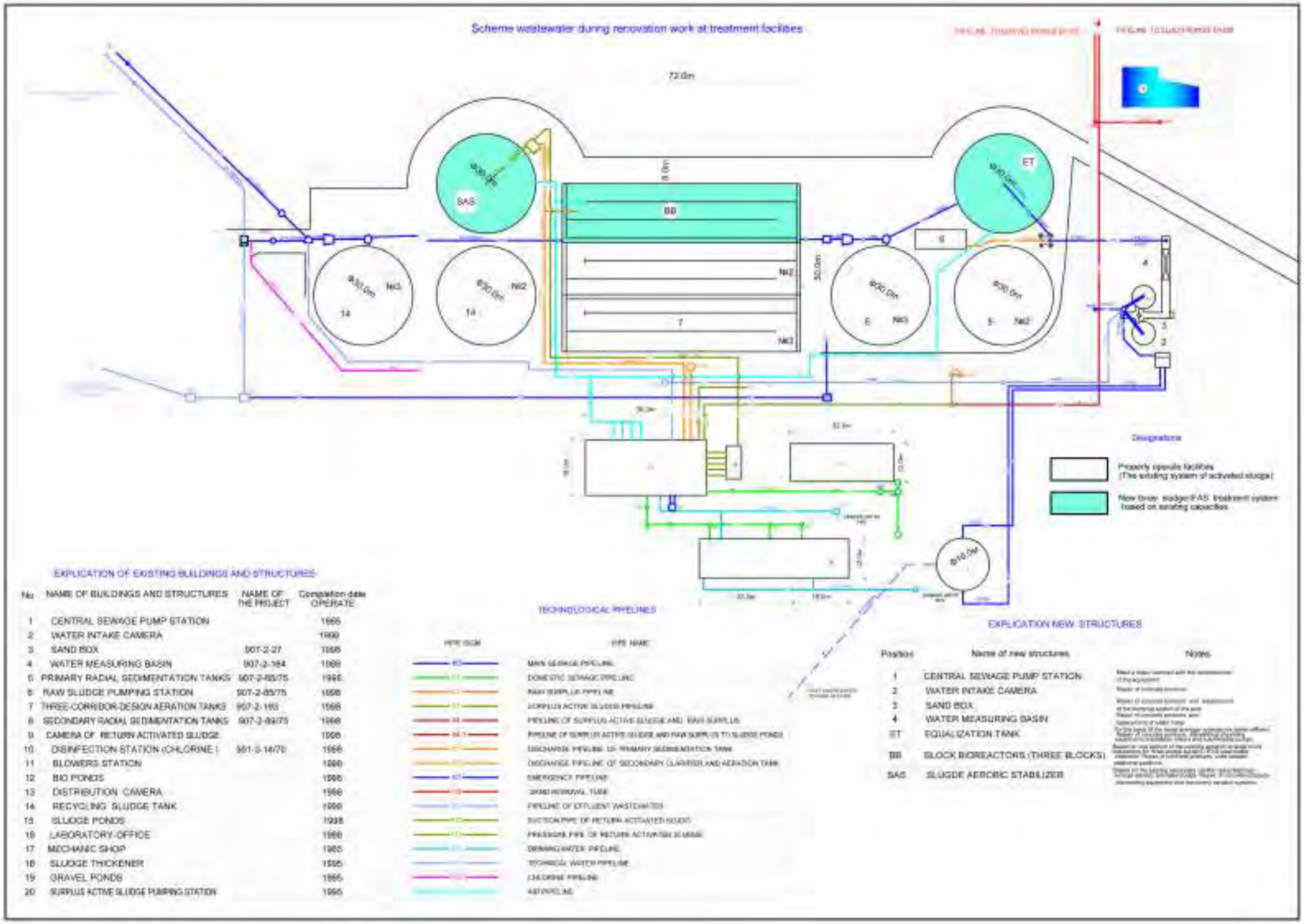


Figure III-3: Treatment plant layout as new integrated fixed-film activated sludge treatment plant

From left to right: WWTP buildings, pumping house, area towards Kharaa river

Figure III-4: Existing WWTP facilities

D. Output 2: Improved wastewater collection system

56. Output 2 comprises the replacement and/or rehabilitation of existing sewer pipes, pumps and ancillary works which are currently broken or beyond their useful economic life, located at various points within the city network. All works will follow existing pipeline alignments, or be located at existing facilities (e.g. pump stations). Sub-components will include: (i) replacement of 1,800m of bypass main and tertiary sewers; and (ii) rehabilitation of 2 pumping stations:

(1) **Sewer replacement**: (i) tertiary sewers at primary south pumping station: 1,400m x 1 m dia. (see below); (ii) tertiary sewers at old Darkhan hospital No. 2: 300m x 0.3 m dia.; and (iii) bypass main at secondary pumping station: 100m x 0.8 m dia.;

(2) **Rehabilitation of secondary pumping station**: The basic structure of the pump house is sound, so the project will carry out the following: (i) full rehabilitation of the existing building – adding surface treatments; (ii) full replacement of pumping facilities (duty and standby units); (iii) replacement of ventilation system (including both inlet and outlet piping); (iv) replacement of power supply system; (v) provision of automated remote control facilities to connect with the overall remote control system panel; and (vi) replacement of facilities including screens and manual lifting equipment.

(3) **Rehabilitation of south pumping station:** Based on the Government's policy to establish an industrial park in the southern part of Darkhan in the late 1980s, the south pumping station was constructed using Russian technology and equipment in 1989. Although the pump station was fully equipped for operation, it has never been used. In addition a section of 1,400 m of gravity flow pipeline is not installed at the pumping station. This needs to be installed to enable the pump station to operate. The basic structure of the pump house is sound, so the project will support the following activities: (i) full rehabilitation of the existing building – adding surface treatments; (ii) full replacement of pumping facilities (duty and standby units); (iii) replacement of ventilation system (including both inlet and outlet piping); (iv) replacement of power supply system; (v) provision of automated remote control facilities to connect with the overall remote control system panel; (vi) replacement of facilities including screens and manual lifting equipment.

57. The location and context of Output 2 sub-components is shown in Figure III-5 to Figure III-11. Details of pumping stations and sewer network rehabilitation activities are presented in **Appendix 4.**

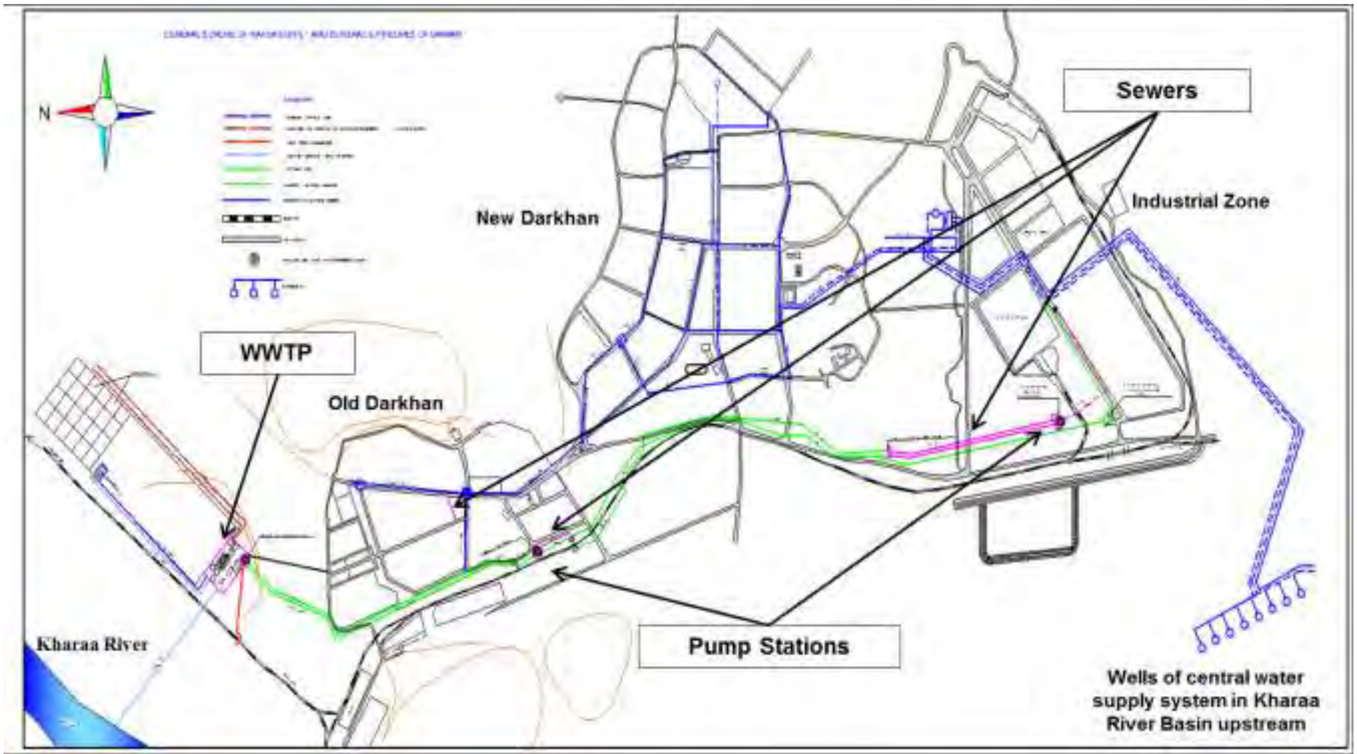


Figure III-5: Location of project interventions in Darkhan City. *Source: ADB Study Team*

Figure III-6: South Pumping Station Tertiary Sewer. *Source: Google Earth, ADB Study Team*

General area Pumping station Access road and ger

Figure III-7: South Pumping Station. *Source: ADB Study Team*

Figure III-8: Tertiary Sewers Old Darkhan Hospital. *Source: Google Earth, ADB Study Team*

Route of Pipeline (from left to right): School (exposed inspection chamber, Inspection chamber, Apartment area

Figure III-9: Tertiary Sewers Old Darkhan Hospital. *Source: ADB Study Team*

Figure III-10: Secondary Pumping Station. *Source: Google Earth, ADB Study Team*

Unused Tertiary pipe | Tertiary pipeline | Secondary Pumping Station

Figure III-11: Secondary Pumping Station. *Source: ADB Study Team*

E. Output 3: Institutional development and capacity building

58. Under Output 3, the project will provide expert support for project management and implementation. It will provide support for institutional enhancement and capacity development in utility management, operation and service provision, detailed technical design and construction supervision, strengthen project management unit and project implementation unit capacities. The project will include policy dialogue on (i) water and wastewater tariff reform to achieve cost recovery, (ii) sanitation improvements including in ger areas, (iii) solid waste management. It will support public awareness campaigns on environmental management, sanitation and solid waste management. It will also provide training, seminars, workshops, and study tours on project management, utility operation and maintenance, financial management, procurement, project monitoring and evaluation. A piggy-back technical assistance will further support institutional development of utility service provision, strategic planning, and operation improvements. The packages under Output 3, including the terms of reference, are defined in the project administration manual (PAM).

F. Project Area of Influence, Project Implementation Schedule

59. The project sites were visited in September 2013 and April 2014 for the preparation of this IEE with particular attention paid to: (i) sensitive natural environmental receptors such as water bodies and wildlife habitats; (ii) sensitive human receptors; and (iii) cultural and heritage sites. The project's area of influence was defined based on the definition provided in ADB's Safeguard Policy Statement (2009) as follows:

(1) **Primary project site(s) and related facilities:** These include the WWTP site in Darkhan, three sections of sewer pipe which are to be rehabilitated along a government right of way near Darkhan hospital, and the secondary and industrial area pumping stations owned by Darkhan *aimag*.

(2) **Associated facilities that are not funded as part of the project**: Under ADB's Environment Safeguards Sourcebook, Associated Facilities are those which are "not funded as part of a project but whose viability and existence depend exclusively on the project". The sewerage network is an existing facility which is not reliant on the project (improvements to the WWTP, 1.1 km of tertiary sewer rehabilitation and pumping stations upgrades). The sewerage network is currently functioning adequately and issues with the existing sewerage network have been identified by Us Suvag and will be addressed as part of their regular and planned maintenance. Therefore it is concluded that there is no facility that depends exclusively on the project. However, there are several facilities which classify as “existing facilities” in accordance to ADB's Safeguard Policy Statement (2009), including: (i) the existing WWTP; (ii) the existing wastewater pumping stations; and (iii) the existing sewer network. For these existing facilities, audits have been conducted, presented in **Appendix 1**, **Appendix 3 and Appendix 4.** The audit for the WWTP was conducted by the State Professional Inspection Agency as well as a private company specialist in concrete structures.

(3) **Areas and communities potentially affected by cumulative impacts from further planned development of the project**: The communities around the project area are principally those industries and houses closest to the WWTP and residents and businesses close to the area which may be affected by noise, during replacement of sewer pipes. Regarding further planned development of the project and its potential impacts, the project, when completed, will not require further development however in the future, the WWTP and sewerage network will require maintenance which will be carried out by the Us Suvag.

(4) **Areas and communities potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location**: It is not anticipated that the WWTP and related improvements will cause any unplanned developments. It is a site-specific project that is not likely to cause additional developments in the city, rather additional developments (housing and industry) will benefit from the project.

60. **Project area of influence.** Based on the above, the area which may potentially be affected by the project can be considered as: (i) “main project areas of influence”, covering component sites (footprints) and areas within 200 m from their edges. 200 m is the potential reach of noise and dust which is likely to have an impact on human receptors which are the most sensitive receptors in the project area; and (ii) ”extended areas of influence” which includes borrow areas/quarry sites, waste disposal sites, access routes to and from component sites and the resources in close proximity to them, sources of water for construction use, resource use and sources of labor, as well as the Kharaa River as receiving water body. Table III-1 shows the potential receptors and resources which may be influenced by impacts from the project at each component site.

Table III-1: Potentially Affected Receptors and Resources in Output Sites

Output	Affected Resources and Distance (meters)
Output 1 - Central WWTP	Soil / Ground - contamination and erosion Water - Kharaa River from effluent WWTP operators/staff - noise and dust Air - dust Waste disposal site Resource use - materials and energy
Output 2 - Infrastructure Replacement/Rehabilitation	**Sewer Replacement at old Darkhan hospital** Socio-Economic- Street sellers outside hospital / market and two businesses in apartment blocks (3 m and 20 m) Residents - apartment blocks (20 m) Social services - School (5 m), Hospital (15 m) Cultural Resources - Temple (100 m) Soil / Ground - contamination and erosion Health and Safety - community Resource use - materials and energy
	Sewer Replacement & Power Distribution at Secondary Pumping Station Soil / Ground - contamination and erosion Water - Kharaa River from effluent Air - dust Residents - gers (130 m from pipe, 30 m from pumping station) Socio-Economic - pastureland Health and Safety - community Resource use - materials and energy
	New south pumping station Soil / Ground - contamination and erosion Socio-Economic - pastureland Air - dust Residents - ger (50 m) Health and Safety - pumping station caretaker Resource use - materials and energy

Source: ADB Study Team

61. **Implementation schedule.** The tentative project implementation schedule for the project is set out in the schedule shown in Figure III-1.

Table III-2: Project implementation schedule

Indicative Activities	2014 (Qtr)				2015 (Qtr)				2016 (Qtr)				2017 (Qtr)				2018 (Qtr)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A. DMF																				
Output 1				■	■	■	■	■	■	■	■	■	■	■						
Activity 1.1: Prepare employer's requirements and procure Design Build and Operation Assistance for WWTP. Approvals.				■	■	■														
Activity 1.2: Renovate, construct and install new equipment, commission of WWTP. (2015–2016)							■	■	■	■	■	■								
Activity 1.3: Start operating and monitoring of WWTP													■	■						
Output 2							■	■	■	■	■	■	■	■						
Activity 2.1: Detailed designs, approvals and procure sewer and pumping station works and equipment							■	■	■											
Activity 2.2: Construct, commission, and start operating sewers and pumping stations										■	■	■	■	■						
Output 3																				
Activity 3.1: Establish PMU, PIUs and recruit staff			■	■	■	■														
Activity 3.2: Project Management and implementation support							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Activity 3.3: Institutional development							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Activity 3.4: Provide staff training							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Activity 3.5: Policy dialogue and public awareness campaigns							■	■	■	■	■	■	■	■	■	■	■	■	■	■
B. Management Activities																				
Establish PMU, PIUs, PSC, etc.			■	■	■															
Consultant selection procedures				■	■	■														
Environment management plan key activities				■	■	■	■	■	■	■	■	■								
Communication strategy key activities				■	■	■														
Annual/Mid-term review							■				■				■				■	
Project completion report																				■

Source: ADB Study Team

IV. DESCRIPTION OF THE ENVIRONMENT (BASELINE)

A. Urban Form, Socio-economic Conditions

62. **Location.** Darkhan is situated at 49°28'08"N; 105°57'27"E approximately 230 km from Ulaanbaatar. The city of Darkhan (now Old Darkhan) was founded in 1961 with construction of New Darkhan commencing one year later. New Darkhan is located about 2 km to the south of Old Darkhan, from which it is separated by a small range of hills. Figure IV.1 shows the location of the two urban centers, the neighboring industrial estate, main ger areas, wastewater treatment plant and Kharaa River. The Kharaa river basin is one of the three drainage basins in Mongolia. Through Lake Baikal 230 km to the North of Darkhan, in the Russian Federation, the basin eventually drains into the arctic ocean.

63. **Administration.** Administratively, Mongolia is divided into 21 *aimags* (provinces) and the capital city Ulaanbaatar. *Aimags* are divided into *soums* which are further divided into *baghs*. The proposed project is in Darkhan-Uul *aimag*, which is divided into 4 *soum*s. The project components are all in Darkhan *soum* which is the most populated of the four *soum*s in Darkhan-Uul. The wastewater treatment plant is owned by Darkhan-Uul *aimag* government but is operated and maintained under an agreement by Darkhan Us Suvag, which is a state-owned company.

64. **Land use.** The current land use for the city is shown in **Figure IV-1**. The figure also shows the *bagh* boundaries; the WWTP is in *bagh* 3 to the north of the city, Old Darkhan. The nearest *ger* housing, or hashaa (plot of land) is approximately 650 m from the WWTP.

65. **Population.** About 85% of the population of Darkhan-Uul *aimag* lives in the city (Darkhan soum) but the population of both the aimag and each of the soums has shown only a very modest increase over the past few years. As Table IV-1 shows, over the past decade, population remained little changed between 2003 and 2009, but following a significant increase in 2010, has shown a decline since then, with a particularly steep decline between 2011 and 2012, and only a slight recovery since then. This suggests that during the period 2003 to 2010 the slow out-migration from Darkhan was being compensated for by the natural population increase.[26] Figures vary as to the proportion of the population of Darkhan soum who live in the centrally planned and serviced apartment areas of Old Darkhan and New Darkhan, and those who live in the peripheral ger areas. Estimates for the former vary from 60% to 69%[27] with the Aimag Land Administration office providing an estimate of 60%. The Aimag Land Administration office indicates that the target is to have 75% of the population living in the centrally planned and serviced areas by 2020. There is a transient population in Darkhan which is not fully captured in the official figures, and for which accurate estimates are not available. This is primarily made up of:

(1) Students: Darkhan is an educational center with ten tertiary educational institutions in addition to 25 secondary schools and 14 kindergartens, and a number of other small vocational training centers. The transient student population during term-time is estimated to peak at about 5,000.[28]

(2) Herders: The number of urban inhabitants rises during the winter months as some herder

[26] Mongolia Human Development Report 2011: From Vulnerability to Sustainability, UNDP, Ulaanbaatar, 2011
[27] The figure of 69% is widely quoted in the MoMo reports and by the Darkhan Us Suvag, but is not verified by the aimag government which provides a figure of 60%. A figure of 65% is used for planning purposes.
[28] Estimate by the office of aimag chief of policy development.

families relocate back to Darkhan after summers spent with their herds. Again, accurate numbers are unknown, but estimated at a few hundred.[29]

66. Based on these additional transient populations, the current population in Darkhan Uul can be estimated to peak at about 100,000 and for Darkhan soum about 82,000. In population equivalent terms, the transient and student population can be estimated to provide a population equivalent of between 4,000 and 5,000.

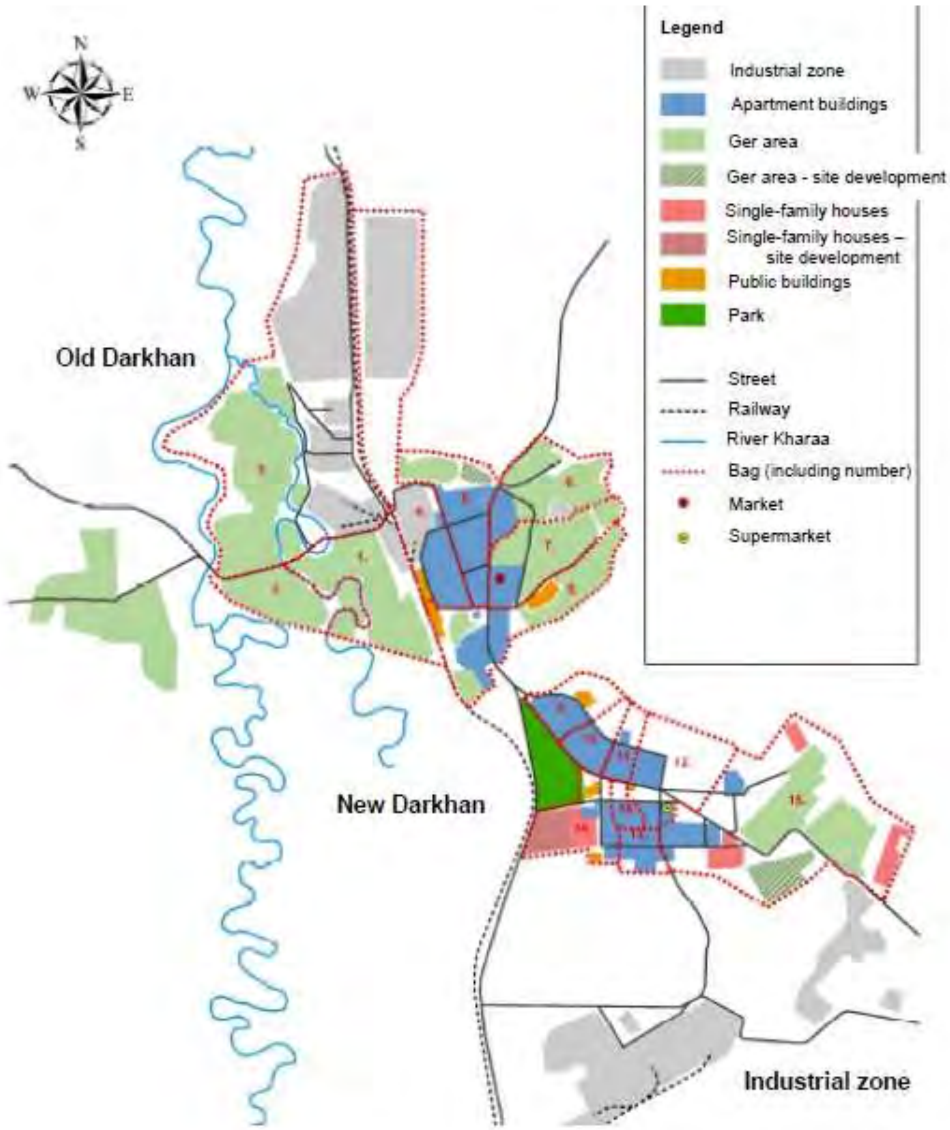


Figure IV-1: Land use, Darkhan city. *Source: K. Sigel (2010)*[30]

67. **Economic Conditions**. Darkhan was established as an industrial city in the 1960s and it continues to be an industrial town. In 2009, manufacturing and mining employed approximately 19,000

[29] Office of the head of Administration; Darkhan Uul aimag.

[30] Sigel, K. (2010) Environmental sanitation in peri-urban ger areas in the city of Darkhan (Mongolia): A description of current status, practices, and perceptions. Helmholtz-Zentrum für Umweltforschung – UFZ Department Ökonom.

people, which is approximately 16% of the *aimag* population.[31] Heavy industries are located close to residential areas of Darkhan. The industrial area, approximately 2 km from Old Darkhan, includes a sheepskin tannery making products for domestic and export markets, a metallurgical plant which produces steel products, a meat processor, a flour mill, cement and brick factories and in old Darkhan there is a timber processing operation. Additional industry is planned, which will afford more employment opportunities. This includes a new ore processing factory which has been built but is not operational, and a new wool processing operation, also not yet operational.

68. **Water and wastewater sector assessment**. A sector assessment is presented in **Appendix 1**. The existing situation with respect to the water and wastewater sectors in Darkhan can be described as problematic, but not critical. Water supply and wastewater management are the responsibility of the Public Urban Services Organization (PUSO) for Darkhan – Darkhan Us Suvag (USAG) - which was established in 1965 and currently has 192 staff of which 40 have an engineering qualification. Darkhan Us Suvag functions as a service organization and a limited liability joint stock company. The company is owned 40 per cent by the aimag government and 60 per cent by the aimag peoples Khural (on behalf of the people of the aimag). The water supply and wastewater assets of the aimag are vested in the Us Suvag LLC.

69. **Poverty**. In April 2012, revised poverty numbers were released for Mongolia according to the World Bank methodology based on the 2011 Household Social Economic Survey conducted by the Mongolian National Statistics Office. According to the joint estimation, poverty headcount index in Mongolia stands at 29.8 percent which is 9.4 percentage points less than in 2010, poverty depth amounts to 7.6 percent which represents a drop of 3.7 percentage points, poverty severity is at 2.8 percent which is 1.8 percentage points less than in 2010. By regions, the poverty headcount index shows that the headcount index in the Central region (in which Darkhan-Uul *aimag* is located) is 27.2 percent, compared to Ulaanbaatar city at 23.5 percent. The data show that for the country as a whole, there is more poverty in rural areas than urban.

70. **Occupational health and safety**. Occupational safety considerations are currently a low priority in Mongolia, given observations on construction sites. Construction workers and maintenance staff can be observed operating without Personal Protective Equipment (PPE). Article 16 of the National Constitution of Mongolia states that every employee has the right to 'suitable conditions of work'. The government adopted a National Program for Occupational Safety and Health Improvement in 2001 and national standards are also adopted such as the National Standard on Occupational Health and Safety MNS 5002:2000.

71. **Community safety related to construction**. The location of the WWTP means that members of the community are unlikely to enter or pass through the WWTP site; it is not close to housing areas or industrial/commercial buildings and does not appear to be used for access. The works required for Output 2 (rehabilitation of pumps and ancillary equipment) may occur in more populated areas, particularly the replacement of sewer pipes at around the hospital in Old Darkhan. However all construction areas in the project should be prepared for managing community health and safety, even if community residents do not appear to be living or working near the construction sites.

72. **Physical cultural resources.** The only cultural site in the project area is the Old Darkhan Buddhist temple, approximately 200 m from Old Darkhan hospital (Output 2, sewer pipe replacement near Old Darkhan hospital). Figure IV-2 shows the temple which can be accessed from several locations. The photograph shows an entrance to the east, 100m from the sewer pipeline (Output 2) to

[31] Sigel K. (2010) Environmental sanitation in peri-urban ger areas in the city of Darkhan (Mongolia): A description of current status, practices, and perceptions

the side of Old Darkhan Hospital. The temple is not a listed cultural heritage site.

Figure IV-2: Old Darkhan Temple, Getsogdarjaalin Monastery. *Source: ADB Study Team*

B. Physical conditions within the study area

a. Topography, Geology, Soil

73. **Topography and Geology**. Darkhan is at an elevation of around 700m above sea level. The east of the city is characterized by rolling hills which are used as pasture land for herders. The west is clearly defined by the Kharaa River and its floodplain which at Darkhan city is approximately 2-3 km wide. The river basin lies in an area where intrusive rocks of leucocratic granite and granodiorite have intruded into sediments. In places where this intrusion has occurred, gold deposits can be found in the Kharaa river basin.

74. Hummocky terrain in the floodplain around Darkhan indicates thermo-karst, which is the thawing of permafrost. Permafrost is characterized by negative temperatures of soils/rocks and occurrence or possible occurrence of underground ice. An active layer is subject to seasonal thawing/freezing, beneath which is a permanently frozen ground. Global warming and anthropogenic impacts intensify permafrost warming and thawing. Permafrost degradation can cause substantial change in water hydrology, damage infrastructure and affect ecosystems. Continuous permafrost lies predominantly in mountain areas with altitude of more than 3,000 m above sea level. Therefore given the altitude of Darkhan (700 m) any permafrost in the floodplain is likely to be sporadic permafrost which occurs in the muddy soil of springs/water bodies.

75. **Soil.** Soil characteristics within the Kharaa basin are identified on a digital soil map which is shown in Figure IV-3. The map shows the project area to be dominated by (i) fluvisols - typically found on flat land associated with flood plains, (ii) kastanozems - are humus-rich soils that were originally covered with early-maturing native grassland vegetation, which produces a characteristic brown surface

layer, found in relatively dry climatic zones.[32] Around the city, where the ground is not covered with vegetation or paved such as in unpaved ger areas, dry friable soils are visible, with gulleying caused by stormwater flow on slopes.

76. The Detailed EIA undertaken for the project included soil sampling at six locations in the project area. The analysis confirmed that samples 1 and 2 are on alluvial soil, samples 3-5 are sandy dark brown soil and sample 5 is a dark brown soil. The results are presented in Table IV-1 and Table IV-2. The Detailed EIA concludes that all the samples tested meet the required Mongolian National Standard relating to soil contamination.

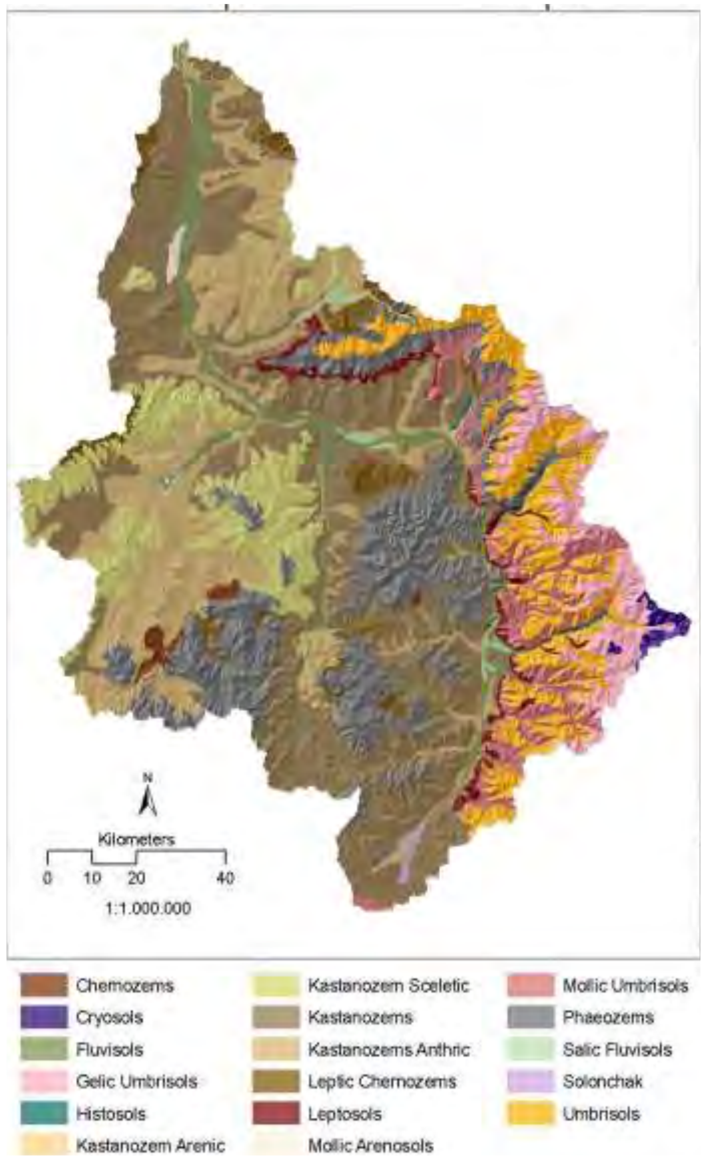


Figure IV-3: Kharaa Basin digital soil map

[32] United Nations Food and Agriculture Organization

Table IV-1: Chemical characteristics of soil samples

Sample Number	Coordinate	pH	$CaCO_3$ (%)	Humus (%)	EC (dS/m)	Mobility (mg/100gr)	
						P_2O_5	K_2O
WWTP-1 River bank	49°30'31.3 105°54'11.5	8.73	0.00	2.073	0.628	1.85	16.2
WWTP-2. River sediment	49°30'31.2 105°54'11.2	8.60	0.00	0.310	0.230	0.14	7.2
WWTP-3. Project area	49°30'24.3 105°55'28	8.40	0.00	6.537	2.512	2.38	31.4
WWTP-4. WWTP area	49°30'28.3 105°55'31.3	8.36	0.00	2.488	0.195	1.954	16.2
WWTP-5. Sludge pond	49°30'33.1 105°55'36.9	7.59	0.00	6.688	0.399	4.26	42.7
WWTP-6. Mountain slope	49°30'22.9 105°56'02	7.95	12.72	2.270	0.840	1.86	30.8
CaCO3 - Calcium Carbonate, EC- Electroconductivity, P_2O_5 - Phosphate (oxide), K_20 - Potassium (oxide)							

Source: Environ LLC. Detailed EIA.

Table IV-2: Heavy metal content of soil samples

Sample number	Heavy metal content mg\kg				
	Chromium	Lead	Cadmium	Nickel	Zinc
WWTP-1. River bank	15.5	20.1	0.23	7.1	187.8
WWTP-2. River sediment	7.9	5.5	0.04	4.7	23.5
WWTP-3. Project area	21.7	18.7	0.08	21.5	200.6
WWTP-4. WWTP area	73.9	12.3	0.05	12.9	94.8
WWTP-5. Sludge pond	60.3	63.8	0.11	8.1	192.7
WWTP-6. Mountain slope	16.9	15.2	0.07	10.6	68.5
Standard (MNS 5850 : 2008)	***150***	***100***	***3***	***150***	***300***

Source: Environ LLC. Detailed EIA.

77. **Land Degradation**. In Mongolia, land is degraded in a number of ways including forest clearance, pasture degradation, damage through mining and chemical pollution. Between 2006 - 2009 annually approximately 110,000 km^2 (approximately 7% of Mongolia's territory) is considered degraded. The majority of this land degradation has occurred in pasture land. However, Darkhan-Uul is shown to have one of the lowest rates of land degradation of all *aimag*s in Mongolia however the main form of degradation is damage to farmland in Darkhan-Uul, see Figure IV-4. In Darkhan-Uul *aimag*, as demonstrated by discussions with the *aimag* Environment Protection Agency officer, deforestation is an issue. This is further supported by the 2011 Human Development Report for Mongolia which states that in some *aimags*, including Darkhan-Uul, if the present rate of deforestation continues, there will be no forests left in three years' time (2014). Currently forests are found in more rural parts of the *aimag*, and are not found near Darkhan *soum.*

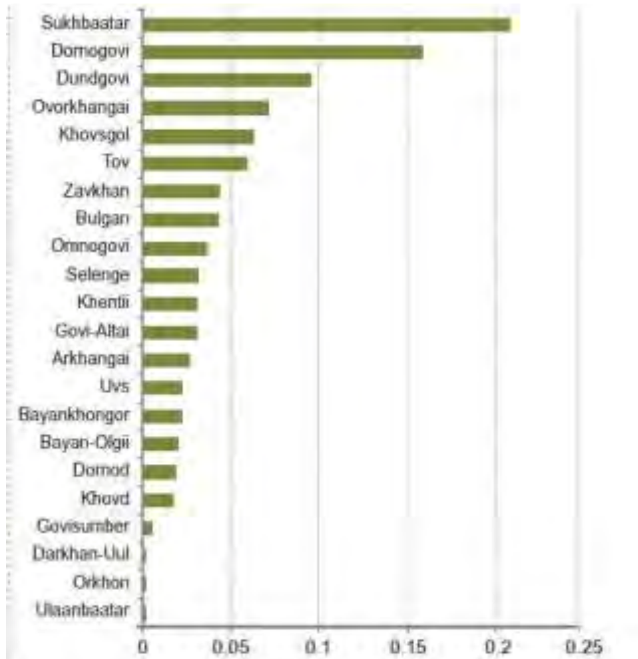


Figure IV-4: Share of *aimag*s in Land Degradation (average 2005-2009)
Source: UNDP (2011) Mongolia Human Development Report 2011. From Vulnerability to Sustainability: Environment and Human Development

b. Climate

78. **Climate**. The Kharaa river basin climate is characterized as a dry winter continental climate. Mean annual temperatures are around 0 °C with long cold winters; mean monthly temperatures in January range from -20 to -25 °C with minimum temperatures reaching - 40 °C. The summer season is short and warm, with average temperatures for July exceeding 15 °C.[33] The Kharaa River is continuously covered with ice between November and March.

79. **Precipitation.** Precipitation data for Baruunkharaa, 80 km from Darkhan city show that the majority falls between June and August in the Kharaa River basin. The relatively low levels of precipitation from November to March mean that snow cover is sparse in the Kharaa basin in winter. Potential evapotranspiration is high during summer; between 85-95% of precipitation is lost through evapotranspiration.[34] Figure IV-5 shows the variation in precipitation in the Kharaa River basin catchment. Specific rainfall data is available for Darkhan Uul, showing that the project area receives about 320 mm of precipitation annually (Figure IV-2), of which over 90% occurs in summer months.[35]

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[33] MoMo (2009). Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo) Case Study in the Kharaa River Basin Final Project Report

[34] MoMo (2009). Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo) Case Study in the Kharaa River Basin Final Project Report

[35] Environ LLC (2014) A Detailed Environmental Impact Assessment Report for Expansion Project of Central Treatment Plant in Darkhan-Uul Province [*sic*].

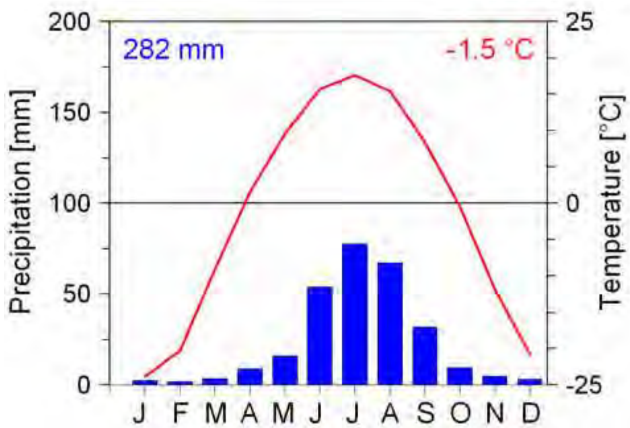


Figure IV-5: Average monthly precipitation and temperature, Baruunkharaa meteorological station

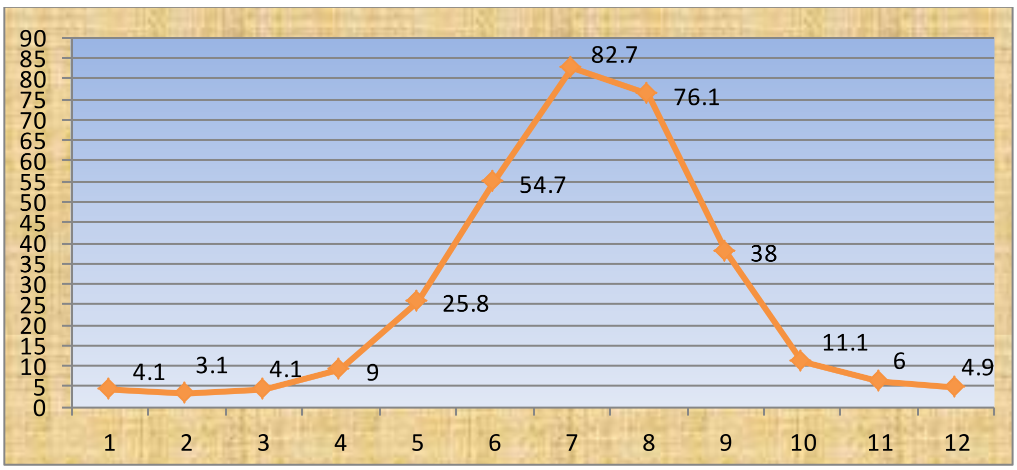


Figure IV-6: Average annual precipitation in Darkhan Uul. *Source: Environ LLC. Detailed EIA.*

80. **Humidity.** The relative humidity in the project area is an annual average of 66% which is one of the most humid areas in Mongolia. Maximum relative humidity in Darkhan is 70-80% during winter, 35-45 % during spring, 55-65% during summer and 40-49% during autumn.

81. **Wind Direction**. Based on 30 years of data, the predominant direction of wind in Darkhan is north and the average wind speed is 3.4 m/sec^{-1}. Figure IV-7 shows the wind direction over 30 years and updated data for 2013.

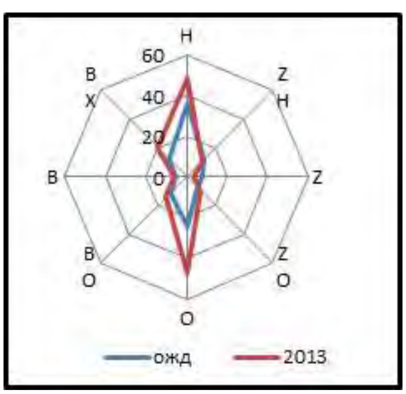
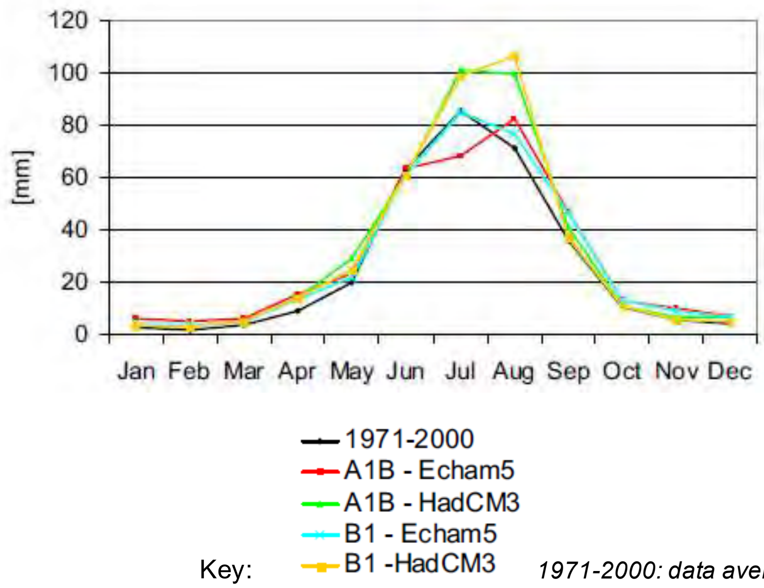


Figure IV-7: Wind Direction, Darkhan.
Source: Environ LLC. Detailed EIA.

82. **Climate variability, climate change projections**. Between 1940 and 2008, evidence shows an increasing trend of winter precipitation and a decreasing incidence of summer rainfall.[36] However for Mongolia, over the longer term, climate models predict that summer rain will increase. Based on appropriate climate models for Mongolia (HadCM3 model of the HADLEY center), results show that the annual precipitation will generally increase. Precipitation in the summer season is predicted to increase by less than 10 percent, which is smaller than the rise in winter precipitation compared to the normal climate. Because of climate change, it is anticipated that winters will become milder and more snowy, while summer will become hotter and drier even though there will be a slight increase of precipitation based on overall climate change predictions. A recent trend of increasing frequency of extreme precipitation events is likely to continue. Specific climate predictions made for the Arctic Ocean drainage basin (in which Darkhan is based) shows that river runoff in the Arctic Ocean basin is predicted to increase by 2-9 mm. However, the projected increase in evaporation from open surface water will exceed the increase in runoff. This will lead to dryer conditions and to an imbalance between inflow and outflow of water bodies.[37] Figure IV-9 shows the predicted changes to precipitation under a number of climate models.



Key: *1971-2000: data averaged for the Kharaa catchment*

Note: A1B and B1 are greenhouse gas scenarios used for climate change predictions. Based on statistical interpretation of the global climate models outputs, the HadCM3 model of the HADLEY center was the most suitable for the specific conditions of Mongolia.

Figure IV-8: Kharaa River Basin Climate Change Scenarios for Precipitation. *Source: Mongolia Second National Communication on Climate Change and MoMo*[38]

83. These Climate Change predictions are consistent with the findings from the recently developed ADB climate change risk screening tool. [39] Annual mean temperature is projected to increase by 2.3 ^{0}C in the 2031-2040 time period, and by 3.2^{0}C in the 2051-2060 time period. Precipitation is projected to

[36] Mongolia 2nd National Communication for UN Framework Convention on Climate Change.
[37] Mongolia 2nd National Communication for UN Framework Convention on Climate Change.
[38] MoMo (2009). Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo) Case Study in the Kharaa River Basin Final Project Report.
[39] ADB Internal Document. EAER Staff Guidance. Assessing Climate Change Risks in PRC and Mongolia. February 2014 (Draft March 2014).

increase approximately 10% or 30 mm in the 2031-2040 time period. Monthly precipitation increases projected for cold months (October – May) are higher than warmer months (June – September) in relative terms. Projections for the 2051-2060 increase are approximately 15% or 44.8 mm in comparison with the 1961-1990 historical data. During this time frame, a reverse pattern is predicted, with higher precipitation increases projected for warmer months (April to August) than colder months (September to March). The annual PET is projected to increase by 8.1% for the 2031-2040 time period and by 12.0% for the 2051-2060 time period. Annual runoff is projected to increase by 10.6% for the 2031-2040 time period and by 12.2% for the 2051-2060 time period. Predicted changes for other variables, such as humidity and soil moisture are minimal. Due to increased temperatures and higher rates of PET, the probability of droughts is projected to increase. Similarly, chances for severe storm and floods may also increase due to increased precipitation. The probability of *dzud* is more likely to increase due to increases for winter precipitation as projected for 2031-2040.

c. Hydrology, Surface Water Quality

84. **Kharaa River.** Surface water resources in the project area are dominated by the Kharaa River. The existing WWTP is approximately 1.5 km from the river. The Kharaa River Basin is shown in Figure IV-9. The Kharaa river basin is part of the larger Selenge river catchment, shown in Figure IV-10. The Kharaa River is 362 km long and has a mean long-term annual discharge (1990-2008) of 12.1 $m^3 s^{-1}$, measured at the Buren Tolgoi, 23 km from Darkhan city. In the lower end of the drainage basin, in which the project is based, the river flows naturally and is channelized in only a limited number of locations and therefore the river meanders and the floodplain meadow still serves its natural function. The runoff regimes into the Kharaa River are dictated primarily by rainfall distribution; average flow increases to 22 $m^3 s^{-1}$ in August, and decreases to 2.5 $m^3 s^{-1}$ in January and February. However a secondary discharge peak occurs in May melt waters from the Khentii area temporarily raise the water levels.

Figure IV-9: Kharaa River Basin Map.
Source: Priess, J. et al.[40]

Figure IV-10: Selenge River Basin.
Source: MoMo[41]

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[40] Priess, J. et al. The consequences of land-use change and water demands in Central Mongolia. Land Use Policy Volume 28, Issue 1, January 2011, Pages 4–10

[41] MoMo (2009). Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo) Case Study in the Kharaa River Basin Final Project Report

85. **Surface water quality.** Long term water quality monitoring data are presented by MoMo[42] for the Kharaa River basin. Darkhan falls in the Kharaa III sub-basin, for which water quality data are presented in Table IV-3. Water quality of all the Kharaa River is monitored weekly by the *aimag* Meteorological Office and the results of the monitoring in comparison with MNS 4586:1998 Water Quality Standards (ambient water quality) are published on their website. Data collected between 21-22 August 2013 by *aimag* Meteorological Office is shown in Table IV-4.

Table IV-3: Kharaa River water quality (*Source: MoMo 2009)*

Parameter	NH4-N (mg/L)	TN (mg/L)	PO4-P (mg/L)	Cl- (mg/L)
Kharaa III sub-basin	0.109	1.08	0.094	8.98
MNS 4586:1998	0.50	10.0	0.10	300
Compliance?	✓	✓	✓	✓

Table IV-4: Kharaa River water quality, Sharingol Bridge, Darkhan (upstream of discharge point), 21-22 August, 2013

Parameter	O_2	BOD	COD	NH_4-N	NO_2-N	PO4-P
Location: Sharingol Bridge, Darkhan (upstream of WWTP)	6.70	1.08	6.5	0.45	0.006	0.103
MNS 4586:1998	*6.0*	*3.0*	*10*	*0.50*	*0.02*	*0.10*
Compliance?	✓	✓	✓	✓	✓	×

Source: Aimag Meteorological Office[43]

86. The Detailed EIA undertaken for the project also presents water quality data for the Kharaa River. The data and a comparison with the Mongolian National Standard are presented in Table IV-5. The table shows that for the data given, the parameters of ammonia (NH4-N) and the Biological Oxygen Demand (BOD) did not meet the standard.

Table IV-5: Kharaa River water quality

Parameter	Kharaa bridge (upstream of WWTP)	Kharaa- Darkhan Meteorological Office (downstream of WWTP)	*MNS 4586:1998*	*Standard is Met*
pH [-]	8.12	8.14	*6.5-8.5*	✓
Solute O2 [mg/L]	9.63	9.67	*6.00*	✓
NH4-N [mg/L]	0.2	1.02	*0.50*	×
NO2-N [mg/L]	0.009	0.019	*0.02*	✓
NO3-N [mg/L]	0.029	1.22	*9.00*	✓
PO4-P [mg/L]	0.043	0.061	*0.100*	✓
BOD5 [mg/L]	2.39	3.02	*3.00*	×

Source: Environ LLC. Detailed EIA

87. **Flooding**. Reduced forest areas in Darkhan-Uul *aimag* may alter water discharge pattern and contribute to increased risks of flooding in the Kharaa River and its tributaries. The Kharaa River does not regularly flood. The most significant flood in recent years was in 1973 when flows of 722 m^3/s were observed. The most recent flood occurred in January 2006 when high rainfall led to the Kharaa River flooding and flowing at 65.9 m^3/s.[44] During intense rainfall events, specific areas of the city are subject to temporary flooding, primarily caused by blocked stormwater channels. The channels are blocked

[42] MoMo (2009). Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo) Case Study in the Kharaa River Basin Final Project Report
[43] Data available on http://www.icc.mn/*aimag*/Darkhan/
[44] http://air.president.mn/en/

with sediment and solid waste. Flooding is exacerbated by the lack of connections to the storm water drainage system; most areas of the city, apart from main roads, have no stormwater flow management.[45] Areas liable to this flooding include old Darkhan's market area, the micro-district in between old and new Darkhan and ger areas built on the flood plain of the Kharaa River, to the west of the railway. The flooding generally lasts for one to two days after a prolonged intense rainfall event. There is no record of floods at the existing WWTP site since it has been put in operation in the 1960's.

88. **Groundwater**. Groundwater in Darkhan is located primarily along the Kharaa River channel and flood plain. The depth to groundwater fluctuates with the season and averages at 3 m. Groundwater resources are abstracted and monitored by Us Suvag. There are 18 groundwater abstraction boreholes in the *aimag* along the Kharaa River valley and about 5 km upstream of Darkhan city, of which currently around five are used for meeting the water use requirements;[46] the current total residential and industrial demand (of about 18,000 m3/d but up to 23,000 m3/d) can be provided from just 5 or 6 production wells. The remainder of the boreholes can be bought into operation by Us Suvag if needed. The wells are located along the Kharaa River and are approximately 70 m deep. The unconfined aquifer is characterized by alluvial sand and gravel with interlaced sandy loam. The main aquifer extends with a width of 10 to 20 km along the Kharaa River, and up to a thickness of 70 m. The groundwater recharge from precipitation is very low in the Darkhan area. The recharge depends on the inflow of groundwater from aquifers of the upper catchment area where precipitation and groundwater infiltration rates are higher. Us Suvag monitors groundwater weekly for between 6 to 18 parameters. Us Suvag confirmed that the groundwater meets the MNS 900:2005 (Mongolian National Standard for potable water).[47] A more detailed description of groundwater resources is presented in **Appendix 1**.

89. **Wastewater treatment plant effluent.** The Meteorological Office[48] of Darkhan-Uul *aimag* is responsible for monitoring the performance of treatment plants in the *aimag*, and the Darkhan WWTP is one of four plants operating within the aimag which are monitored for compliance with national effluent discharge standards. The results from sampling at the points of discharge from the treatment plants to the Kharaa River carried out in the summer of 2013 are shown in Table IV-6. This reveals that despite its operational problems, the Darkhan WWTP delivers an effluent which satisfies the effluent discharge standards on 80% of occasions. This is supported by evidence from *MoMo* which states that "the impact of the wastewater input is detectable [in the Kharaa River] although the nutrient levels are on a moderate level".

[45] MoMo (2009). Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo) Case Study in the Kharaa River Basin Final Project Report
[46] Meeting Ms Sarangerel, Us Suvag Laboratory 26. 09. 2013
[47] Meeting Ms Sarangerel, Us Suvag Laboratory 26. 09. 2013
[48] Source: Darkhan Meteorological Office Data available on http://www.icc.mn/aimag/Darkhan/

Table IV-6: Darkhan-Uul aimag WWTP discharge against quality standard, 21-22 August, 2013

Wastewater Treatment Plant Location	Approximate Distance from Darkhan city (km)	% of effluent samples meeting Standard for wastewater discharge to water bodies (MNS 4943:2011)
Darkhan WWTP	-	80.0
Khongor *Soum* WWTP	25 km	36.9
Salkhit WWTP	35 km	42.9
Sharin Gol WWTP	47 km	70.4

Source: Aimag Meteorological Office[49]

90. The Detailed EIA undertaken for the project also presents quality data for the influent and effluent of the wastewater treatment plant. The data and a comparison with the Mongolian National WWTP effluent standard are presented in Table IV-7. The table shows that for the data given, the parameters of ammonia (NH4-N), phosphorus (PO4-P) and Chemical Oxygen Demand (COD) did not meet the standard.

Table IV-7: Influent and effluent water quality of the WWTP (monitored in Feb 2014)

Parameter	Influent	Effluent	Standard for wastewater discharge to water bodies (MNS 4943:2011)	*Standard is Met*
pH [-]	8.44	8.09	*6-9*	✓
SS [mg/L]	486	5.8	*50*	✓
NH4-N [mg/L]	65	25	*6*	×
PO4-P [mg/L]	7.61	1.98	*0.3*	×
BOD5 [mg/L]	249	13.5	*20*	✓
COD [mg/L]	607.7	99	*50*	×

Source: Environ LLC. Detailed EIA

d. Air Quality, Noise

91. **Ambient air quality.** Air quality is monitored by the Meteorological Institute of Darkhan at an air quality station in Darkhan. Figure IV-11 shows the last 13 years of measurements for sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) in Darkhan. Recently available data (Table IV-8) indicates that air quality met the national air quality standards and meets the WHO standards for 24 hour mean of SO_2 (0.02 mg/m^3) and NO_2 (0.04 mg/m^3).[50] Figure IV-12 shows annual average SO_2 & NO_2 data for Darkhan *soum* against the National Standard MNS 5919:2008.

92. The data in Table IV-8 are for air quality in late summer, which is known to be higher quality than in winter, when the thermal power plant and ger areas of Darkhan emit higher levels of emissions. Therefore the average Figures given in Figure IV-11 are higher, particularly for SO_2, as this includes both winter and summer data; the comparison of these two data sets demonstrates how differences may occur between summer and winter air quality.

93. The environmental assessment undertaken by the Meteorological Office for the National Committee on Reducing Air Pollution[51] concludes that the main cause of air pollution in Darkhan is the power station, as some of the boilers in the thermal power plant are not meeting air quality emissions requirements. This is leading to higher than expected outputs of pollutants such as NO_2 and SO_2 which exceed standards MNS 5919:2008 (emissions from industrial boilers and thermal power plants) by a

[49] Data available on http://www.icc.mn/*aimag*/Darkhan/

[50] The text emphasizes that the data ''indicate'' that standards are met, rather than 'it does' meet the standards as the data available are not 24 hour means, therefore are not directly comparable with the standard.

[51] http://air.president.mn/en/

factor of 1.2 to 1.5 for NO_2, leading to air pollution in Darkhan.

94. The 2011 Human Development Report for Mongolia noted that air quality issues are significant in urban areas. The report made a policy recommendation specifically to reduce the vulnerability of urban residents to urban air pollution in a number of urban areas including Darkhan by improving energy use industries.

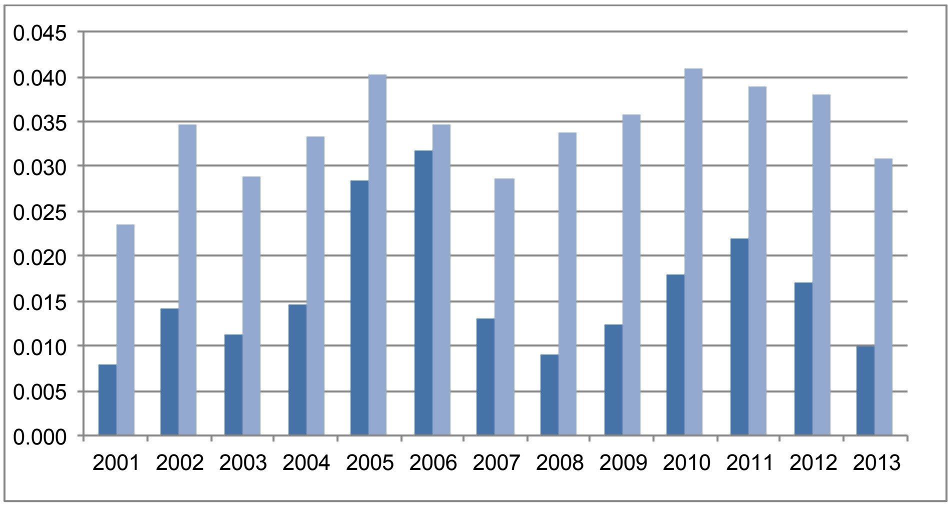
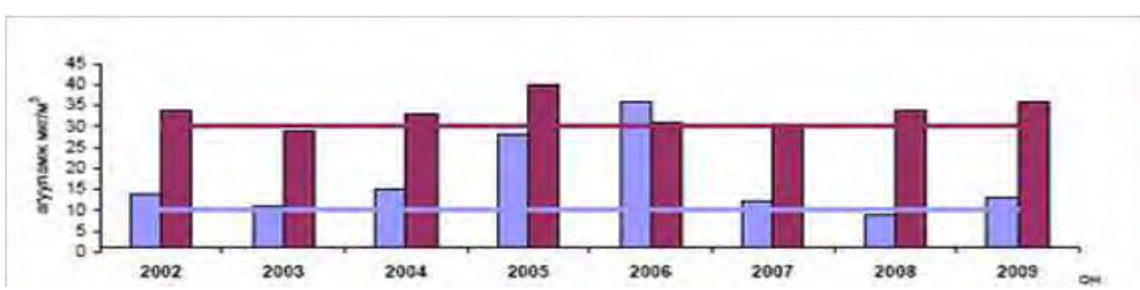


Figure IV-11: Annual average SO_2 and NO_2 concentrations in Darkhan, [mg/m^3] *Source: Environ LLC. Detailed EIA*

Table IV-8: SO_2, NO_2, and Dust, Darkhan (12/09/2013)

	Sulfur dioxide SO_2	Nitrogen dioxide NO_2	Dust
Average	0.003	0.024	0.053
Mongolian Standard 24 hr Mean	0.020	0.040	0.15
Units	mg/m^3	mg/m^3	mg/m^3

Source: Meteorological Institute of Darkhan



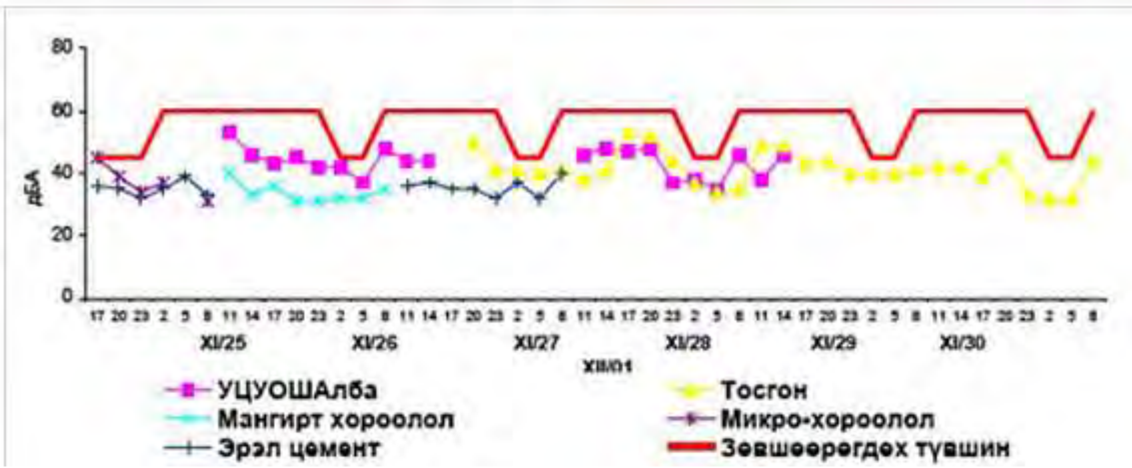
SO2 NO2

Source: National Committee on Reducing Air Pollution[52]

Figure IV-12: Darkhan *soum* Air Pollution Emission 2002-2009 Annual Average

[52] http://air.president.mn/en/

95. **Acoustic environment.** Noise can affect sensitive receptors such as humans. No regular noise monitoring data were available to inform this study relevant to WWTP site. However noise data are available for a specific study undertaken in November 2012 for an assessment of the environmental condition of Darkhan, undertaken by the *aimag* Meteorological Institute. The data were recorded in five locations, and showed that the daytime average was 30-45 dB (Mongolian National Standard is 60 dB) and night time average is 31-43 dB (Mongolian National Standard 45 dB). Figure IV-13 gives noise monitoring data for five locations in Darkhan.



Key to Locations
Pink - Meteorological Institute, Blue - Mangirt ger district, Black - Erel Cement Factory
Yellow - Tosgon ger district, Purple - Micro district - between Old/New Darkhan
Red line = National Standard
Source: National Committee on Reducing Air Pollution[53]

Figure IV-13: Darkhan *soum* Noise Monitoring Data

C. Ecological resources within the project area

96. **Context.** The location of project output 1 (WWTP) is in an ecologically disturbed environment which has been used as an industrial type site for at least 48 years, i.e., since the WWTP was established. Output 2 (pumping stations, pipes and ancillary works) are in (i) an urban environment, largely devoid of vegetation and other ecological resources and also (ii) in the industrial area of the city, in which heavy industry such as the thermal power plant and tannery are based. In these circumstances, coupled with heavy grazing on the grasslands around the city, available data suggests that flora and fauna in the area to limited and of low ecological value.

97. **Flora and Fauna**. The project area is located in the Mongolian steppe or Mongolian-Manchurian grassland.[54] 59% of the Kharaa River basin area is characterized by grasslands. These grasslands are mainly in the lower reaches of the river, in which Darkhan is located. As the altitude of the basin increases, the vegetation changes to mountain forest steppe zone in the middle reaches and boreal coniferous in the mountainous upper reaches.

[53] http://air.president.mn/en/

[54] World Wildlife Fund. Temperate grasslands, savannas and shrublands; Ecoregions. - http://worldwildlife.org/ecoregions/pa0813

98. The grasslands are currently being threatened by grazing. Sheep-grazing is dominant, although the number of goats raised on the Mongolian-Manchurian grasslands has increased due to the high prices for cashmere wool. Goats eat a wider range of plant species than sheep, forage more aggressively and consume the whole plant; this has contributed to degradation of the grasslands over a widespread area. The flora is dominated by feathergrass (*Stipa baicalensis, S. capillata, and S. grandis*), Sheep Fescue (*Festuca ovina*), *Aneurolepidium chinense*, *Filifolium sibiricuman*, and *Cleistogenes sqarrosa.*[55]

99. World Wildlife Fund (WWF) confirms that the only endemic bird to use the grassland type habitat is the brown eared pheasant and one of the most significant mammals in the grassland is the Mongolian Gazelle (*Procapra gutturosa*).[56] However the IUCN Red Listconfirms that the pheasant is only present in the grasslands of the People's Republic of China and the range of *Procapra gutturosa* does not extend as far north as the grasslands around Darkhan. [57]

100. The Detailed EIA for the project confirmed that although approximately 20 species of birds may use the area around the project site for roosting or transiting, none of the species are on the IUCN red list and those that are present, such as crows and sparrows, are familiar with habitats which have been degraded by human activities. [58] The Detailed EIA also includes information on a number of rodents which are common in Mongolia, such as the house mouse (*Mus musculus*) and Mongolian gerbil (*Meriones unguiculatus*), however the study also concludes that the presence of these mammals cannot be confirmed, and that the habitat is already greatly disturbed by human activities. Therefore, any species present are likely to be those which tolerate disturbance and do not need a habitat with a high ecological value.

101. Ecological assessments of flora and fauna in the Kharaa River basin are presented by *MoMo*. The report states that the analysis of the macro-invertebrate communities along the Kharaa catchment indicated good ecological conditions at most of the sites and an assessment of the fish communities showed a good or very good ecological status at most of the sites sampled. Further information is provided in Figure IV-14.

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[55] Ibid.
[56] Ibid.
[57] A global list of endangered species. http://www.iucnredlist.org
[58] Environ LLC (2014) A Detailed Environmental Impact Assessment Report for Expansion Project of Central Treatment Plant in Darkhan-Uul Province [*sic*]

site	Macro-invertebrates average of 5 to 6 metrics	Fish fauna FIBS	Water Quality General parameters		Ecological Status average of MZB, fish and Water Quality	Priority Substances Heavy Metals
Kharaa River Main Channel						
Sug_2	2,0	2,0	2,0		2,0	2,0
Sug_1	2,0	2,0	1,0		1,7	2,0
Kh_8.5	2,0	2,0	2,0		2,0	2,0
Kh_8	1,0	2,0	2,0		1,7	2,0
Kh_7	2,0	2,0	2,0		2,0	2,0
Kh_6	3,0	2,0	2,0		2,3	2,0
Kh_5	3,0	2,0	2,0		2,3	2,0
Kh_4	3,0	2,0	2,0		2,3	2,0
Kh_3	3,0	3,0	2,0		2,7	2,0
Kh_2	2,0	2,0	2,0		2,0	5,0
Kh_1	2,0	2,0	2,0		2,0	2,0

Note: For quality classes: "very good" = blue, "good" = green, "moderate" = yellow, "poor" = orange, "bad" = red. FIBS= German assessment tool

Figure IV-14: Ecological Assessment and Priority Substances. *Source: MoMo (2009). Integrated Water Resources Management for Central Asia: Model Region Mongolia (MoMo) Case Study in the Kharaa River Basin Final Project Report.*

102. **Protected areas and endangered species.** Darkhan is one of three provinces in Mongolia which does not have any Specially Protected Areas (Strictly Protected Area, National Conservation Parks, Nature Reserves and Monuments). Locally however Darkhan-Uul *aimag* authorities have a local nature reserve status for two local areas of the Kharaa River: (i) Khongor *soum*, the east side of the river bank bagh 1,3; and (ii) Darkhan *soum* the east side of the river bank in *bagh* 2 and 3, 500 m from Ukhaa hoshuu river. These areas were defined by local decisions including (i) the 61st decree of People's Representatives' Meeting in *aimag*, 2007; and (ii) the 4th decree of People's Representatives' Meeting in *Soum*, 2006 respectively. This nature reserve status is not set out in national law, but rather it supports the *aimag* with protecting the natural beauty of an area and therefore is focused on the visual appeal of the area. Discussions with *aimag* Environmental Protection Agency staff confirmed that there are no concerns with rare wildlife species in the area; the main issues dealt with by staff is regarding the illegal collection of fire wood, forest fires and artisanal gold mining. None of these issues will be exacerbated by the project.

V. ALTERNATIVE ANALYSIS

103. Under ADB's Safeguards Policy Statement (2009) there is a requirement to examine alternatives to the project's location, design, technology, and components and their potential environmental and social impacts and consider the no project alternative.

A. No Action Alternative

104. **The "No Action Alternative**" addresses the likely consequences of not undertaking the proposed action. For this project, the failure to develop and improve the existing sewerage infrastructure may be an impediment to development of the Darkhan as a livable city and may give rise to pollution of the Kharaa River basin as a result of failing WWTP equipment and a predicted increase in wastewater. The improvement of the WWTP will ensure that the urban environment is 'future proofed' and that new developments both in terms of industry and expansion of the town, do not affect negatively on the environment as a result of increased volumes of wastewater. Therefore, it can be determined that the "No Action Alternative" is not a reasonable option if the future environmental quality in Darkhan and the Kharaa River Basin is to be maintained and improved.

B. Location Alternatives

105. The project seeks to improve the efficiency and performance of the existing sewerage network. The central WWTP is currently in a suitable location; it is on the edge of the town, not close to any residential areas and is well served by the sewerage network of pumping stations and pipes in the city. The current WWTP has a large footprint with enough land to store the drying sludge, as currently happens as well as approximately 90 days of wastewater retention capacity, if required. Therefore given the existing location for the WWTP and the current pipe network that services it, location alternatives are not considered further.

C. Design and Technology Alternatives

106. **Pumping houses - design for reuse**. A key consideration regarding the design of the WWTP is the condition of the existing buildings, in particular the pump houses. The pump houses are in a reasonable condition and the fabric of the buildings is sound. In order to consider the most environmentally and socially sound option for WWTP design, the Waste Hierarchy can be applied (Figure V-1). The Waste Hierarchy is a classification of waste management options, ranging from most preferable (waste prevention) to least preferable (disposal).

107. The design of the WWTP takes into account the current structures at the project sites. The chosen option is to rehabilitate the central, secondary and industrial pumping stations. The alternatives include constructing new buildings, and either leaving the existing pumping stations or demolishing them. However the chosen option, of reusing the existing buildings where possible, is the most environmentally and socially acceptable option as falls under the 'waste prevention' category of the Waste Hierarchy. It is anticipated to be the least resource intensive option as constructing new buildings requires considerable resources, in terms of energy, raw materials and associated embodied

carbon[59].

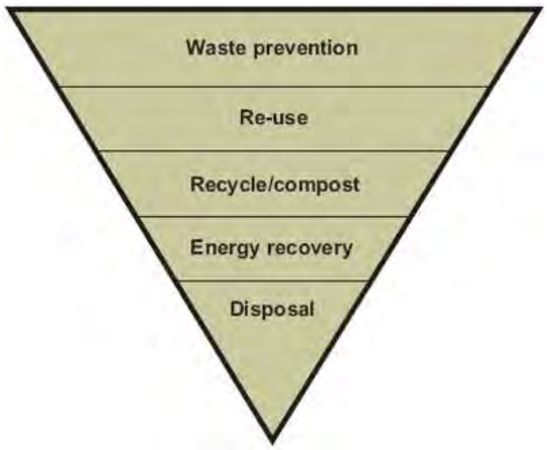

Figure V-1: Waste Hierarchy

Source: Department for Environment and Rural Affairs (UK)

108. **WWTP technology alternatives**. The treatment technologies proposed have been the subject of intensive analysis, based on both international and Mongolian experience of wastewater treatment under condition similar to those found in Darkhan. Wastewater treatment plants are complex systems which rely on a series of sensitive physical, biological and (sometimes) chemical processes to achieve optimal treatment results. While the evaluation of alternative options has narrowed the technology choices to those which are most appropriate for Darkhan, the specific design of the treatment plant, and the way in which it is operated, will need to respond precisely to local conditions and the current and changing nature of the wastewater it will receive, as new generators connect to the wastewater network. Given the context of the Darkhan WWTP, the technology alternatives evaluated as part of the Technical Assistance are narrowed to:

- Option 1. rehabilitation of the existing WWTP as a modified activated sludge process;
- Option 2: construction of a step-feed activated sludge system;
- Option 3: construction of a sequencing batch reactor; and
- Option 4: construction of an Integrated Fixed-film Activated Sludge (IFAS) Plant

109. In terms of environmental risks, there is little difference between the options considered as all, if operated correctly, will offer adequate performance. In terms of costs, the step-feed activated sludge is slightly more expensive and has slightly higher operational cost than the other two systems.

110. The performance of the treatment options is the key environmental and social concern. This includes the adequate mineralization of sludge and the likelihood of accidents or errors in the WWTP operation which may result in the emission of untreated effluent. It is considered that all three options are technically feasible in Mongolia and will be able to meet the necessary effluent standards and sludge mineralization requirements.

111. The client has reviewed the evaluation prepared by the consultants. In addition, Darkhan Uul *aimag* Government and Us Suvag have been given presentations by the consultants on the treatment

[59] Embodied Carbon is the greenhouse gas emissions (usually expressed as carbon dioxide equivalents – CO2e) associated with a product lifecycle; for construction this is the manufacture and transport of the construction materials and components , includes the construction process itself and end of life aspects of the building

system evaluation and the options under consideration. The conclusions and recommendation of this group have been as set out below:

(1) In its meeting held in December of 2013, the MCUD Project Steering Committee concluded that a separate meeting involving MCUD, academia, technical experts and specialists, and Us Suvag should be convened on 27th January 2014 to select the preferred technology for the WWTP;

(2) The expert group met on 27^{th} January 2014, and a presentation was made by the consultant team. However, the group recommended that the MCUD Technical Committee on Water and Wastewater Infrastructure should consider the options and make a recommendation;

(3) On 20th February 2014 a meeting of the MCUD Technical Committee on Water and Wastewater Infrastructure recommended: (i) that the consultants look again at moving bed bioreactor and modified bioreactor options for treatment; (ii) that the existing structures of the WWTP should be rehabilitated if proved to be feasible; and (iii) that a modified activated sludge process technology – such as the IFAS system - should be adopted which is proven suitable for Mongolian conditions;

(4) At the MCUD Steering Committee meeting held on 2^{nd} April 2014 it was concluded that: (i) the proposed design capacity of 20,000 m3/d should be reviewed and confirmed by the consultants based on projections of future wastewater generation rates; (ii) the most appropriate and up-to-date technology should be used for the plant; (iii) the committee supported the adoption of the modified activated sludge process (i.e., Integrated Fixed-film Activated Sludge (IFAS) process) for the Darkhan WWTP, and that the existing structures should be used where feasible, and where consistent with the treatment plant adopting the most modern treatment approaches.

112. As a result of this consultative process, Option 4 (IFAS) was selected, with the reuse of existing buildings. The solution is considered to be environmentally sound; in particular it will produce approximately 1/3 of the sludge as produced by SBR technology and therefore will require smaller volumes of sludge to be treated and disposed of. The effluent quality of IFAS is predicted to be sufficient to adequately meet Mongolian National Standards.

113. A comprehensive description of the technical alternatives for the wastewater treatment process and rehabilitation procedure prepared by the TA consultant is presented in **Appendix 5**.

114. **Wastewater disinfection.** 2 alternatives were considered for effluent disinfection prior to discharge, including UV and chlorine. UV disinfection was selected for the following reasons: (i) there are significant concerns associated with chlorination including the production of potentially hazardous byproducts (chlorinated organic compounds), toxicity concerns from chlorine residual for the biota in receiving surface waters, and the potential hazards associated with handling the chlorine at the treatment plant; and (ii) unlike chlorine, UV does not pose disinfection byproducts, toxicity, or hazardous materials concerns.

VI. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. Environmental Impact Screening

116. The following section screens the potential impacts according to the following factors, and recommends mitigating activities on this basis:

(1) **"Receptor"**: the resource (human/natural environment/economic/social) which is potentially going to receive and have to cope with an impact;
(2) **"Sensitivity"**: ability to cope with an impact and/or its importance to the country of Mongolia. It is generally accepted that human health is always a high sensitivity receptor, however in terms of environmental/natural resources, the sensitivity varies according to the receptor e.g. scrubland with no significant biodiversity is considered less sensitive than a mature forest which supports ecosystems and livelihoods;
(3) **"Magnitude"**: the size of the potential impact. Impacts may be short term and considered low magnitude (e.g. noise or temporary reduction of income during a short construction project) or high magnitude (e.g. the disposal of large quantities of hazardous waste into a water course);
(4) **"Source-Pathway-Receptor"**: Where an impact may occur, but where no receptor is exposed to the impact, no mitigating action will be required. This follows the source-pathway-receptor model, whereby in order for there to be an impact, the pollutant or issue (source) needs to be present, the pathway to a receptor is needed (such as fissures in rocks, or water for human consumption) and a receptor must be present to receive the impact, such as humans, flora or fauna.
(5) **"Residual Impact"**: The impact on a receptor after mitigation is the 'residual impact'. This is key to the assessment of impacts and demonstrates the importance of the implementation of EMP mitigation measures. Table VI-1 shows the matrix used during the screening process to anticipate the *Potential Impact Significance* (PIS). This assists with identifying the most significant and most likely impacts, to be addressed in the Environmental Management Plan (EMP).

Table VI-1: Impact Significance

Receptor Sensitivity & Importance	Magnitude of Impact: LOW	Magnitude of Impact: MEDIUM	Magnitude of Impact: HIGH
LOW	Low	Low	Medium
MEDIUM	Low	Medium	High
HIGH	Medium	High	High

117. The Potential Impact Significance (PIS) and Residual Impact Significance (RIS) are presented in Table VI-2 to Table VI-4. RIS is the significance of the impact remaining after mitigation has taken place. This more accurately describes the impacts of the project as it is anticipated that the requirements of the EMP will be followed and impacts satisfactorily mitigated. Table VI-2 to Table VI-4 are also in line with the Detailed EIA[60] undertaken in accordance with the laws of Mongolia.

Table VI-2: Impact Screening - Project Design

	Category	Impact Yes/No	Receptor Sensitivity	Magnitude	PIS	RIS
DIRECT IMPACTS						
Physical	Water	Yes	Kharaa River - has ecological value and is a water source. Design must ensure uninterrupted sewage treatment. Medium	Short term during construction until new plant on line. Medium	Medium	Low
	Soil	No	-	-	-	-
	Air	No	-	-	-	-
	Noise	No	-	-	-	-
	Resource Use	Yes	Design will affect energy efficiency, and re-use of existing buildings. Medium	Long term operational implications for energy efficiency. Medium	Medium	Low
Biological	Fauna	No	-	-	-	-
	Flora	No	-	-	-	-
Socio-Economic	Land Acquisition	Yes	-	-	-	-
	Cultural Heritage	No	-	-	-	-
	Economic Displacement	Yes	Some local businesses may be temporarily affected. Low	Short term. Low	Low	Low
INDIRECT, INDUCED AND CUMULATIVE IMPACTS						
No impacts anticipated resulting from project design/location						

60 Environ LLC (2014) A Detailed Environmental Impact Assessment Report for Expansion Project of Central Treatment Plant in Darkhan-Uul Province [*sic*].

Table VI-3: Impact Screening – Construction Impacts

	Category	Impact Yes/No	Receptor Sensitivity	Magnitude	PIS	RIS
	DIRECT IMPACTS					
Physical	Soil	Yes	Poor quality soil, not fertile lands. Low	Worst case is medium term if contamination is from chemical spillage. High	Medium	Low
	Flooding	No	-	-	-	-
	Air	Yes	Airborne dust will arise and could affect nearby human receptors. High	Short term, most construction sites will not be close to receptors. Medium	Medium	Medium
	Water	Yes	Kharaa river flood plain - emergency sewer pipe Output 2. Medium	Short term with contamination from construction waste. Low	Low	Low
	Waste	Yes	Poor waste controls could affect soil / water, and public health. High	Hazardous waste may be produced if PCBs are encountered, however quantity is small. Medium	High	Medium
	Resource Use	Yes	Construction resources include fuel and materials such as concrete which may need to be imported. Medium	Relatively small quantities but project will lead to more efficient WWTP. Medium	Low	Low
Biological	Fauna	Yes	Higher fish species in Kharaa river. Medium	Potential contamination from spillages at WWTP but would be diluted by river as construction will not take place near water body. Low	Low	Low
	Flora	No	-	-	-	-
Socio-economic	Cultural Heritage	Yes	Getsogdarjaalin Monastery monks and visitors (Output 2). High	Temporary noise and dust impacts may affect people attending the site. Low	Medium	Low
	Noise	Yes	Noise will impact on the community, particularly hospital residents (Output 2). High	Temporary during construction and construction period near hospital will be brief. Medium	High	Medium
	Community Health &Safety	Yes	Public health and impacts on people from noise, dust and construction sites e.g. open trenches. High	Temporary during construction as construction area will be near a school and housing areas. Medium	Medium	Low
	Economic Displacement and / or Land Acquisition	Yes	These issues are covered in the Land Acquisition and Resettlement Plan which is developed for the project according to SPS 2009.			
	Occupational Health & Safety	Yes	Occupational health. High	Throughout construction, risks may arise. Medium	High	Low
	Utilities Provision	Yes	Limited impact assuming accidental damage only to other services buried near sewer pipes. No district	Assume short term and unlikely impact. Low	Low	Low

	Category	Impact Yes/No	Receptor Sensitivity	Magnitude	PIS	RIS
			heating pipes are near project sites. Low			
	Employment	Yes	Anticipated positive impact as the labor supply (around 50 workers) is likely to be met by the local population.			
	Interruption to pasture land	Yes	Animals out to pasture may be affected by disturbance from project sites in pasture areas (Output 2). Low	Short term during construction. Low	Low	Low
INDIRECT IMPACTS						
Physic -al	Physical resources	No	-	-	-	-
Biolog -ical	Biological resources	No	-	-	-	-
Socio-Economic	Traffic & Journey Times	Yes	Minor journey delays for road users. Low	Short term during single pipe excavation. Low	Low	Low
CUMULATIVE and INDUCED IMPACTS						
Physi cal	Physical Resources	No	-	-	-	-
Biolog -ical	Biological Resources	No	-	-	-	-
Socio-Economic	Noise	Yes	Can affect health for example in hospital patients, Old Darkhan Hospital. High	Hospital near a main road therefore constant level of background noise, but elevated noise short term during pipe excavation. Medium	Medium	Medium

Table VI-4: Impact Screening – Operational Impacts

	Category	Impact Yes/No	Receptor Sensitivity	Magnitude	PIS	RIS
	DIRECT IMPACTS					
Physical	Water	Yes	Kharaa river flood plain – existing emergency sewer pipe above ground[61]. Medium	Pipe is rarely used but needs to be well maintained. Medium	Medium	Low
Physical	Water and Soil	Yes	Inappropriate sludge disposal and poorly mineralized sludge may impact on immediate soil quality, but soil in existing industrial brownfield site. Low	Contamination would be low but over a long period. Medium	Medium	Low
Physical	Water, Soil, Waste & Resource Use, Air Quality	Yes	Positive impacts anticipated on surface water quality given the increased efficiency of the WWTP and sewerage infrastructure.			
Biological	Flora	Yes	Positive impacts for flora and fauna in Kharaa river are anticipated given the increased efficiency of the WWTP and sewerage infrastructure.			
Biological	Fauna	Yes				
Socio-Economic	Community Health and Safety	Yes	Positive impacts anticipated.			
INDIRECT, INDUCED AND CUMULATIVE IMPACTS						
No significant indirect, induced or cumulative impact anticipated resulting from project operation						

118. The screening process showed that following mitigation, related to project design (design phase), the most significant impacts are the temporary economic displacement of 5 street vendors and the need for ensuring continuity of wastewater treatment. The majority of impacts will arise during the construction phase. The most significant impacts may arise from hazardous waste arising and noise and dust arising from excavations which at one project site, is outside a school and a hospital. During operation, no significant environmental impact is anticipated. Through training and appropriate technological design, operational risks of the project can be significantly reduced. The discharge of treated effluent will have no significant impact on the water quality of the Kharaa River.

B. Positive Impact and Environmental Benefits

119. The project will directly benefit about 10,000 households in the apartment areas and 2,000 businesses already connected to the WWTP. The indirect beneficiaries are all residents of Darkhan city. The project will impact household income and well-being of Darkhan city residents through the following mechanisms: (i) increased effectiveness of the Water Supply and Sanitation Company (Darkhan Us Suvag); (ii) extension of business activities; (iii) improvement of health conditions, and (iv) more pleasant environment for residents. Further beneficiaries are those downstream of Darkhan in

[61] The existing above-ground overflow pipe is designed to convey wastewater to nearby existing system of ponds (nearby railway tracks) in case of pump failure at the secondary pumping station.

the Kharaa River basin. The river basin's population and ecology will benefit from any measure which will minimize pollution discharge to the water body. The project will also have significant energy efficiency gains through the use of existing structures (as opposed to the deconstruction of old facilities and construction of new facilities), and through system selection and optimization. Electricity consumption during operation is expected to decrease from today's 1.3 kWh/m3 to 0.9-1.0 kWh/m3, or some 1.7-2.0 million kWh per year. This will result in some 60,000-70,000 USD electricity costs reduction.

120. The development of an efficient and effective WWTP will ensure that in the future, those relying on the Kharaa River as a raw drinking water source are not affected by poor water quality. This includes nomadic herders who graze their livestock on the Kharaa River flood plain, and residents of *ger* areas in the flood plain.[62] The nomadic herders are generally the poorer members of the population, and as such, are less able to withstand health shocks which may be associated with health impacts from poor water quality.

121. Darkhan is considered an industrial city in Mongolia, and the potential attraction of additional industries to the city, will increase the likelihood that industrial wastewater volumes will increase. Current and future industries will benefit from the WWTP as their effluent will be able to be treated centrally in the WWTP, following pre-treatment where required.

C. Impacts Associated with Project Location, Planning and Design

122. Impacts associated with the project location and design focus on the following key areas:

(1) Planning to ensure the current WWTP will remain operational until the new WWTP is operational; and
(2) Resource use: Ensuring that the existing plant and machinery, to the extent possible, are reused in accordance with the Waste Hierarchy (see Figure V-1).

123. **Mitigation measures and actions during design and pre-construction**. The mitigation of impacts from these design issues are as follows:

(1) Careful planning of WWTP rehabilitation and extension works to ensure continuous treatment capacity of existing facility in accordance with the rehabilitation plan defined in Appendix 2;
(2) Design must account for waste management hierarchy philosophy (i.e., where possible existing buildings and machinery shall be reused).

124. Further actions will be implemented in the pre-construction phase to **ensure the project's environment management readiness.** These include:

(1) Appointment of one safeguards staff (PIU-SS) within the PIU to coordinate project EMP implementation;
(2) Contracting of a licensed environmental monitoring institute by the PIU for project specific environmental quality monitoring, developing detailed monitoring plan for pre-construction and construction period (on the basis of the monitoring plan defined in EMP, Table EMP-4), and conduct pre-construction environment quality monitoring;
(3) Updating of the EMP, as required, and incorporated into the detailed to detailed design;

[62] Sigel K. 2010. Environmental sanitation in peri-urban ger areas in the city of Darkhan (Mongolia): A description of current status, practices, and perceptions.

(4) Tender and contract documents to include (updated) EMP requirements;
(5) Develop and implement a grievance redress mechanism (GRM) on the basis of the GRM defined in the IEE, Chapter VIII; and
(6) Consult and inform residents and key stakeholders (including monastery, school No. 15, old Darkhan hospital) regarding construction timing and approach (Output 2).

125. Before the construction starts, the 3 civil works contractors will prepare a **contractor EMPs** (C-EMP) which shall fully respond to the requirements set in the project EMP, and shall include a number of sub-plans, including: (i) soil erosion control plan; (ii) borrow and spoil management plan; (iii) water protection plan; (iv) health and safety risk management plan; (v) spill management plan; and (vi) waste management plan:

(1) The soil erosion protection plan will identify likely areas of soil erosion and the mitigation measures which the contractor will employ to minimize potential erosion around any excavations and construction areas;
(2) The borrow and spoil management plan will specify location of borrow pits, quarries and spoil disposal sites, as needed. Contractors will ensure that (i) borrow areas will be located away from residential areas, water bodies and will avoid valuable pasture/grazing land, (ii) after use borrow pit areas will be graded to ensure drainage and visual uniformity, and (iii) borrow pit restoration will follow the completion of works in full compliance with all applicable standards and specifications;
(3) The water protection plan will include measures to be taken during construction to avoid/mitigate pollution of the Kharaa River arising from construction site drainage (silt), use of chemicals, construction around existing wastewater containing equipment and other potential pollution sources;
(4) The health and safety risk management plan (HSMP): For management of occupational health and safety, the contractor will prepare a HSMP for the construction workers.
(5) The spill management plan will document the specific requirements, protocols, responsibilities, and materials necessary to implement an emergency spill response following an incident;
(6) The waste management plan for construction sites will provide procedures for management of household type waste, hazardous waste, and sewage (if appropriate). It will evaluate the type and quantities of waste, as well as detail arrangements for storage and transportation of the waste to its disposal point. It will include agreements with the *aimag* authorities for waste disposal and consideration of the Waste Hierarchy. The plan will include polychlorinated biphenyl (PCB) assessment and management plan for all pumping station sites. It will include a schedule for disinfection of all waste collection and storage areas.

126. **Utilities Provision**. It is not anticipated that the project will disrupt utilities or any municipal services during construction however excavations associated with sewer pipe replacement at Old Darkhan Hospital (Output 2) may result in accidental interruption to cables or pipes which may be buried near the sewer. The concerned Contractors (2) will consult with relevant *aimag* departments to check location of utilities in advance of construction at all sites.

D. Environmental Impact and Mitigation Measures during Construction

1. Impact on Physical Resources

127. **Impacts on Soil Resources.** Three types of potential impacts on soil are anticipated, including: (i) soil erosion; (ii) soil contamination; and (iii) inappropriate management of borrow and spoil.

(1) Soil erosion: May be caused by excavation of borrow pits, stockpiles and spoils from earthworks during pipe excavation and groundworks for the central WWTP. The factors that are expected to contribute to accelerated erosion in the project area are any exposed soil during periods of rainfall from June to August.
(2) Soil contamination: Localized contamination of soil in the construction phase may result from the inappropriate transfer, storage, and disposal of petroleum products, lubricants, chemicals, hazardous materials, liquids and solid waste. These impacts are particularly associated with construction site chemical storage, and during refueling of plant and equipment.
(3) Borrow and spoil: Borrow will be needed to provide fill for groundworks, particularly associated with adequate coverage of the Secondary Pumping Station tertiary pipes (Output 2) which are above ground and will need adequate protection from cold weather. Spoil will be generated through the excavation of trenches for pipes.

128. **Mitigation of impacts on soil.** The impacts on soil will be mitigated through a number of measures which are defined in the EMP, and which will be incorporated in the bid documents and construction contracts. A summary of the mitigation activities defined in the EMP is as follows:

(1) Soil erosion: (a) soil erosion management plan to be prepared by the contractor before construction starts; (b) minimizing the area of soil clearance; (c) maintaining slope stability at cut faces by implementing erosion protection measures; (d) construction in the flood plain (tertiary pipe at Secondary Pumping Station) should be mainly restricted to the dry season; (e) control silt runoff particularly around tertiary pipe at Secondary Pumping Station; (f) cover soil stockpiles; (g) properly stabilize slopes and re-vegetate disturbed surfaces; and (h) use of temporary berms or other appropriate temporary drainage provisions at construction sites to prevent water eroding cut faces, stockpiles and other exposed areas of soil.
(2) Soil contamination: (a) store chemicals/hazardous products and waste on impermeable surfaces in secure, covered areas with clear labeling of containers and with a tray or bund to contain leaks; (b) regularly remove all construction wastes from the site to approved waste disposal sites; (c) establish emergency preparedness and response plan (Spill Management Plan); (d) provide spill cleanup measures and equipment at each construction site; (e) conduct training in emergency spill response procedures (f) ensure fuel is stored in a tank and vehicle refueling takes place on hard standing, away from sensitive receptors, such as surface water.
(3) Borrow and spoil: (a) Develop and implement borrow and spoil management plan, specifying location of borrow pits, quarries and spoil disposal sites; (b) ensure that borrow areas are located away from residential areas, water bodies and valuable pasture/grazing land; (c) after use, grade borrow and spoil areas to ensure drainage and visual uniformity, and (d) borrow pit restoration must follow the completion of works in full compliance with all applicable standards and specifications;

129. **Impact on air quality.** Moderate temporary air quality impacts during the construction stage of the project could be anticipated because of fugitive dust generation at construction sites for the sections of replaced pipe and at the central WWTP. Minor increases in the level of nitrogen oxides (NO_x) and sulphur oxides (SO_x) from construction plant and machinery are expected. Air quality impacts during construction are likely to result from the following sources:

(1) Emissions from construction machinery and equipment, movement of haulage trucks to all construction sites;
(2) Fugitive dust from stripping of pavement during pipe replacement near Old Darkhan Hospital (Output 2);

(3) Fugitive dust and odor from concrete batching plants required for construction or other plant for manufacture of pavement surfaces when making good after pipe excavation;
(4) Fugitive dust from earthworks such as establishment and use of borrow pits, and back-filling activities;
(5) Fugitive dust from loading, unloading and haulage of spoil for disposal following pipe excavation particularly in areas where human receptors are present such as near Old Darkhan Hospital (Output 2); and
(6) Dust created by wind acting on unprotected surfaces.

130. The key receptor for air quality impacts is people, who would need to be near the construction works before an impact will occur as the impacts will be localized. Air quality issues could affect nearby residential areas at the site of Old Darkhan hospital which also includes a school.

131. **Mitigation of impacts to air quality.** The mitigation measures to protect sensitive receptors from air quality issues are:

(1) <u>Stockpiles</u> must be managed to reduce dust emissions. The location of the stockpiles must be downwind of sensitive receptors. The stockpiles must be sprayed with water before material is moved. If a stockpile is within 300m of dwellings, additional precautions must be taken including using a reusable stockpile cover and fencing to form a high barrier and prevent wind lifting and dispersing;
(2) <u>Construction site management</u>: Water will be sprayed on construction sites and material handling routes where fugitive dust is generated.
(3) <u>Transport of materials</u>: Trucks carrying earth, sand or stone will be covered with tarpaulins or other suitable cover. Construction vehicles and machinery will be maintained to a high standard to minimize emissions (note that local standards do not exist for vehicle emissions)
(4) <u>Manufacturing plants</u>: Site any plants for the production of concrete or pavement covering such as asphalt at least 500 m from the nearest dwelling and locate downwind.

132. **Impacts to water quality.** Overall the project will improve water quality, however it may impact on surface water quality during construction through primarily accidental contamination particularly on the Kharaa River flood plain (Output 2, tertiary pipe at Secondary Pumping Station) during periods of heavy rainfall (June - August). Also leaving the city without any WWTP during construction would have detrimental impacts on water quality. Construction activities have the potential to contaminate groundwater if accidental spills occur in areas of high water table. Groundwater may be impacted upon should a large spill occur; however an impact on the drinking water quality is unlikely as the groundwater extraction boreholes are around 5 km from Darkhan city and residents do not use their own boreholes or wells for drinking purposes.

133. **Mitigation of impacts on surface and groundwater**. The impacts on surface and groundwater will be mitigated through a number of measures defined in the EMP, and which will be incorporated in the bid documents and construction contracts:

(1) Contractors will be required to develop and implement contingency plans for control of spills of oil and other hazardous substances (Spill Management Plan) as part of the C-EMP;
(2) Adequate WWTP capacity will be maintained at all times throughout rehabilitation of the WWTP in accordance with the rehabilitation stage plan (Appendix 2);
(3) Temporary drainage provision will be provided during construction at the Secondary pumping Station tertiary pipes site to ensure that any storm water running off construction areas will be controlled. This will ensure that potentially contaminated sediment laden water does not impact on the flood plain;

(4) Enclosed drainage around chemical storage areas on construction sites and storage will be on hard standing;
(5) Fuel storage, maintenance shop and vehicle cleaning areas must be stationed at least 300 m away from the nearest water body and will include enclosed drainage to ensure contaminated water does not cause pollution and storage, maintenance and cleaning activities will be on hard standing;
(6) Construction wastes and materials (e.g. fuel) will be properly contained during construction on hard standing and fuel tanks will be located in a bunded area which has a capacity of 110% of the fuel tank. Wastes will be stored in a hard standing area which is protected from rain and wind and waste removed from site and taken to approved disposal facilities.

134. **Waste management and resource use.** Minimizing waste conserves valuable natural resources. Disposal of construction wastes could have adverse impacts on soil, water and health of contractors and the community. Waste streams will include inert construction wastes (e.g. soil, spoil, debris, concrete) and municipal type wastes (construction workers' food and packaging wastes from construction consumables). Hazardous waste may include fuel containers, oil filters, oily rags, but potentially will include Polychlorinated Biphenyls (PCBs) from the transformers which remain in the New South Pumping Station (Output 2). PCBs were widely used as coolant fluids and may be found in older transformers. This would require disposal of PCB contaminated equipment as well as liquids.

135. **Mitigation of impacts from solid waste and resource use.** The potential impacts arising from solid and liquid waste production and disposal will be mitigated through a number of activities defined in the EMP, and which will be incorporated in the bid documents and construction contracts:

(1) <u>Waste hierarchy</u>: Construction will be subject to the waste hierarchy to ensure efficient use and management of resources. The preference is for prevention of waste at source. This means the effective management of materials on site through good house-keeping and work planning, in order to generate less waste. Procurement options will play a role in waste prevention as the procurement of materials which have less packaging for example, would be preferable. Waste minimization is the second preferred option. Reuse or recycling options should be considered prior to disposal, separate containers for recyclables shall be used if there is a market for the materials. Disposal of waste which cannot be reused or recycled shall take place at sites authorized by the aimag authorities.
(2) <u>Storage and containment</u>: Provide appropriate waste storage containers for worker's construction wastes; install confined storage points of solid and liquid wastes away from sensitive receptors, regularly haul to an approved disposal facility; include scope for long term storage of hazardous liquid waste (PCB) which requires high temperature incineration;
(3) <u>Use of contractors</u>: Use a contractor approved by the aimag authorities to remove all wastes from construction sites;
(4) <u>Spoil management</u>: Spoil will be disposed only in sites which are defined in the Borrow and Spoil Management Plan; spoil will not be disposed of on slopes or near pasture land where it may impact on vegetation; rehabilitate and restore spoil disposal sites in accordance with the agreed plan.
(5) <u>PCB assessment</u>: Assessment of likelihood of PCBs being present at pumping-stations prior to works commencing; disposal strategy for PCB arisings which is likely to include incineration for total PCB destruction. Incineration is the only waste management option which destroys PCBs. If this is not viable, PCB contaminated equipment and PCB containing liquid must be stored safely until its destruction can be arranged outside

Mongolia.[63]

(6) General Management: Prohibit burning of waste at all times.

2. Impact on Biological Resources

136. **Fauna and Flora.** The potential impact of construction activities on biological resources is anticipated to be minimal as the environmental baseline showed a lack of flora and fauna in the project area. Overall the project will improve water quality, however it may impact on surface water quality during construction through primarily accidental contamination particularly on the Kharaa river flood plain (Output 2, tertiary pipe at Secondary Pumping Station) during periods of heavy rainfall (June - August). This in turn may impact on higher fish species in the Kharaa River, which are sensitive to changes in water quality. Also leaving the city without any WWTP during construction could have detrimental impacts on water quality. The measures defined under "mitigation of impacts on soil" (para 130) and "mitigation of impacts on surface and groundwater" (para 135) will effectively protect ecological resources during construction activities.

3. Impact on Socio-economic Resources

137. **Cultural Resources**. Output 2 (Old Darkhan Hospital site) is 100 m away from a Buddhist temple (Getsogdarjaalin Monastery). The temple is not a cultural heritage site but is regularly attended by worshippers which will primarily be affected by noise during construction, particularly any excavation works. There may be a limited impact on accessibility, however the temple has several entrances, only one of which is likely to be impacted upon by the construction work. In order to minimize the impacts arising from construction, the concerned contractor together with the PIU will consult with monks in advance of construction. In consultation with the temple monks, the plan for construction will be developed which will not coincide with any culturally significant dates or festivals in order to ensure that temple attendees are not affected. Dialogue to be maintained during construction.

138. **Health and safety.** Health and safety risks to include noise, dust, construction site safety, traffic safety, as well as occupational health and safety. Dust control is discussed in paragraph 129. Other health and safety risks are discussed below.

139. **Noise**. The major sources of noise pollution near the project area are removal and replacement of existing surface materials for pipe excavation, which is close to human receptors and may affect community members. Other noise sources will include the general movement of construction vehicles, rollers during re-surfacing, the haulage of construction materials to the construction sites and the use of generators.

140. Construction activities are expected to produce noise levels up to 90 dB(A) within 5m of the machinery as shown in Table VI-5 which indicates noise levels for construction machinery. For the project, no receptors other than construction workers will be this close to the machinery, and construction workers will use appropriate Personal Protective Equipment (PPE). Output 2 (Secondary pumping station and Old Darkhan Hospital) have receptors (residential areas, hospital, school and businesses) within 20-50m of the construction sites, which may be expected to be subject to noise in the scale of 80 dB(A).

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[63] An asbestos and asbestos containing material (ACM) risk screening was conducted during IEE. The assessment concluded that presence of asbestos of ACM at pumping stations was highly unlikely. This was confirmed by environmental inspectors of the Darkhan Uul Department of the State Professional Inspection Agency (SFIA).

Table VI-5: Construction Machinery Noise

Machine Type	Distance to Machinery									
	5 m	10 m	20 m	40 m	60 m	80 m	100 m	150 m	200 m	300 m
Loader	90	84	78	72	68.5	66	64	60.5	58	54.5
Vibratory Road Roller	86	80	74	68	64.5	62	60	56.5	54	50.5
Bulldozer	86	80	74	68	64.5	62	60	56.5	54	50.5
Land Scraper	90	84	78	72	68.5	66	64	60.5	58	54.5
Excavator	84	78	72	66	62.5	60	58	54.5	52	48.8
Roller	87	81	75	69	65.5	63	61	57.5	55	51.5
Mixing Equipment	87	81	75	69	65.5	63	61	57.5	55	51.5

Source: Government of Mongolia. 2011. Initial Environmental Examination (IEE) of the proposed Regional Logistics Development Project.

141. **Construction noise mitigation**. The potential noise impacts will be mitigated through a number of activities defined in the EMP, which will be incorporated in the bid documents and construction contracts:

(1) Source control: Maintain all exhaust systems in good working order; undertake regular equipment maintenance;
(2) Locate sites for concrete-mixing and similar activities at least 300 m away from sensitive areas;
(3) Operate between 8am-6pm only and reach an agreement with nearby residents regarding the timing of heavy machinery work, to avoid any unnecessary disturbances;
(4) Provide advance warning to the community, including residents, school, monastery and hospital on timing of noisy activities. Seek suggestions from community members to reduce noise annoyance;
(5) Public notification of construction operations will incorporate noise considerations; information procedure of handling complaints through the Grievance Redress Mechanism will be disseminated;
(6) Ensure noise monitoring is undertaken near sensitive receptors, particularly dwellings, monastery, school and hospital;
(7) All construction workers to use appropriate Personal Protective Equipment (PPE).

142. Issues relating to **construction site safety** can be mitigated as follows:

(1) Temporary traffic management, road safety awareness: During any works which involve crossing roads and affecting traffic movements (Output 2, Old Darkhan Hospital sewer), road users and pedestrians will be made aware of changes to traffic flows through clear signage in advance of construction and during construction at the site;
(2) Construction site safety: Clear signs will be placed at construction sites in view of the public, warning people of potential dangers such as moving vehicles, hazardous materials and excavation and raising awareness on safety issues. Heavy machinery will not be used after day light and all such equipment will be returned to its overnight storage area/position before night. All sites will be made secure, discouraging access by members of the public through fencing or security personnel, whenever appropriate. Specific notices will be issued to the School Number 16, opposite Old Darkhan Hospital (Output 2) in order to inform children about construction site safety.

143. **Occupational Health and Safety.** The three civil works contractors will implement adequate precautions to protect the health and safety of construction 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:

(1) Environment Health and Safety Officer: An Environment Health and Safety Officer (EHSO) will be nominated to develop, implement and supervise a Health and Safety Management Plan (HSMP), as well as to ensure that the requirements of the EMP are implemented.

(2) Implementation of HSMP: The EHSO will ensure that the HSMP, submitted to Darkhan aimag prior to construction, is approved and implemented. This includes recording and reporting any occupational health and safety incidents, and reviewing the distribution and use of appropriate Personal Protective Equipment. The HSMP will include the following provisions:

a) *Clean water.* Provide a clean and sufficient supply of fresh water, for construction and for all houses, camps, offices, laboratories and workshops.

b) *Sewage and wastewater.* Provide adequate sanitation facilities at all work sites.

c) *Solid waste.* Provide garbage receptacles at construction sites, which will be periodically cleared and disinfected.

d) *Liquid chemical waste.* Provide receptacles in suitably bunded areas for the storage of liquid chemical waste prior to disposal. Include clear warnings with health risks.

e) *Personal protection.* Provide personal protection equipment (PPE), such as safety boots, helmets, gloves, protective clothing, goggles, and ear protection, in accordance with relevant health and safety regulations, for workers.

f) *Emergency Preparedness and Response.* An emergency response plan to take actions on accidents and emergencies, including public health emergencies associated with hazardous material spills and similar events will be prepared. Emergency phone contacts with hospitals in Darkhan will be established.

g) *Records Management.* A Records Management System that will store and maintain easily retrievable records protected against loss or damage should be established. It will include documenting and reporting occupational accidents, diseases, and incidents. The records will be reviewed during compliance monitoring and audits.

h) *Safety communication.* Ensure that safety, rescue and health matters are given a high degree of publicity to all persons regularly or occasionally at active construction sites. Posters in Mongolian and any other language appropriate for the contractors drawing attention to relevant health regulations will be made or obtained from the appropriate sources and will be displayed prominently at construction sites.

144. **Potential indirect impact during construction: interruption to pasture**. During the excavation of pipes (Output 2 at secondary and industrial pumping stations), there will be disturbance to pasture land along the length of the excavated sections. These sites are in areas where a livestock was seen grazing during IEE preparation. However, given the area of land, the project will affect a minimal proportion of pasture and there is enough land for the animals to graze away from any noise disturbance which may be generated. Mitigation measures include:

(1) A robust GRM which will be signposted at each of the sites in order for those with grazing animals to contact the project if they have a concern with the construction works;

(2) Notices in advance of construction work will be put up to warn residents, including owners of animals, that the work will commence including start/end dates and details of work.

145. **Potential indirect impact during construction: traffic disturbance.** When the WWTP and related infrastructure is constructed, indirect impacts will result in potential longer journey times for traffic passing by the central area of Darkhan including Old Darkhan Hospital as traffic will be temporarily interrupted when the sewer pipe under the road is excavated. The interruption will be short term as the excavation is for a single pipe. The mitigation associated with this impact is:

(1) Contractor to consult with relevant aimag authority on the timing of the road excavation, including departments responsible for transport and traffic police;
(2) Signage to warn motorists of when the road closure will be operational; and
(3) Use of appropriate traffic signals if alternate line traffic is required to maintain access along the road.

146. **Potential negative cumulative impact during construction: noise.** Pipe excavation will cause incremental noise outside Old Darkhan Hospital during sewer pipe replacement. Although this noise is a necessary part of the project implementation, it can be mitigated through:

(1) Consultation with hospital managers regarding advising on timing during the day when excavation may be least disruptive and the overall timing of construction.
(2) Maintaining dialogue with hospital managers and ensuring they are aware of the GRM process throughout the construction process.

E. Environmental Impact and Mitigation Measures during Operation

147. No significant negative environmental impact is anticipated during operation of the project facilities. Comprehensive training and appropriate technological design will contribute significantly to reducing operational risks of the project. Issues pertaining to the operational phase of the project include: (i) the lack of operation and maintenance capacities within Us Suvag LLC; which could result in non-compliance of the WWTP with effluent quality requirements; (iii) odor from WWTP and sludge treatment; (iv) noise produced during wastewater pumping and treatment; (v) pipe freezing and bursting; (vi) pollution of the Kharaa River, also as a result of WWTP malfunctioning and/or breakdown and failure in industrial pre-treatment; and (vii) occupational health and safety requirements.

148. **Treatment performance of the WWTP.** Prior to commissioning of the WWTP, a series of tests will be conducted to ensure proper functioning of the WWTP and ability to achieve Mongolian discharge standard.[64] A SCADA system including wastewater quality monitoring devices for real-time monitoring of key parameters (COD, TP, NH_4-N) will be installed at the WWTP. Daily check, repair and maintenance procedures will be instituted for all wastewater treatment steps. As a part of the design-build-commission contract, the contractor will provide hands-on training to Us Suvag staff to make sure that capacities to operate, monitor and maintain the new facilities are created. In order to avoid pipe freezing and bursting, the depth of the pipe will be determined by a cold weather engineering specialist. Us Suvag as WWTP operator will regularly inspect the pipes and ensure the packed earth is in good condition.

149. **Air quality (odor).** The operation of WWTP would emit odor. Potential odor sources in the WWTP include the intake screen, influent pump room, fine screen, main reactor, sludge filter press house, and sludge drying beds. The sludge filter press will be located indoor with ventilation and odor

[64] Standard for wastewater discharge to water bodies (MNS 4943:2011)

removal facilities. There is currently no settlement within 300 m downwind of the WWTP. No odor impact is expected from the operation of the WWTP, including open drying of dewatered sludge in the sludge drying beds within the WWTP site. Monitoring of H_2S and NH_3 will be conducted quarterly by the Central Laboratory of Environment of Darkhan.

150. **Noise.** Operational noise impact could potentially come from the WWTP, and more importantly, from the pumping houses. Noise levels from equipment range from 80-105 dB(A) according to estimates provided in the DEIA. To mitigate potential noise impacts, building walls with sufficient thickness and acoustic measures such as barriers or sound absorbing materials will be used. Noise monitoring will be conducted quarterly by the Central Laboratory for Environment to confirm compliance with the national ambient noise standard (MNS 4585:2007).

151. **Impact on Kharaa River.** The treated effluent of the WWTP will continue to be discharged to the Kharaa River, using the existing discharge pipeline. In Chapter IV the quality of the receiving water is provided (Table IV-3 to IV-5). The quality of the receiving water includes the effects of low quality discharges of wastewater from the existing WWTP as well as other point- and non-point sources of pollution. The rehabilitated WWTP will act to clean up the Kharaa River by discharging into the water body a treated effluent which is significantly higher in quality than the effluent of the current WWTP (MNS 4943:2011, see Table II-8). The domestic EIA predicts that under normal operating conditions, the impact of effluent discharge on the Kharaa River quality will be acceptable. The amount of treated effluent discharged to the Kharaa River will amount to 1.5% of the annual average flow, and to maximum of 6% of the minimum river flow in January and February. Surface water quality monitoring will be conducted regularly by Us Suvag central laboratory (at least monthly) to confirm that national ambient water quality standard (MNS 4586:1998) is being complied with. The wastewater treatment plant will remove significant amounts of pollutants, including COD (3,000 tons per year); BOD (1,700 tons per year); nitrogen (330 tons per year); and phosphorous (42 tons per year).

152. **Risks of Accidental Discharge, Overload and Emergency Preparedness.** Although the proposed wastewater treatment process is relatively simple to operate, any large complex wastewater treatment plant requires significant technical expertise and management oversight to ensure proper operations. The volume and wastewater characteristics may vary considerably. There is also a non-negligible risk of accidental release of untreated wastewater at the WWTP, due to a possible malfunctioning of the electric, mechanical or control system, or the failure of the treatment process as a result of shock loads or chronic system overload. This risk has been identified and assessed in the FSR and DEIA. The mitigation measures include: (i) retaining of existing pond system with a retention time of approximately 100 days[65]; (ii) provision of dual power supply; (iii) spare parts for key components; (iv) regular inspection and proper maintenance of the WWTP; (v) automated on-line, real-time monitoring of influent and effluent quality; and an in-house analytical lab will be established prior to operation of the WWTP. The major analytical equipment will include the following: wastewater sampler, pH meter, flow meter, conductivity meter, UV/VIS spectrophotometer, DO meter, COD speedy tester, thermostat incubator, electric balance, and centrifuge. An emergency preparedness and response plan will be formulated and put in place before the WWTP becomes operational. The emergency preparedness and response plan will address, among other things, training, resources, responsibilities, communication, procedures, and other aspects required to respond effectively to emergencies associated with the risk of accidental discharges.

153. **Solid Waste.** Primary filtration residue mainly consist of floating solids, discarded plastic, sticks and leaves, and generally contains no toxic and harmful substances. Sludge mainly comes from the

[65] This retention time will provide ample time to define corrective actions. Temporary mobile pumps would be deployed to pump untreated wastewater into the wastewater treatment process.

grit chamber, oxidation ditch and secondary settling tank. Primary filtration residue will be dried, baled, and transported to designated landfills for burying by semi-closed dump truck. Sludge management is discussed below.

154. **Sludge management.** The inappropriate disposal of sludge has potential to cause pollution to the soil in the WWTP area. WWTP sludge will be dewatered through a filter press (project financed), and disposed of in the existing sludge drying beds, which will be rehabilitated under the project. Sludge quality will be confirmed by obtaining baseline information on the sludge from the current WWTP and testing its chemical content during commissioning. This will enable further options for beneficial sludge use to be investigated. However the existing sludge management is at almost zero cost for Darkhan Uul and Us Suvag. Any future options for beneficial sludge use will need to be economically realistic, as well has safe from an environmental and public health point of view, in order to be sustainable and be implementable by the *aimag* authorities.

155. **Industrial pre-treatment of wastewater.** One of the main risks during project operation is damage to the wastewater treatment process from the discharge of potentially toxic wastewater from new industries that will locate in Darkhan. To mitigate the risk, the Government ensures to enforce the order No a/11/05/A/18 of January 10 1997 which prescribes the "Allowable limits of industrial wastewater composition before letting effluents into the central wastewater system". The project will support Darkhan Us Suvag with (i) developing mechanisms to effectively monitor industrial wastewater composition before it enters the public sewer system, (ii) reviewing existing emergency measures that enable toxic flows to be diverted to the existing fly ash storage ponds nearby the industrial zone so it cannot enter the WWTP, and (iii) advising existing and new industries on optimal technology solutions for their respective industrial processes in case of potential toxic effluents.

156. **Occupational Health and Safety.** WWTP operators may be injured by slips, trips and falls on wet floors; by falls into treatment ponds, pits, clarifiers or vats and by splashes of hazardous liquids; they may suffer cuts and pricks from sharp tools, contusions, etc. They are exposed to hazards related to work in confined spaces. The following measures will be implemented to safeguard their safety and health:

(1) use safety shoes or boots with non-slip soles;
(2) wear personal protective equipment and chemical resistant clothing to avoid exposure of skin or eyes to corrosive and/or polluted solids, liquids, gases or vapors;
(3) post safety instructions in each workshop regarding the storage, transport, handling or pouring of chemicals;
(4) check electrical equipment for safety before use; verify that all electric cables are properly insulated; take faulty or suspect electrical equipment to a qualified electricity technician for testing and repair;
(5) wear safety goggles in all cases where the eyes may be exposed to dust, flying particles, or splashes of harmful liquids;
(6) wear respiratory mask in the sludge dewatering and de-odor workshops and when moving and transporting sludge;
(7) obey all safety instructions concerning entry into confined spaces, e.g., check atmosphere for oxygen or for poisonous gases, use respiratory protection equipment if needed, have a co-worker stand guard in case of need for help, etc;
(8) all workers will undergo periodic examinations by occupational physician to reveal early symptoms of possible chronic effects or allergies; and
(9) health and safety will be incorporated into the regular staff training programs.

157. **Climate risk, adaptation to climate variability and change.** Climate model projections agree

that temperatures will increase in the project location (2.0-2.2 degrees) of the lifespan of the project (2050). Precipitation was also projected to increase approximately 10% or 30mm in the 2031-2040 period. Between 1940 and 2008, evidence shows an increasing trend of winter precipitation and a decreasing incidence of summer rainfall. However for Mongolia, over the longer term, climate models predict that summer rain will increase. Based on appropriate climate models for Mongolia (HadCM3 model of the HADLEY center), results show that the annual precipitation will generally increase. Precipitation in the summer season is predicted to increase by less than 10 percent, which is smaller than the rise in winter precipitation compared to the normal climate. Because of climate change, it is anticipated that winters will become milder and more snowy, while summer will become hotter and drier even though there will be a slight increase of precipitation based on overall climate change predictions. A recent trend of increasing frequency of extreme precipitation events is likely to continue. Specific climate predictions made for the Arctic Ocean drainage basin (in which Darkhan is based) shows that river runoff in the Arctic Ocean basin is predicted to increase by 2-9 mm. However, the projected increase in evaporation from open surface water will exceed the increase in runoff. This will lead to dryer conditions and to an imbalance between inflow and outflow of water bodies. These projections are consistent with the findings from the recently developed ADB/EARD climate change risk screening tool[66]: Annual mean temperature is projected to increase by 2.3 ^{0}C in the 2031-2040 time period, and by 3.2^{0}C in the 2051-2060 time period. Precipitation is projected to increase approximately 10% or 30 mm in the 2031-2040 time period. Monthly precipitation increases projected for cold months (October – May) are higher than warmer months (June – September) in relative terms. Projections for the 2051-2060 increase are approximately 15% or 44.8 mm in comparison with the 1961-1990 historical data. During this time frame, a reverse pattern is predicted, with higher precipitation increases projected for warmer months (April to August) than colder months (September to March). The annual PET is projected to increase by 8.1% for the 2031-2040 time period and by 12.0% for the 2051-2060 time period. Annual runoff is projected to increase by 10.6% for the 2031-2040 time period and by 12.2% for the 2051-2060 time period. Predicted changes for other variables, such as humidity and soil moisture are minimal. Due to increased temperatures and higher rates of PET, the probability of droughts is projected to increase.

158. The project's vulnerability to climate variability and change has been reviewed and is considered low in the sense that the project outcome will not be affected by climate change, whereas some of the outputs might be very moderately affected. The projected increase in average and peak precipitation, and the related risk of increased urban stormwater runoff, is addressed by Darkhan aimag through separate pipes for sanitation and storm water. As a result, the impact on the urban water system is expected to be minimal and within the planned capacity for the system. The WWTP will not be affected by increased peak flows. Specific climate risk mitigation measures will be included in the design-build-operate-transfer contract for the WWTP as well as the consulting services under the loan. They include (i) climate proofing of civil works structures (WWTP foundation works) accounting for possible changes in soil moisture that could cause ground subsistence; and (ii) local capacity building for Darkhan Us Suvag to properly monitor, supervise and maintain project facilities, including annual review of maintenance budget to account for potential increases in maintenance requirements.

[66] C. Yeager and H. Zhou: EAER Staff Guidance. Assessing Climate Change Risks in PRC and Mongolia. February 2014

VII. INFORMATION DISCLOSURE AND PUBLIC CONSULTATIONS

A. Information Disclosure and Consultation during Project Preparation

159. **Consultation with Government Officers and Experts**. During preparation of this IEE, individual consultation meetings were held with experts and Government officers (September 2013) in order to discuss the project, obtain baseline data, and identify potential environmental impacts and concerns. The names of those consulted are in Table VII-1. Key activities and discussion points included:

(1) **Consultation with *aimag* Us Suvag LLC:** (i) joint field visits to project sites; (ii) provision of data on aspects of wastewater treatment, industrial wastewater, current and planned activities and environmental monitoring.

(2) **Consultation with *aimag* Meteorological Institute**: (i) data was provided; (ii) the monitoring routine was confirmed; (iii) key environmental problems associated with not meeting national standards (i.e., nitrogen and phosphorous removal).

(3) **Consultation with *aimag* Environmental Protection Agency**: (i) the agency confirmed that it is not aware of any particular current environmental problems which will impact on this project; (ii) the agency staff confirmed that their current key concerns were around the illegal fire wood collection, artisanal mining and forest fires; (iii) provision of information on protected areas, waste management, environmental education.

(4) **Consultation with *aimag* Policy Development Department**: (i) consultation on GRM approach; (ii) provision of baseline data.

(5) **Consultation with *aimag* Land Administration**: (i) land use within Darkhan *soum*, (ii) land use around WWTP (iii) provision of maps and data.

Table VII-1: Officers and Experts Consulted

Name	Role/Department
Ms Enkkhtuya, Project Engineer	Us Suvag LLC.,
Ms. Sarangerel, Head of Laboratory	Us Suvag LLC., Laboratory
Ms Sainsay, Laboratory Engineer	*Aimag* Meteorological Office
Ms Handolgion, Head of Environmental Department	Aimag Meteorological Office
Mr Khurelchuluun, Senior Environment Specialist	*Aimag* Environment Protection Agency
Mr Bayasgalan, Policy Department Chief	*Aimag* Policy Development Department
Mr Ravjaadelgerekh, Senior Specialist	*Aimag* Policy Development Department
Mr Munkh-Erdene , Head of Land Administration	*Aimag* Land Administration
Mr Olonbayar, Senior Land Officer	*Aimag* Land Administration

Source: ADB Study Team

160. **Consultation with residents and affected people.** Public consultation and information disclosure was undertaken twice during the preparation of this IEE. The consultation was facilitated by the company undertaking the Detailed EIA as required under Mongolian law:

161. **Public Opinion Survey on Water Supply and Wastewater treatment** (22-27 January 2014). The consultees were selected from 100 households from apartment residents and 100 households from the *ger* district in Darkhan City. The survey covered the following issues: (i) socio-economic status of survey covered households; (ii) current situation and consumers satisfaction with the current water

supply and waste water treatment services; and (iii) needs for improvement of water supply and wastewater treatment services.

162. The findings from the survey include: (i) for ger area households, poverty incidence is 44.0%, while it is 9.0% for apartment area households; (ii) awareness on information about the water supply and sanitation services in Darkhan city is low; 25% of residents are not aware of the organizations which provide these services; (iii) many residents do not realize that there are problems with the water supply and wastewater services but awareness is lower in apartments; (iv) poor sanitation services was ranked 8th of 12 environmental and social infrastructure issue; (v) no ger area residents is satisfied with the current sanitation situation as opposed to 80% apartment area residents who are satisfied; (vi) air pollution and pollution of Kharaa River were ranked first and second respectively amongst selected environmental and social infrastructure issues; (vii) 64% of respondents supported re-use of grey water e.g. for toilet flushing. In summary the consultation showed a difference between the *ger* area and apartment residents. *Ger* residents are unhappy with their current sanitation and see a need for improved sanitation services, whereas apartment residents are largely satisfied.

163. **Public consultation and information dissemination** (February – March 2014). Consultation took place during the data collection process for detailed environmental impact assessment (DEIA) conducted by the licensed EIA Institute (Environ LLC). Public consultation focused on potential project beneficiaries. Two criteria were considered in selecting the consultees: (i) select and interview those households, whose geographical location is downwind of the dominant wind direction of the proposed wastewater extension project location and current wastewater treatment plant; and (ii) select and interview those households, whose location is around or nearby the WWTP effluent outlet.

164. During the consultation meetings, the project was introduced by Mr. Azjargal, Darkhan *soum* governor and Mr. Batzul, *soum* environmental inspector. Consultees included: (i) Bagh governors, Ms. Tuya, governor of 3rd bagh; (ii) speakers of bagh citizen representatives, Ms. Tungalag, local bagh speaker (Figure VII-1). In addition, residents of affected by the WWTP, covering more than 100 households, were consulted through individual interviews (26-27 February; 10-11 March 2014).

165. Figure VII-2 shows interviews being undertaken with local residents. Local residents were asked a number of questions in relation to their views on the WWTP and potential mitigation measures which could be taken in order to improve any negative impacts. The results of the consultations are given in Figure VII-3 and Figure VII-4.

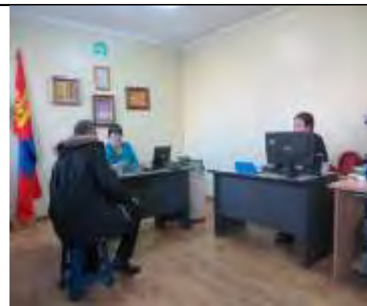
166. The results show that residents are concerned about the negative impacts the existing WWTP is having on quality of life. In particular strong views are expressed on the nuisance caused by the odor from the WWTP (expressed as main concern by 50% of respondents), especially during warm season (75% of respondents).

167. With regards to future needs, respondents expressed the need to extend and/or rehabilitate the existing WWTP, or to build a new WWTP (50% and 18% of respondents, respectively). 25% of respondents expressed the need to control access of people and livestock to the WWTP through fencing and guards.

168. Where appropriate, the recommendations provided during the consultation meetings were integrated into the mitigation measures in this IEE. This includes improvements to the WWTP which will include odor emissions - this is inherently integrated into the project as the use of improved modern technology will improve the mineralization and reduce the quantities of sludge which will reduce the odor particularly in summer. Access to the rehabilitated facilities will be strictly controlled through fencing. In general the project is supported by residents of Darkhan as it will tackle a number of issues

which are a concern to them.

Meeting with Mr. Azjargal B., Darkhan soum governor



Meeting with Ms. Tuya D, 3rd bagh governor, Ms. Tungalag, local meeting speaker, Ms. Munkhtsetseg, social worker of 3rd bagh of Darkhan soum

Mr. Batzul, soum environmental inspector

Figure VII-1: Consultation with local authorities. *Source: Environ, DEIA.*

Figure VII-2: Interviews with local residents. *Source: Environ, DEIA.*

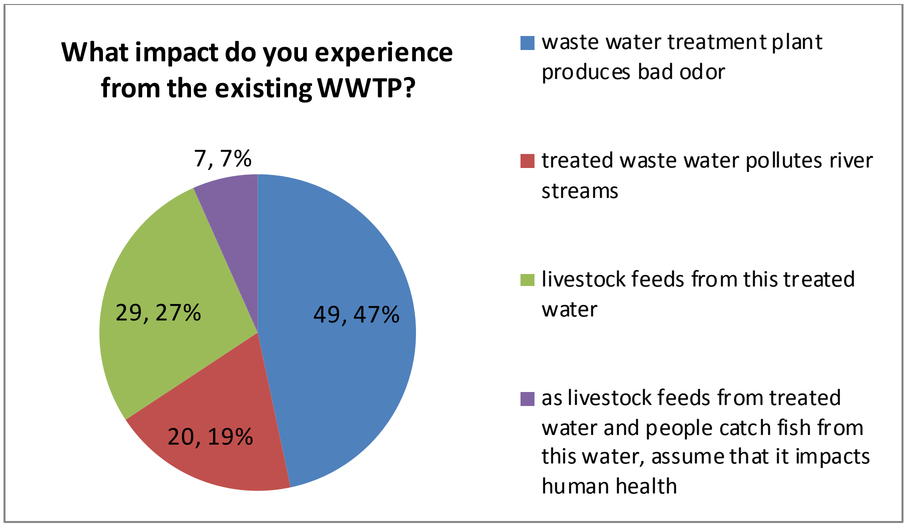


Figure VII-3: Results from consultation interviews, Question 1 - 104 respondents.
Source: Environ, DEIA.

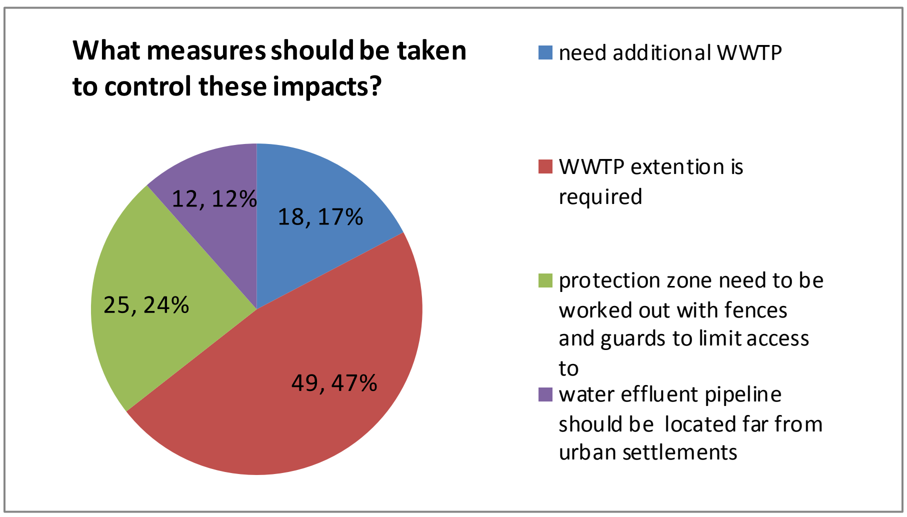


Figure VII-4: Results from consultation interviews question 2, 104 respondents. *Source: Environ, DEIA.*

B. Future Information Disclosure

169. In compliance with the SPS, environmental information related to the project will be disclosed as follows:

(1) the initial environmental examination (IEE) is disclosed on ADB's project website (www.adb.org), and is available for consultation in the PIU's office;
(2) the detailed environmental impact assessment (DEIA) approved by the Ministry of Environment and Green Development (MEGD) is disclosed on the MEGD website; and
(3) semi-annual environment monitoring results and annual reports on project's compliance with the EMP will be disclosed on www.adb.org.

VIII. GRIEVANCE REDRESS MECHANISM

A. Grievance Redress Mechanism Objective

170. A grievance redress mechanism (GRM), consistent with the requirements of the ADB Safeguard Policy Statement (2009) will be established to prevent and address community concerns, reduce risks, and assist the project to maximize environmental and social benefits. In addition to serving as a platform to resolve grievances, the GRM has been designed to help achieve the following objectives: (i) open channels for effective communication, including the identification of new environmental issues of concern arising from the project; (ii) demonstrate concerns about community members and their environmental well-being; and (iii) prevent and mitigate any adverse environmental impacts on communities caused by project implementation and operations. The GRM is accessible to all members of the community.

B. Proposed Grievance Redress System

171. The proposed GRM follows the existing approach taken for managing complaints about local issues by members of the public in Mongolia. Residents' complaints or concerns are generally taken to *bagh* or *soum* representatives for resolution, therefore this system is proposed for the GRM. The GRM approach also fits with the *aimag*'s existing approach to managing complaints for the public, which is focused on taking complaints to *soum*s. The *aimag* Government confirmed their support for the approach presented in this IEE.[67]

172. In its capacity as the IA, the Darkhan *aimag* will establish a Public Complaints Unit (PCU). The PCU will be established within the PIU prior to construction to deal with complaints from affected people (AP) throughout implementation of the project.

173. The PIU-based Safeguards Staff (PIU-SS) will be responsible for ensuring the setting up and coordination of the GRM at a local level and will staff the PCU. The PIU-SS will be the key contact point for *bagh* and *soum* representatives who may require information about the project or who have an issue they would like to discuss. The PIU and PIU-SS will issue public notices to inform the public within the project area of the GRM. The PCU's phone number, fax, address, email address will be disseminated to the people at the *bagh* and *soum* levels. The PIU-SS will have facilities to maintain a complaints database and communicate with contractors, supervision engineers, the environmental inspectors of the Darkhan Uul Department of the State Professional Inspection Agency (SFIA), *aimag* environmental authorities of Darkhan Uul, the PMU, and representatives of Darkhan *soum* and affected *baghs*.

C. GRM Steps and Timeframe

174. Procedures and timeframes for the grievance redress process are as follows and shown in Figure VIII-1.

(1) **Stage 1: Access to GRM.** If a concern arises, the AP may resolve the issue of concern directly with the contractor, or make his/her complaint known to either the PCU directly, or through the *bagh* or *soum*, whichever level of authority he/she is most comfortable with;

(2) **Stage 2: Official Complaint to PCU.** If a complaint is filed at *bagh/soum* level, the *bagh/soum* representative will submit an oral or written complaint to the PCU. For an oral

[67] Meeting with Mr Ravjaadelgerekh, *aimag* Senior Specialist in Engineering - project contact.

complaint the PCU must make a written record. For each complaint, the PCU must assess its eligibility. If the complaint is not eligible, e.g. related to an issue outside the scope of the project, PCU will provide a clear reply within five working days to the AP;

(3) **Stage 3: PCU Complaint Resolution.** The PCU will register the eligible complaint informing the Darkhan *aimag*, the PIU, contractors, the PMU and ADB. The PCU, with support of the loan implementation environment consultant (LIEC), will take steps to investigate and resolve the issue. This may involve instructing the contractor to take corrective actions. Within seven days of the redress solution being agreed upon, the contractor should implement the redress solution and convey the outcome to the PCU;

(4) **Stage 4: Stakeholder Meeting.** If no solution can be identified by the PCU or if the AP is not satisfied with the suggested solution under Stage 3, within two weeks of the end of Stage 3, the PCU will organize a multi-stakeholder meeting under the auspices of the head of Darkhan *aimag*, where all relevant stakeholders will be invited. The meeting should result in a solution acceptable to all, and identify responsibilities and an action plan. The contractor should implement the agreed redress solution and convey the outcome to the PCU within seven working days;

(5) **Stage 5: *Aimag* Governor Resolution**. If the multi-stakeholder meeting cannot resolve the problem, and the AP is unsatisfied, the PCU will set up a meeting with the *aimag* Governor to identify a solution.

175. **Reporting**. The PCU will record the complaint, investigation, and subsequent actions and results. The PIU-SS will include this information in the quarterly EMP progress reports to the PMU. In the construction period and the initial operational period covered by loan covenants the EA will periodically report complaints and their resolution to ADB in the quarterly project progress reports and annual environmental monitoring reports. The tracking and documenting of grievance resolution within the PCU will include the following elements: (i) tracking forms and procedures for gathering information from project personnel and complainant(s); (ii) dedicated staff to update the database routinely; (iii) periodic reviews of complaints so as to recognize grievance patterns, identify any systemic causes of grievances, promote transparency, publicize how complaints are being handled, and periodically evaluate the overall functioning of the mechanism; (iv) processes for informing stakeholders about the status of a case; and (v) procedures to retrieve data for reporting purposes, including the periodic reports to the EA and ADB.

176. **Members and Responsibilities of the PCU**. The responsibilities of the PCU are implemented by the PIU-SS, who is the PCU focal point. In addition to the PIU-SS, the members of the PCU will be those in a position to resolve complaints and will include representatives of: (i) PIU-SS - focal point of PCU; (ii) Darkhan Uul aimag; (iii) Darkhan Us Suvag; (iv) Darkhan soum and (v) relevant bagh representatives. The responsibilities of the PCU are as follows:

- The PCU will instruct contractors and construction supervisors to refer any complaints that they have received directly to the PCU. Similarly, the PCU will coordinate with local government departments capture complaints made directly to them;
- The PIU-SS, as the focal point of the PCU, will log complaints and date of receipt onto a complaints database and inform the IA/PIU and the Contractor.
- The PCU will investigate the complaint to determine its validity and to assess whether the source of the problem is because of project activities, and identify appropriate corrective measures and responsible persons;
- The PCU will inform the AP of investigation results and the action taken;

- If a complaint is transferred from local government agencies, the PIU-SS will submit an interim report to local government agencies on status of the complaint investigation and follow-up action within the time frame assigned by the above agencies;
- The PCU will review the contractor's response to the identified corrective measures, and the updated situation;
- The PCU will undertake additional monitoring, as necessary, to verify as well as review that any valid reason for complaint does not reoccur.

177. **Multi-stakeholder meetings**. The invitees to this meeting will depend on the nature of the complaint. For example if the complaints relate to health, land disputes, or labor issues, the appropriate specialist in this field will be invited to the stakeholder meeting. This may include officers from the Land Administration (land rights issues), Mongolian Chamber of Commerce Policy & Representative (business/commercial issues), Women's Union NGO (gender issues), Health authority (health issues), MEGD (environmental issues), Ministry of Labor & Social Security Officer (labor issues).

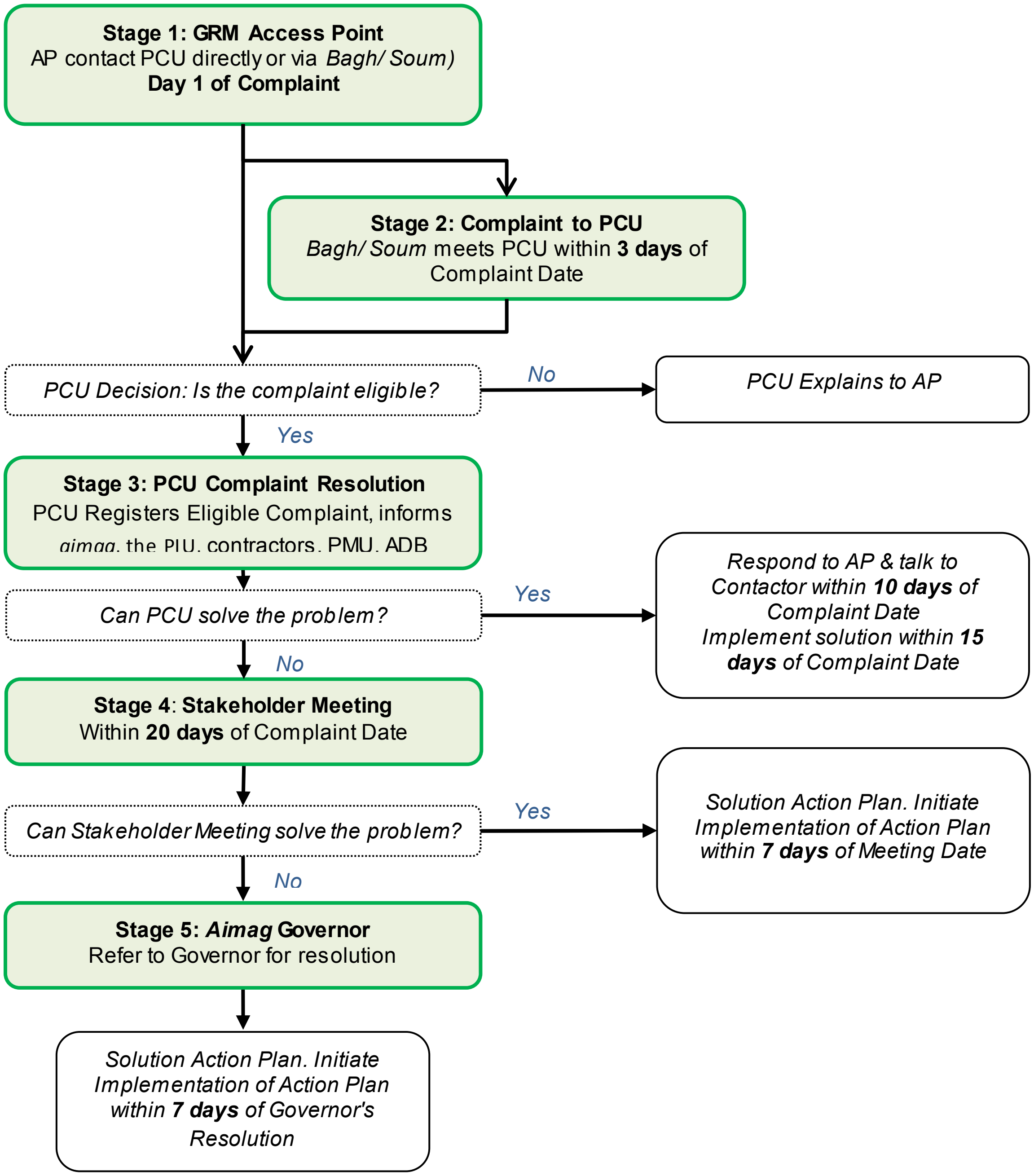


Figure VIII-1: Proposed Project GRM. *Source: ADB Study Team*

IX. ENVIRONMENTAL MANAGEMENT PLAN

178. The environmental management plan (EMP) for the project is presented in **Appendix EMP**. The EMP defines the roles and responsibilities of the institutions involved in EMP implementation. Such institutions will seek to ensure continuous improvement of environmental protection activities during preconstruction, construction, and operation of the project in order to prevent, reduce, or mitigate adverse impacts.

179. The EMP has been prepared in line with ADB's Safeguards Policy Statement (2009). Specific measures are developed in relation to the design, construction and operation of each project output, and the impacts identified in relation to physical, biological, cultural and socio-economic resources, as discussed in Section VI of this IEE.

180. The EMP also defines training requirements (Table EMP-3), monitoring requirements (Table EMP-4), and reporting requirements (Table EMP-5). The mitigation measures to be undertaken during project design, construction and operation are identified in Table EMP-7).

V. CONCLUSIONS

A. Rationale and Benefits

181. Currently Darkhan suffers from an outdated and inefficient wastewater treatment plant which is at the end of its economic life. Due to the dilution capacity and turnover processes in the Kharaa River, the nutrient levels are moderate and there is a limited detectable impact on the ecology of the river, however it is possible that at times of low flow and with a predicted increase in housing and industry, the impacts on the river arising from the current WWTP would become more significant and the environmental sustainability will be compromised. This is increasingly likely as the outdated wastewater treatment technology becomes progressively more unreliable with age. The project will have substantial environmental and socioeconomic benefits. The strengthening of Darkhan's municipal wastewater collection and treatment capacity will provide protection and improvement to Kharaa River's water environment, which is key to the sustainability of Darkhan's socio-economic development. The wastewater treatment plant will remove significant amounts of pollutants, including COD (3,000 tons per year); BOD (1,700 tons per year); nitrogen (330 tons per year); and phosphorous (42 tons per year).

B. Impacts and Mitigation Measures

182. Findings of the IEE and DEIA show that the project does not have any predicted significant, long term or irreversible impacts on the physical, biological or socio-economic environment.

183. **During construction**, the project will have short-term impacts which can be mitigated to an acceptable level through mitigation measures which seek to reduce the potential for harm to the environment and human health. Without mitigation, the principal impacts during construction will be on the sensitive human receptors in particular around old Darkhan hospital, including a school and the hospital itself. Dust and noise generated by sewer line rehabilitation activities will be a nuisance to nearby residents. Discharge of wastewater from construction sites could potentially pollute the Kharaa River. Mitigation measures specified in the EMP will manage the impacts to acceptable levels and an emphasis will be placed on meetings and discussions with affected people, therefore school and hospital administrators/managers will be consulted on the timing of the construction activities. Waste arising is an inevitable consequence of a construction project. There is likelihood that hazardous waste materials will be generated during the refurbishment of the New South Pumping Station and sewer pipes; anticipated wastes include PCBs and oily wastes. In order to manage this sustainably and with least risk to the environment and human health, a robust forward looking Waste Management Plan will be developed and adhered to by the contractor. Surface water quality and effluent will be measured regularly throughout the construction phase.

184. **During operation**, no significant environmental impact is anticipated. Comprehensive training and appropriate technological design will contribute significantly to reducing operational risks of the project. Prior to commissioning of the WWTP, a series of tests will be conducted to ensure proper functioning of the WWTP and ability to achieve Mongolian discharge standard. A SCADA system including wastewater quality monitoring devices for real-time monitoring of key parameters (COD, TP, NH_4-N) will be installed at the WWTP. Odor and noise generating facilities will be equipped with containment facilities. Daily check, repair and maintenance procedures will be instituted for all wastewater treatment facilities/equipment. In order to avoid pipe freezing and bursting, the depth of the pipe will be determined by a cold weather engineering specialist. Us Suvag as WWTP operator will regularly inspect the pipes and ensure the packed earth is in good condition. WWTP sludge will be dewatered through filter press, and disposed of in existing on-site sludge drying beds. In the interests of

good practice, although no evidence has been found to confirm that the existing sludge management practices are impacting negatively on the environment and human health, sludge will be analyzed in order to understand its quality. When the quality of the sludge is known, alternatives to the existing drying beds can be sought which will put it to a more beneficial use.

185. An emergency preparedness and response plan will be formulated and put in place before the WWTP becomes operational. The emergency preparedness and response plan will address, among other things, training, resources, responsibilities, communication, procedures, and other aspects required to respond effectively to emergencies associated with the risk of accidental discharges. The project's impact on the Kharaa River will be positive, as discharge of nutrients will be reduced through increased WWTP treatment efficiency. This will be confirmed through compliance monitoring. The Kharaa River is already monitored by the *aimag* Meteorological Institute. This existing monitoring will be supported with project specific monitoring at the effluent outfall (i.e., within mixing zone), and monitoring of the effluent itself.

186. **Environment management plan (EMP).** An EMP has been defined which specifies the roles and responsibilities of key project stakeholders, including MCUD, the PMU, Us Suvag LLC, Darkhan-Uul aimag, the PIU, MEGD, State Professional Inspection Agency, contractors, and loan implementation environment consultants, in overall environmental management. In order to ensure that adequate environmental management capacities are in place during project implementation, the PMU will procure the services of loan implementation environment consultants (LIEC) to provide support in (i) project preparation including updating the project EMP; (ii) training; (iii) regular environmental quality monitoring (air, surface and ground water, and noise) in compliance with the monitoring plan; (iv) annual project EMP progress reporting; and (v) identifying environment-related implementation issues and necessary corrective actions.

C. Consultation, information disclosure, GRM

187. The stakeholder consultation process conducted during the development of the IEE, particularly with Darkhan *aimag* and Us Suvag, demonstrated that the project has local support as it will result in benefits in terms of the long term environmental and social sustainability of Darkhan's WWTP. In compliance with ADB's Safeguard Policy Statement (2009), environmental information related to the Project was and/or will be disclosed as follows: (i) this initial environmental examination (IEE) is disclosed on ADB's project website (www.adb.org), and is available for consultation in the PIU's and PMU's office; (ii) the detailed environmental impact assessment (DEIA) approved by the Ministry of Environment and Green Development (MEGD) is disclosed on the MEGD website; and (iii) annual reports on project's compliance with the EMP will be available at www.adb.org. Environment safeguards related complaints or disputes will be handled in accordance with the grievance redress mechanism (GRM) established for the project. The PIU will coordinate the environment GRM, with support of the LIEC.

D. Risks and Assurances

188. Risks and risk mitigating measures have been identified in the risk assessment and risk management plan. A minor risk is damage to the wastewater treatment process from the discharge of potentially toxic wastewater from new industries that will locate in Darkhan. To mitigate the risk, the Government will ensure to enforce the order No a/11/05/A/18 of January 10 1997 which prescribes the "Allowable limits of industrial wastewater composition before letting effluents into the central wastewater system". Further, the project (through output 3) will provide expert support to the government to develop policy mechanisms that ensure industries pre-treat their wastewater in pre-treatment facilities if required

(e.g. through enforcement of fines already provided for by law, but not yet always enforced). The project will also provide expert support to Darkhan Us Suvag with (i) developing mechanisms to effectively monitor industrial wastewater composition before it enters the public sewer system, (ii) enhancing existing emergency measures to avoid toxic flows to be discharged to the WWTP; and (iii) advising existing and new industries on technological options (i.e., pre-treatment requirements and solutions) for their respective industrial processes in case of toxic effluents.[68]

189. The Government, MCUD and Darkhan-Uul Aimag government have assured ADB that implementation of the project shall conform to all applicable ADB policies including those concerning anticorruption measures, safeguards, procurement, consulting services, and disbursement as described in detail in the project administration manual and in the draft loan agreement. In addition to these standard assurances, the Government has agreed with ADB on a number of assurances, listed below (subject to final agreement between ADB and the Government of Mongolia):

(1) The Government will ensure or cause the EA to ensure that the preparation, design, construction, implementation, operation and decommissioning of the Project and all Project facilities comply with (a) all applicable laws and regulations of the Government relating to environment, health and safety; (b) the applicable principles and requirements set forth in the ADB's Safeguard Policy Statement (2009) (SPS); and (c) all measures and requirements set forth in the IEE, the EMP, and any corrective or preventative actions set forth in (i) any safeguards monitoring report, or (ii) which are subsequently agreed between ADB and the Government.

(2) The Government, through MCUD, will cause the Darkhan-Uul Aimag government to ensure that (a) water supply and wastewater tariff for all users are restructured to cover all costs associated with water supply and sewerage services; (b) the Darkhan Us Suvag, the public urban service organization of Darkhan-Uul Aimag government undertakes annual reviews of tariff and fees; (c) no entity receiving water supply services is exempted from payment of the tariff, or excused for delays in payments without penalty, and (d) a review is conducted of the impact of increase water and sanitation tariff on the poor taking into account the ability of consumers, particularly vulnerable people, to pay for such increases.

(3) Without limiting the application of the SPS or the RP, the Government will ensure or cause the EA to ensure that no physical or economic displacement takes place in connection with the Project until: (a) compensation and other entitlements have been provided to the displaced persons as described in and in accordance with the RP; and (b) a comprehensive income and livelihood restoration program has been established in accordance with the RP.

(4) The Government will make available or cause the EA to make available necessary budgetary and human resources to fully implement the EMP and RP and IPP, if required.

(5) The Government will ensure or cause the EA to ensure that all bidding documents and contracts for works contain provisions that require contractors to: (a) comply with the measures relevant to the contractor set forth in the IEE, EMP and RP, and any corrective or preventative actions set forth in any safeguards monitoring report, or (ii) subsequently agreed between ADB and the Government; (b) make available a budget for all such environmental and social measures; (c) provide the Government with a written notice of any unanticipated environmental, resettlement or indigenous peoples risks or impacts that arise

[68] Phase III of the MoMo project (financed by the German Government) will provide support to Us Suvag in establishing industrial wastewater monitoring system, amongst others.

during construction, implementation or operation of the Project that were not considered in the IEE, EMP and RP; (d) adequately record the condition of roads, agricultural land and other infrastructure prior to starting to transport materials and construction; and (e) reinstate pathways, other local infrastructure, and agricultural land to at least their pre-project condition upon the completion of construction.

(6) The Government will do the following or cause the EA to do the following: (a) submit annual environmental monitoring and semi-annual social safeguards monitoring reports to ADB; (b) if any unanticipated environmental and/or social risks and impacts arise during construction, implementation or operation of the Project that were not considered in the IEE, EMP and RP, promptly inform ADB of the occurrence of such risks or impacts, with detailed description of the event and proposed corrective action plan; and (c) report any actual or potential breach of compliance with the measures and requirements set forth in the EMP or the RP promptly after becoming aware of the breach.

(7) The Borrower, through the EA, IA, PMU and PIU, will not award any works contract which involve environmental impacts until each of MCUD, IA, PMU and PIU has incorporated the relevant provisions from the EMP into the works contract(s).

(8) The EA shall cause the Darkhan-Uul Aimag environment authorities to ensure through regular compliance monitoring that industries discharging industrial wastewater to the public sewer network meet the relevant discharge standard, and that the monitoring results are reported to ADB in the annual environment monitoring reports. Furthermore, MCUD will ensure that an emergency preparedness and response plan is developed for the wastewater treatment plant, including (but not limited to) the connection of critical units to a standby generator in case of power shutdown.

(9) The EA shall cause Darkhan-Uul Aimag to ensure that sludge drying beds at the wastewater treatment plant will be properly designed for air drying with leachate collection, and that sampling tests are carried out for the sludge from the WWTP on a quarterly basis until approval of the project completion report to determine its suitability, through compliance with the Borrower's applicable standards for either disposal to a sanitary landfill or for beneficial use (urban landscaping).

E. Overall Conclusion

190. The IEE concludes that the project will not have any significant, long term or irreversible impacts on the physical, biological or socio-economic environment. The project will have short term impacts during construction which can be mitigated to an acceptable level through mitigation measures which seek to reduce the potential for harm to the environment and human health. These measures relate primarily to implementing good construction practice as well as meeting the particular needs of the project area through consultation with affected people. Good practice through comprehensive training and appropriate technological design will also contribute significantly to reducing the operational impacts of the project.

191. The project will have significant positive environmental benefits. It will lead to improved water quality in the Kharaa River as the effluent quality from the WWTP will be significantly improved over the long term. The use of modern technology and replacement of the outdated and broken equipment will lead to better wastewater and sludge management which will benefit the environment and the residents of the city. Category B for environment is confirmed. The project is feasible from an environment safeguards point of view.

APPENDIX EMP: ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

1. This environmental management plan (EMP) has been prepared for the ADB supported Darkhan Wastewater Management Project, in line with ADB's SPS 2009. Specific measures are developed in relation to the design, construction and operation of each project component and the impacts identified in relation to physical, biological, cultural and socio-economic resources, as discussed in Section VI (Anticipated Impacts and Mitigation Measure) of the Initial Environment Examination (IEE).

2. The environmental management plan (EMP) for the project defines mitigation and monitoring measures and describes the institutions, responsibilities and mechanisms to monitor and ensure compliance. Such institutions and mechanisms will seek to ensure continuous improvement of environmental protection activities during preconstruction, construction, and operation of the project in order to prevent, reduce, or mitigate adverse impacts. The EMP draws on the domestic EIA and on discussions had with the relevant government agencies. The EMP will be reviewed and updated if there are any changes to the detailed design. The final IEE and EMP will be disclosed on ADB's website following any required updates.

B. Roles and Responsibilities

3. **Project Steering Committee (PSC).** The state-level PSC has been established for the Urban Sector Development Project for Mongolia (Loan 2301-MON) and will continue to provide overall policy guidance on the project and will have full powers to take decisions on matters relating to Project execution. The Project Coordinator is the Member Secretary and the committee is chaired by the State secretary of Ministry of Construction and Urban Development. Members of the committee include the Director Ministry of Economic Developments, Director Ministry of Finance, representatives of the MEGD and Industry and the *aimag* government of Darkhan-Uul. Once the Project is made effective, the PSC will meet at regular intervals (at least once every 3 months) to review project performance and take decisions on major issues, such as, counterpart funding, implementation bottlenecks, land disputes, special procurement, policy reforms, etc. Reports on EMP implementation will be provided to the Steering Committee by the Executing Agency (EA).

4. **Executing Agency (EA)**. The Ministry of Construction and Urban Development (MCUD) will be the EA of the Project. The EA has overall responsibility for the project and therefore is ultimately responsible for ensuring the implementation of the mitigation in the EMP and for ensuring compliance with loan covenants.

5. **Project Management Unit (PMU)**. The existing PMU of the Urban Sector Development Project for Mongolia (Loan 2301-MON) will extend its existing responsibilities to include the Project. The PMU will continue to be headed by a Project Coordinator (PC). The PMU will reside in the EA and supports the EA in its duties. The PMU will manage the procurement process. With regard to EMP implementation, the PMU will (with the support of the LIEC) do the following: (i) updating the IEE and

EMP after detailed project design; (ii) overseeing incorporation of EMP recommendations into the bidding documents; (iii) ensuring the procurement of environmentally responsible contractors; (iv) ensuring that DEIA approval by MEGD has been secured prior to the awarding of civil works contract.

6. **Implementing Agency (IA)**. Implementation of the WWTP improvements for Components A and B will be carried out by the Darkhan-Uul *aimag* government with assistance from MCUD.

7. **Project Implementation Unit (PIU).** MCUD will establish a PIU in Darkhan-Uul which will reside in the IA, headed by a senior engineer or technical specialist experienced in environmental engineering, wastewater management construction and equipment installation, as the PIU Project Director. The PIU will handle day-to-day activities under the project. The PIU will be staffed with at least one safeguard staff (PIU-SS). Under the guidance of the LIEC, the PIU-SS will be responsible for the supervision of the implementation of the EMP, including (but not limited to) (i) setting up and coordinating the grievance redress mechanism (GRM, see below); (ii) monitoring contractors to ensure adherence to the project EMP and the contractor EMPs; (iii) preparing quarterly reports on project EMP implementation to the PMU; (iv) coordinating consultation with local stakeholders as required, informing them of imminent construction works, updating them on the latest project development activities, GRM, etc.; and (v) coordinating the conduct of periodic environmental compliance monitoring by licensed monitoring institutes (laboratories), as defined in the monitoring program.

8. **Role of Darkhan Us Suvag.** As the water undertaking, Us Suvag will continue to provide technical support to Darkhan-Uul *aimag* but will not have direct responsibilities for EMP implementation unless otherwise directed by the *aimag* government.

9. **LIEC**. The Project will procure the services of loan implementation environment consultants (LIEC) to provide support in (i) project preparation including updating the project EMP; (ii) training; (iii) coordinating the conduct of regular environmental compliance monitoring (air, surface and ground water, and noise) in compliance with the monitoring plan; (iv) annual project EMP progress reporting; and (v) identifying environment-related implementation issues and necessary corrective actions. The Terms of Reference for the LIEC is provided in the **Attachment to the EMP**.

10. **Civil works contractors** (3 contracts) will be required to formulate contractor EMPs with management systems for adverse impacts, e.g., dust control, noise control, traffic management, addressing as minimum the requirements of this EMP and the DEIA. The contractor EMPs will be renewed on a yearly basis, submitted to PIU and LIEC for review, and to MEGD for approval. Each civil work contractor will appoint an environment, health and safety officer (EHSO) to coordinate contractor EMP implementation. To ensure that the contractors comply with the EMP provisions, the PMU with the help and technical support of LIEC, will prepare and provide the following specification clauses for incorporation into the bidding procedures: (a) a list of environmental management requirements to be budgeted by the bidders in their proposals; (b) environmental clauses for contractual terms and conditions; and (c) the full EMP in Mongolian. The contractor will also fully cooperate with the environmental inspectors of the Darkhan Uul Department of the State Professional Inspection Agency (SFIA). Contractors will submit monthly contractor EMP implementation reports to the PIU, and provide information including reports, monitoring results or other information relating to EMP implementation as requested by the PIU, PMU, and LIEC.

C. Project Readiness Indicators

11. Table EMP-1 presents the Readiness Indicators which provide a measure of whether environmental commitments are being carried out and environmental management systems are in place before pre-construction.

Table EMP-1: Readiness Indicators Pre-Construction

Indicator	Measurement Methods	Measurement	
Surface water & effluent quality baseline monitoring	• Monitoring completed by Darkhan *Aimag* Meteorological Office and Us Suvag Water Laboratory	Yes	No
Environmental Supervision in place	• PIU in position before construction, with PIU-SS appointed	Yes	No
	• GRM established	Yes	No
Bidding documents and contracts with environmental safeguards	• Bidding documents and contracts incorporate the environmental loan assurances	Yes	No
	• Bidding documents and contracts incorporate the EMP mitigation and monitoring requirements	Yes	No
EMP financial support	• The fund from ADB and/or the Government of Mongolia is in place to support the EMP implementation.	Yes	No
Contract documents	• Environmental requirements of EMP included in contract documents for civil works construction contractors.	Yes	No
	• Contractor EMPs developed and submitted to PIU and LIEC	Yes	No

Source: ADB Study Team

12. Performance indicators for monitoring environmental performance in relation to key project risks and impacts during construction are set out in **Table EMP-2.**

Table EMP-2: Performance Indicators During Construction

Indicator	Measurement Methods	Measurement	
Stakeholder Interviews	• Quarterly interviews with stakeholders in project area, submitted to Darkhan Uul *aimag* (by PIU-SS)	Yes	No
Water & Effluent Monitoring	• Quarterly monitoring results submitted to Darkhan aimag environment authorities (by PIU-SS)	Yes	No
Health & Safety Reporting	• Monthly reports submitted to Darkhan Uul aimag environment inspectors (by contractors)	Yes	No
EMP Implementation	• PIU monitors mitigation implementation and confirms compliance, reporting quarterly to PMU	Yes	No

Source: ADB Study Team

D. Environment Impact Mitigation Plan

13. This section describes the potential environmental issues and impacts during the detailed design, pre-construction, construction and operation phases of the project, as identified during the Initial Environmental Examination (IEE), as well as corresponding mitigation measures designed to minimize the impacts. The recommended mitigation measures consist of actions, activities, plans and documents (including resettlement/compensation plan, environmental approval documents, Contractor EMP) that need to be undertaken, observed, obtained, prepared to prevent, mitigate, or compensate for, the salient adverse impacts enumerated in Chapter IV of the IEE. The broad measures are outlined below; while the specific measures are presented in the Environmental Mitigation Plan (**Table EMP-7**):

- Ensuring the engagement of environment-responsible Contractors by incorporating the SPScompliant Project EMP into the bidding documents, for use as basis in the preparation of the Contractor's C-EMP by the selected Contractors. C-EMP to be quantitatively and qualitatively evaluated against the Project EMP and cleared by the PIU-SS and the LIEC prior to the commencement of any work on site, and sent to MEGD;

- Quality construction supervision by the PIU, and environmental monitoring by licensed monitoring institutes (to be contracted by the PIU through the LIC budget);
- Observance of the grievance redress mechanism and prompt action/ resolution of lodged grievances.

14. The Environmental Mitigation Plan points out that most measures are the usual good engineering practices. The effectiveness of the measures will be evaluated based on the results of the environmental monitoring and inspection to determine whether they should be continued or improvements should be made. Improvements need to be confirmed through stipulated environmental management procedures.

E. Environmental Training Requirements

15. The Terms of Reference for the LIEC state that she/he will be responsible for providing EMP specific training during project implementation. The focus will be on the *aimag* officers, PIU and PMU staff and the contractors regarding EMP implementation. Training on specific issues associated with operation of the WWTP will be provided to Us Suvag and appropriate *aimag* staff by the technology provider. Additional budget is provided to allow external technical specialists to deliver requested specific relevant training in order to develop Institutional Capacity.

Table EMP-3: Training Requirements

Training Participant & Provider	Topic	Timescale	Cost
Participants: *aimag* staff, bagh representatives, Us Suvag, PIU and PMU staff **Provider**: LIEC	- Use and purpose of GRM - ADB requirements for GRM - GRM procedure	Pre-construction phase	$500
Participants: *aimag* staff, contractors, Us Suvag, PIU and PMU staff **Provider**: LIEC	- EMP: Purpose, scope, and contractor responsibilities - Purpose and implication of EMP updates or revisions	Pre-construction phase	$500
Participants: Us Suvag, *aimag* meteorological office, other licensed monitoring institutes **Provider**: LIEC	- Environmental monitoring for EMP - purpose, requirements and data analysis - Agreement on monitoring program	Pre-construction	$1,000
Participants: As required, e.g. Us Suvag, *aimag* meteorological office, *aimag* environment inspectors, PIU and PMU staff **Provider**: External Experts if required	Example training if required: - Environmental mitigation activities for construction, - Construction good practice, - Waste management	As needed	$3,000

Training Participant & Provider	Topic	Timescale	Cost
Participants: Us Suvag and *Aimag* staff **Provider**: WWTP technology provider	- O&M of WWTP	Pre-operation phase	Outside IEE - included in WWTP costs (contract package A1)
Total			***$5000***

Source: ADB Study Team

F. Environmental Monitoring

16. Civil works contractors will develop contractor environment management plans (C-EMP) with environmental management and internal supervision systems based on the approved project EMP and the DEIA, undertake self-check activities and fully cooperate with the environmental inspectors of the Darkhan Uul Department of the State Professional Inspection Agency (SFIA). Contractors will appoint environment, health and safety officers (EHSO), who will submit monthly EMP implementation reports to the PIU. Project EMP implementation coordination and verification for the construction period will be carried out routinely by the PIU through its safeguards specialist (PIU-SS) with the support of the services of the loan implementation environment consultant (LIEC). Professional organizations and laboratories will be contracted by the PIU (through the LIEC) to conduct periodic environmental compliance monitoring covering soil, air, surface water, sludge and noise. These organizations[1] will submit semi-annual monitoring reports to the PIU, LIEC as well as the aimag environmental authorities of Darkhan Uul. The results of project EMP implementation and environmental impact monitoring will be communicated to ADB through the annual project EMP progress reports, and summarized in the quarterly project implementation reports. The annual project EMP progress reports will be disclosed on the ADB website, and submitted to MEGD, environmental inspectors of the Darkhan Uul Department of the State Professional Inspection Agency (SFIA), and aimag environmental authorities of Darkhan Uul. The project monitoring requirements for are set out in Table EMP-4.

Table EMP-4: Project Monitoring Requirements

Environmental Media/Issue	Location, Parameters, Monitoring Technique	Responsibility & Frequency
	Pre-Construction Phase	
Project readiness	• **Method:** Review of Project Readiness based on indicators in Table EMP-1 • **Parameters:** Table EMP-1	PIU-SS, LIEC Once before construction
Surface water and Effluent quality	• **Method, Location:** Kharaa River, 50 m upstream and 200m downstream of WWTP effluent outfall; WWTP effluent. • **Parameters:** Temperature, Suspended particles, pH, dissolved oxygen, chemical oxygen demand, biological oxygen demand, faecal coliforms (according to laboratory capabilities in Darkhan, including laboratory in Us Suvag)	Darkhan Aimag Meteorological Office, Us Suvag Central Water Lab Once before construction
	Construction Phase	
Soil erosion	• **Method, Location:** Visual inspection; along pipe trenches, wastewater treatment plant construction footprint; • **Parameters:** adequacy of soil erosion prevention measures;	EHSO - Weekly; LIEC – three times during construction period (April, July,

[1] Laboratories will include: Darkhan Aimag Meteorological Office; and the Us Suvag Central Water Laboratory;

Environmental Media/Issue	Location, Parameters, Monitoring Technique	Responsibility & Frequency
	adequacy of soil contamination prevention techniques;	October)
Soil contamination (compliance monitoring)	• **Method, Location:** Soil sampling and chemical analysis; effluent pipeline outlet, sludge pond, wastewater treatment area. • **Parameters:** heavy metals (Cr, Pb, Cd, Ni, Zn);	Licensed monitoring institute (contracted by PIU) Twice per year (April, October)
Solid and liquid waste management	• **Method, Location:** Visual inspection of all active construction sites. • **Parameters:** Adherence to Site Waste Management Plan and Construction Camp Management Plan.	EHSO – Weekly; LIEC – three times during construction period (April, July, October)
Occupational health and safety	• **Method, Location:** Visual inspection and interviews with construction workers and contractors at active construction sites • **Parameters:** (i) adherence to the Environmental, Health and Safety Management Plan (EHSMP); (ii) worker complaints and concerns and recorded incidents.	EHSO – Weekly; LIEC – three times during construction period (April, July, October)
Community health and safety and GRM	• **Method, Location:** Visual inspection of all active construction sites, informal interviews with nearby residents. • **Parameters:** (i) availability of information on GRM; (ii) adequacy of construction site signage and fencing; (iii) adequacy of relevant mitigation measures; (iv) accidents involving public and workers; (v) emergencies and responses; (v) public complaints about issues such as noise, air pollution, construction site safety;	PIU – Monthly LIEC – three times during construction period (April, July, October)
Surface water and effluent quality (compliance monitoring)	• **Method, Location:** Kharaa River, 50 m upstream and 200m downstream of WWTP effluent outfall; WWTP effluent. • **Parameters:** Temperature, Suspended particles, pH, dissolved oxygen, chemical oxygen demand, biological oxygen demand, faecal coliforms (according to laboratory capabilities in Darkhan, including laboratory in Us Suvag)	Licensed monitoring institute (contracted by PIU) Twice per year (April, October)
Air quality (compliance monitoring)	• **Method, Location:** WWTP site, Output 2 Old Darkhan Hospital, School No. 16 and gers at Secondary and New South pumping stations. • **Parameters:** SOx, NOx, PM10	Licensed monitoring institute (contracted by PIU) Twice per year (April, October)
Air Quality – dust	• **Method, Location:** Visual observation of dust at receptors/dwellings near construction sites. Observations to record if dust generated by construction activities crosses property boundaries. • **Parameters:** Fugitive dust emissions	EHSO – Weekly; LIEC – three times during construction period (April, July, October)
Noise (compliance monitoring)	• **Method, Location:** WWTP site, Output 2 Old Darkhan Hospital, School No. 16 and gers at Secondary and New South pumping stations. **Parameters:** Db(A) at receptors (dwellings) outside and inside if possible.	Licensed monitoring institute (contracted by PIU) Three times per year (April, July, October)
Interview with APs	• **Method, Location**: Interview with potentially affected people (AP) adjacent to construction sites including street vendors, near Old Darkhan market/hospital and Getsogdarjaalin Monastery monks • **Parameters:** Discussion on environmental and socio-	PIU – Monthly Three times per year (April, July, October)

Environmental Media/Issue	Location, Parameters, Monitoring Technique	Responsibility & Frequency
	economic issues.	
EMP Compliance	• **Method, Location:** Review of project's adherence with EMP and loan covenants • **Parameters:** EMP and loan covenants	MCUD, LIEC, ADB – Annually
	Construction Completion and Operation Phase	
Post-construction site inspection	• **Method, Location:** Visual inspection, post-construction environmental condition assessment at each construction site. • **Parameters:** Performance checked against the management plans submitted before construction for specific aspects such as aggregate, borrow pit and spoil management plan.	PIU-SS, LIEC – Once after completion
WWTP effluent quality	• **Method, Location:** Automated monitoring, WWTP effluent point. • **Parameters:** COD, BOD, TKN, TP, (online); NH4-N, SS, EC, pH (parameters of MNS 4943:2011)	Us Suvag Central Water Lab – Daily (online monitoring); WWTP onsite laboratory
Sludge quality	• **Method, Location:** Sludge drying beds • **Parameters:** Heavy metals, ammonia, nitrate, phosphorous, faecal coliforms (according to laboratory capabilities in Darkhan, including laboratory in Us Suvag)	Us Suvag Central Water Lab – Weekly
Air quality (noise, odors)	• **Method, Location:** At boundary of WWTP, effluent point, sludge beds, pumping stations. • **Parameters:** dB(A), H_2S, NH_3.	Central Laboratory of Environment, Darkhan – Quarterly
Kharaa River water quality	• **Method, Location:** Water quality monitoring, 50m upstream and 200m downstream of effluent discharge point. • **Parameters:** Temperature, DO, SS, NH_3N, TN, TP, BOD_5, COD_{Cr}, sulfate, nitrate, chloride, oils.	Aimag Meteorological Office - Monthly

Source: ADB Study Team, DEIA.

G. Environmental Reporting

17. Environmental monitoring and inspection activities and findings shall be documented for purposes of reporting, recording, verifying, referring on and evaluating the environmental performance of the Project. The documentation shall also be used as basis in correcting and enhancing further environmental mitigation and monitoring. Environmental monitoring reports (EMRs) shall be prepared as follows (see also Table EMP-5):

(i) Monthly internal progress reports by the Contractors during construction, submitted to the PIU and LIEC. These monthly reports will include; (i) physical progress of the component; (ii) mitigation measures implemented; (iii) grievances received, resolved, closed and/or directed to other mechanisms; (iv) emergencies responded to; and (v) corrective actions taken.

(ii) Semi-annual environmental impact monitoring reports by licensed monitoring institutes/laboratories to report on the results of environmental quality monitoring as specified in the EMP. The reports will include the analysis results and assessment of compliance/non-compliance with Mongolian and international standards.

(iii) Annual EMP progress reports, by the LIEC (on behalf of PIU/PMU) to be submitted to the ADB and MEGD to comply with environmental agreement in the loan and Mongolian

Law on EIA. The Annual EMP progress report will not only report on the progress and results of environmental monitoring and compliance of EMP implementation but will also briefly: (i) assess the effectiveness of instituted measures; (ii) point out violation/s, if any; (iii) assess/recommend corrective actions; and (iv) cite any coordination made for corrective actions and, if applicable, certifications for having instituted them effectively. It shall also feature possible innovative mitigation measures applied by the Contractor, Operator or affected residents themselves, and other lessons learned in EMP implementation. These will be useful in adjusting the EMP to adapt to real ground situations.

Table EMP-5: Project Reporting Requirements

Report From	Report To	Purpose	Frequency
Contractor	Darkhan aimag, PIU	Progress with EMP Implementation	Monthly
PIU (PIU-SS)	PMU	Progress with EMP Implementation	Quarterly
PMU	ADB	Project progress reports	Quarterly
Licensed monitoring institutes	PMU, PIU, aimag environmental authorities of Darkhan Uul	Environment monitoring results (air, noise, water, soil, sludge)	Semi-annually
LIEC (PIU/PMU)	ADB	EMP progress reports	Annually

Source: ADB Study Team

H. EMP implementation cost estimates

18. The mitigation measures related to construction works, which will be shouldered and budgeted by contractors, amounts to approximately 1.5% of the construction costs (150,000 USD). The environmental mitigation and monitoring measures requiring a specific budget outside the civil works contracts are shown in **Table EMP-6**.

Table EMP-6: EMP Budget

Item	Estimated Cost $USD
Loan Implementation Environment Consultant (6pm)	$ 20,000
PIU safeguards staff (salary costs, 12pm)	$40,000
Environmental Monitoring by licensed monitoring institutes	$ 50,000
EMP-related training, consultation	$ 5,000
Transportation, Reporting, Translation	$ 10,000
Total	**$125,000**

Table EMP-7: Environmental Mitigation Plan

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
Pre-Construction						
Strengthen local capacities to implement EMP	PIU Office	Establish PIU, appoint PIU safeguards staff (PIU-SS); Contract licensed environment monitoring institute (LMI); Contract loan implementation environment consultant (LIEC).	Tender Preparation	No additional cost	PMO, PIU	ADB
Updating EMP	N.A.	Mitigation measures defined in this EMP will be updated and incorporated into the detailed design to minimize adverse environmental impacts.	Tender Preparation	No additional cost	PIU, LIEC	ADB
Provide comprehensive and responsive complaints process	PIU office	Development and implementation of Grievance Redress Mechanism (GRM)	Pre-Construction (1 month before construction commences)	No additional costs	PIU, LIEC	PMU, ADB
EMP contractual obligations	3 civil works contracts	Tender and contract documents to include EMP obligations	Tender Preparation	No additional cost	MCUD (PMU)	ADB
Contractor EMP	3 civil works contracts	Preparation of Contractor Environmental Management Plans (C-EMPs), which shall include sub-plans, including Health and Safety Management Plan (HSMP), Soil Erosion Management Plan, Aggregate/Borrow Pits and Spoil Management Plan, Spill Management Plan, Hazardous and Non-Hazardous Waste Management Plan, Water Protection Management Plan.	Pre-Construction (approval 1 month before construction commences)	Included in contractor costs	Contractor	PIU-SS, LIEC, aimag environment inspector
Environment monitoring	All construction sites	Develop detailed monitoring plan for construction period covering water, soil, air, noise, health and safety, and contract licensed monitoring institutes to conduct the monitoring during project implementation.	Pre-Construction (1 month before construction commences)	LIC budget	PIU, LIEC	PMU, ADB
Consultation	Output 2	Consultation with Monastery, School No. 15, Old Darkhan Hospital, street vendors and affected residents regarding construction timing and	Pre-construction	No additional cost	PIU-SS, LIEC	PMU, ADB

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
		approach.				
Utilities Interruption	3 civil works contracts	Consult relevant *aimag* departments to confirm location of utilities for each site	Pre-construction	Included in contractor costs	Contractor	PIU-SS, LIEC
Construction Phase: Physical Resources						
Soil Resources – Erosion	All sites	- Develop soil erosion management plan as part of the C-EMP before construction starts; - minimize the area of soil clearance; - maintain slope stability at cut faces by implementing erosion protection measures; - construction in the flood plain (tertiary pipe at Secondary Pumping Station) should be mainly restricted to the dry season; re-seed to re-vegetate with appropriate species of local provenance including cover on tertiary pipe; stock-proof fencing along length of pipe to ensure animals do not erode soil covering. - control silt runoff particularly around tertiary pipe at Secondary Pumping Station; - cover soil stockpiles; - properly stabilize slopes and re-vegetate disturbed surfaces; and - use of temporary berms or other appropriate temporary drainage provisions at construction sites to prevent water eroding cut faces, stockpiles and other exposed areas of soil.	During construction	Included in contractors costs	Contractor	PIU-SS, LIEC, environment inspector
Soil Resources – Contamination	All sites	- Develop Spill Management Plan as part of the C-EMP; - Properly store hazardous chemicals and wastes on hard standing with containment tray or bunding. - Keep a stock of absorbent materials (e.g. sand, earth or commercial products) onsite to deal with spillages and train staff in their use. - Ensure wastes from spill management are suitably disposed of. - Record any spill events and actions taken in environmental monitoring logs and report to PIU-SS and aimag environment inspector. - Remove all construction waste from the site to approved waste disposal sites.	During construction	Included in contractor's costs	Contractor	PIU-SS, LIEC, environment inspector
Soil Resources	Borrow and spoil	- Develop and implement borrow and spoil	During	Included in	Contractor	PIU-SS,

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
– Borrow and spoil	disposal sites	management plan (as part of C-EMP), specifying location of borrow pits, quarries and spoil disposal sites; - ensure that borrow areas are located away from residential areas, water bodies and valuable pasture/grazing land; - after use, grade borrow and spoil areas to ensure drainage and visual uniformity, and - borrow pit restoration must follow the completion of works in full compliance with all applicable standards and specifications; -	construction	contractor's costs		LIEC, environment inspector
Air quality - Dust	All construction sites	- Manage stockpile areas to avoid mobilization of fine material, cover with tarpaulin and/or spray with water. - Fill material should be delivered to construction sites in a damp condition - Water sprays or a dust suppression agent should be correctly applied to reduce dust emissions and reduce water usage - Any raw material spills should be removed promptly - Do not overload trucks transporting earth materials. - Equip trucks transporting earth materials with covers or tarpaulin to cover loads during transport. - Install wheel washing equipment or conduct wheel washing manually at each exit of the works area to prevent trucks from carrying mud onto public roads. - Immediately clean up all mud on public roads. - Frequent watering of unpaved areas and excavations to suppress dust. - Adjust practices as necessary to increase dust suppression if nomadic herders relocate to be near construction sites, such as more frequent watering of stockpiles and roads - Regularly inspect and certify vehicle and equipment emissions and maintain to a high standard. - Concrete batching or asphalt (or other pavement surface) plants to be sited at least 500 m from the nearest dwelling and locate downwind.	Throughout construction	No additional cost	Contractor	PIU-SS, LIEC, environment inspector

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
Surface Water Quality	Central WWTP (Output 1)	- Adequate WWTP capacity will be maintained at all times throughout rehabilitation in accordance with the rehabilitation stage plan.	Throughout construction	No additional cost	Contractor for A1	PIU-SS, LIEC, environment inspector
Surface Water Quality	Output 2 Tertiary pipe; secondary pumping station	- Temporary drainage provision will be provided during construction - Contaminated water will be removed off-site for disposal in the facilities identified in the Construction Site Management Plan	Throughout construction	No additional cost	Contractors for A2.1 and A2.2	PIU-SS, LIEC, environment inspector
Surface and Groundwater Quality	All construction sites	- Develop and implement contingency plans for control of spills of oil and other hazardous substances (Spill Management Plan); - Fuel storage, maintenance shop and vehicle cleaning areas must be stationed at least 300m away from the nearest water body and will include enclosed drainage to ensure contaminated water does not cause pollution and storage, maintenance and cleaning activities will be on hard standing; - -Enclosed drainage around chemical storage areas on construction sites and storage will be on hard standing. - Construction wastes and materials (e.g. fuel) will be properly contained during construction on hard standing and fuel tanks will be located in a bunded area which has a capacity of 110% of the fuel tank. Wastes will be stored in a hard standing area which is protected from rain and wind and waste removed from site and taken to approved disposal facilities.	Pre-construction & during construction	No additional cost	Contractors	PIU / MCUD
Waste Management	All sites	- Waste Hierarchy to be the guiding principal in the Waste Management Plan and Borrow and Spoil Management Plan; - Document consideration of waste prevention and reuse through procurement options if feasible; - Provide appropriate covered waste storage containers for all wastes and adequately segregate hazardous and non-hazardous waste streams; - Install confined storage points of solid and liquid wastes away from sensitive receptors; - Regularly haul wastes to an approved disposal	Pre-construction and during construction	Included in contractors costs	Contractors	PIU-SS, LIEC, environment inspector

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
		facility as agreed with *aimag* authorities if appropriate; - If waste is removed by a third party, ensure the contractor is approved by the *aimag* authorities; - Contractors to be responsible for proper removal and disposal of any significant residual materials, wastes and contaminated soils prior to construction camp site handover; - Spoil will not be disposed of on slopes or near pasture land where it may impact on vegetation; - Rehabilitate and restore spoil disposal sites in accordance with the agreed plan. - Prohibit burning of waste at all times - Waste Management Plan to include (i) PCB assessment and management plan for all pumping station sites (ii) scope for long term storage of hazardous liquid waste (including PCB containing oils) which requires high temperature incineration - Prohibit burning of waste at all times; - Schedule of disinfection for each waste storage area to be implemented.				
Construction Phase: Socio-economic Resources						
Cultural Heritage	Output 2 (Old Darkhan Hospital site-Getsogdarjaalin Monastery)	- Maintain dialogue with Getsogdarjaalin Monastery monks during construction; - Feedback corrective mitigation actions to PIU as required.	During Construction	Included in PIU staff costs	PIU-SS Contractors	PIU-SS, LIEC, environment inspector
Health and Safety: Noise	All sites	- Schedule construction activities, avoid noisy equipment working concurrently; - Avoid construction works from 1800hrs to 0800hrs - If night time construction needed, consult nearby residents beforehand for their consensus; - Locate sites for rock crushing, concrete mixing and other noisy activities at least 200m away from sensitive noise receptors which are present at the time of set-up; - Provide notices for advance warning of excavation works particularly for school and hospital on timing of noisy activities; - Ensure GRM information is disseminated; - All construction workers to use appropriate	Throughout construction	No additional cost	Contractors	PIU-SS, LIEC, environment inspector

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
		Personal Protective Equipment for protection against damage from noise.				
Pasture Land – Economic Resource	Output 2 - Tertiary pipe at secondary pumping station; and new south pumping station	- Spoil is to be disposed of only in areas delineated in the Aggregate and Spoil Management Plan which should avoid productive pasture land. - GRM will be signposted at each of the sites in order for those with grazing animals to contact the project if they have a problem with the construction works. - Notices in advance of construction work will be put up to warn residents, including owners of animals, that the work will commence including start/end dates and details of work.	During Construction	Included in contractor costs	Contractor	PIU-SS, LIEC, environment inspector
Health and Safety: Construction site safety	All sites	- Clear signs placed at construction sites in view of the public, warning people of potential dangers such as moving vehicles, hazardous materials and excavation and raising awareness on safety issues - Heavy machinery will not be used after day light and all such equipment will be returned to its overnight storage area/position before night; - All sites, particularly pipe excavations will be made secure, discouraging access by members of the public through fencing or security personnel, whenever appropriate; - Specific notices will be issued to the School Number 16, opposite Old Darkhan Hospital (Output 2) in order to inform children about construction site safety; - Road safety awareness signage - road users and pedestrians made aware of changes to traffic flows through clear signage.	During Construction	Included in contractor costs	Contractors	PIU-SS, LIEC, environment inspector
Health and safety - temporary traffic safety	Output 2, Old Darkhan Hospital - main road	- Consult and maintain dialogue with relevant *aimag* authority on the timing of the road excavation, including departments responsible for transport and traffic police; - Signage to warn motorists of when the road closure will be operational; and - Use of appropriate traffic signals if alternate line traffic is required to maintain access along the road.	During Construction	Included in PIU and contractor costs	PIU-SS Contractor	PIU, LIEC, environment inspector

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
Occupational Health and Safety	All sites	- An Environment Health and Safety Officer (EHSO) will be hired or nominated to implement and supervise a Health and Safety Management Plan (HSMP); - HSMP implementation will be monitored by the EHSO and all incidents recorded and report with corrective actions identified.	During Construction	Included in contractor costs	Contractor	PIU-SS, LIEC, environment inspector
Operation Phase						
WWTP treatment performance	WWTP, Kharaa River	- Prior to commissioning of the WWTP, conduct a series of tests to ensure proper functioning of the WWTP and ability to achieve Mongolian discharge standard; - Install SCADA system including wastewater quality monitoring devices for real-time monitoring of key parameters (COD, TP, NH4-N); - Institute daily check, repair and maintenance procedures for all wastewater treatment steps; - Provide hands-on training to Us Suvag staff to make sure that capacities to operate, monitor and maintain the new facilities are created; - Conduct regular WWTP effluent monitoring and Kharaa River water quality monitoring b (at least monthly) to confirm compliance with national ambient water quality standard (MNS 4586:1998) and Standard for wastewater discharge to water bodies (MNS 4943:2011).	During commissioning and of operation	Included in construction costs	Design-construct-commission contractor; Us Suvag	Darkhan *aimag,* PMU
Risks of Accidents, Emergency Preparedness	WWTP, Kharaa River	- Retain existing pond system with a retention time of approximately 100 days for temporary retention of accidental discharge; - Provide dual power supply and spare parts for key components; - Conduct regular inspection and proper maintenance of the WWTP; - Install automated on-line, real-time monitoring of influent and effluent quality; - Establish onsite analytical lab prior to operation of the WWTP (wastewater sampler, pH meter, flow meter, conductivity meter, UV/VIS spectrophotometer, DO meter, COD speedy tester, thermostat incubator, electric balance, and	During Commissioning and Operation	Included in detailed design and construction contract	Contractor, Us Suvag	Darkhan *aimag environment inspector*, PMU

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
		centrifuge). - Formulate and implement emergency preparedness and response plan before the WWTP becomes operational. The emergency preparedness and response plan shall address, among other things, training, resources, responsibilities, communication, procedures, and other aspects required to respond effectively to emergencies associated with the risk of accidental discharges. -				
Odor from WWTP	WWTP (intake screen, influent pump room, fine screen, main reactor, sludge filter press house, and sludge drying beds)	- Equip odor generating facilities with ventilation or odor containment; - Locate sludge filter press indoor with ventilation and odor removal facilities; - Institute daily check, repair and maintenance of all wastewater treatment facilities/equipment; - Conduct regular monitoring of H2S and NH3;	During operation	Included in Us Suvag operation budget	Us Suvag	Darkhan *aimag environment inspector*
Noise	WWTP, pumping houses	- Design building walls with sufficient thickness and acoustic measures such as barriers or sound absorbing materials; - Conduct regular noise monitoring to confirm compliance with the national ambient noise standard (MNS 4585:2007).	During Design and Operation	Included in Us Suvag operation budget	Us Suvag	Darkhan *aimag environment inspector*
Pipe design and maintenance	Rehabilitated pipes (under output 2)	- Adequate layering and packing of earth around the tertiary pipe in order to protect it from cold weather. The depth of the material to be advised by a cold weather engineering specialist; - Maintenance and repair of stock proof fencing either side of the tertiary pipe in order to protect it from trampling by grazing stock, thus maintaining its integrity; - Us Suvag to regularly inspect all pipes and to implement repairs if required	During Operation	Included in Us Suvag operation budget	Us Suvag	Darkhan *aimag environment inspector*
Sludge management	WWTP	- Dewater WWTP sludge through a filter press to max. 80% moisture content; - Dispose sludge cake in the existing (but rehabilitated) sludge drying beds, - Monitor sludge quality, investigate alternative	During Operation	Included in Us Suvag operation budget	Us Suvag	Darkhan *aimag environment inspector*

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
		options for beneficial sludge.				
Industrial pre-treatment of wastewater	Existing and future industries	- Take action to enforce the order No a/11/05/A/18 of January 10 1997 which prescribes the "Allowable limits of industrial wastewater composition before letting effluents into the central wastewater system"; - Ensure proper monitoring of pre-treatment systems is in place at all wastewater contributing industries; - Develop mechanisms to effectively monitor industrial wastewater composition before it enters the public sewer system; - Establish emergency measures at industry level to enable toxic flows to be contained so does not enter the sewer system; - Advise existing and new industries on optimal technology solutions for their respective industrial processes in case of potential toxic effluents.	During Operation	Included in Us Suvag operation budget	Us Suvag	Darkhan *aimag environment inspector*
Occupational health and safety	WWTP, pumping stations	- Use safety shoes or boots with non-slip soles; - Wear personal protective equipment and chemical resistant clothing to avoid exposure of skin or eyes to corrosive and/or polluted solids, liquids, gases or vapors; - Post safety instructions in each workshop regarding the storage, transport, handling or pouring of chemicals; - Check electrical equipment for safety before use; verify that all electric cables are properly insulated; take faulty or suspect electrical equipment to a qualified electricity technician for testing and repair; - Wear safety goggles in all cases where the eyes may be exposed to dust, flying particles, or splashes of harmful liquids; - Wear respiratory mask in the sludge dewatering and de-odor workshops and when moving and transporting sludge; - Obey all safety instructions concerning entry into confined spaces, e.g., check atmosphere for oxygen or for poisonous gases, use respiratory protection equipment if needed, have a co-worker	During Operation	Included in Us Suvag operation budget	Us Suvag	Darkhan *aimag environment inspector*

Issue	Location/ Component	Mitigation	Timeframe	Estimated Cost $ USD	Implemented by	Supervised/ Approved by
		stand guard in case of need for help, etc; - All workers will undergo periodic examinations by occupational physician to reveal early symptoms of possible chronic effects or allergies; and - Health and safety will be incorporated into the regular staff training programs.				
Climate risk (adaptation)	WWTP, sewer network	- Climate proofing of civil works structures (WWTP foundation works) accounting for possible changes in soil moisture that could cause ground subsistence; - Assess annually the need to adjust WWTP and pipe network maintenance budget to account for increased maintenance requirements resulting from climate change.	During Operation	Included in the design-build contract for the WWTP	Us Suvag	Darkhan *aimag environment inspector*

APPENDIX TO THE EMP: TERMS OF REFERENCE FOR LOAN IMPLEMENTATION ENVIRONMENT CONSULTANT (LIEC, NATIONAL 12 PERSON-MONTHS, INTERMITTENT)

The specialist will have a minimum of 10 years practical experience in the implementation of EMPs and environmental monitoring, ability to work with a multidisciplinary team and dealing with all aspects of site-related environmental issues, and excellent communication skills. Previous experience as a National Environment Specialist for at least one ADB funded project in Mongolia is desirable. The LIEC will facilitate the implementation of the EMP and ensure the grievance redress mechanism functions effectively. The expert will perform the following with respect to environmental management:

(i) Review IEE and project EMP as well as domestic detailed EIA (DEIA) to understand the environmental issues associated with the project area;
(ii) Consult with PIU to identify if there are any changes in the project sites or baseline environmental conditions. Assess impacts of any changes and update EMP;
(iii) Assist the PIU in obtaining all necessary domestic environmental approvals to allow the projects to proceed, as required;
(iv) Assist PIU in establishing Grievance Redress Mechanism (GRM) in accordance with GRM procedure defined in the IEE, coordinate consultation with local stakeholders as required, informing them of imminent construction works, updating them on the latest project development activities, GRM, etc. Facilitate consultation between the contractor and local stakeholders including Bagh committees and Affected People (including residents, vendors, Old Darkhan Hospital, temple monks and School No. 16) with respect construction scheduling, and proposed mitigation measures to control dust, and to minimize disruption to local traffic;
(v) Review Tender and Contractor Documents to ensure all required environmental specifications have been included, update as required;
(vi) Prepare environmental audit checklists for weekly and monthly supervision of the EMP by the PIU, and review contractor-EMPs to confirm compliance with the project EMP;
(vii) Coordinate the conduct of periodic environment compliance monitoring by licensed monitoring entities, as defined in the monitoring program.
(viii) On behalf of PMU and PIU, prepare annual EMP progress reports for ADB. The reports should review progress with project implementation, results of checking and monitoring, identify problems encountered, actions taken/or proposed to be taken to resolve problems and activities programmed for next monitoring period. Include water quality and effluent sampling results and discussion in the monitoring reports and advise/support the contractor in taking remedial actions if any of the test results are not within the required limits;
(ix) Conduct training events for PIU and contractors on the requirements and implementation of the EMP in accordance with the training plan defined in the project EMP;
(x) Conduct regular site visits to the project area during the construction period and conduct EMP compliance inspections (in accordance with monitoring and inspection plan defined in the EMP);
(xi) Undertake research to identify local solutions for sewage sludge based on sewage quality data analysis. Liaise with national experts if required.

Appendix 1: Description of existing water supply, sewerage system, pumping stations, and wastewater treatment facility; water demand and wastewater generation projections

(A) Existing water supply, sewerage system, pumping stations, and wastewater treatment facility

1 The existing situation with respect to the water and wastewater sectors in Darkhan can be described as problematic, but not critical. Water supply and wastewater management are the responsibility of the Public Urban Services Organisation (PUSO) for Darkhan – Darkhan Us Suvag (USAG) - which was established in 1965 and currently has 192 staff of which 40 have an engineering qualification. Darkhan Us Suvag functions as a service organisation and a limited liability joint stock company. The company is owned 40 per cent by the aimag government and 60 per cent by the aimag peoples Khural (on behalf of the people of the aimag). The water supply and wastewater assets of the aimag are vested in the Us Suvag LLC.

The Water Supply System

2 The city is served through a system of wells located in the Kharaa river valley and about 5 km upstream of Darkhan city. A total of 18 wells are available which could deliver a theoretical 70,000 m3/d of groundwater. However, current total residential and industrial demand (of about 18,000 m3/d but up to 23,000 m3/d) can be provided from just 5 or 6 production wells. This includes "technical water" of about 8,000 m3/d used by the thermal power plant, and which is drawn from their own wells. Us Suvag abstracts about 11,000 m3/d for domestic and other industrial use. During August 2013 abstraction rates varied from 8,800 to 12,100 m3/d, with an average of 11,000.[1]

3 The raw water is generally of drinking quality at the point of extraction, and as such is not normally subject to treatment. However, chlorination facilities exist at raw water storage tanks and it is reported[2] that chlorination is occasionally carried out during the summer period when quality declines. Despite this, water quality problems are experienced at the point of delivery as a result of the poor condition of many sections of the 40 year-old pipe network, which suffers an overall leakage rate currently estimated at about 40%. Progressive replacement of key elements of the water supply network (which has been commenced) is likely to result in a progressive improvement in the leakage situation. However, there are still some sections which remain in urgent need of replacement.[3]

4 In addition to the abstraction from Us Suvag's own well network and those of the thermal power plant, some individual households and businesses extract groundwater from their own wells. However, over recent years, Us Suvag has attempted to stop this practice and now the vast majority of water supplied to residences is from the Us Suvag well fields via the distribution network, although there are still some private deep wells which provide water in the ger areas.

5 Of the 11,000 cubic meters produced by Us Suvag per day, about 3,000 m3/d is consumed by industry and 8,000 m3/d by residential, institutional and commercial users. Of this amount most is consumed in the core serviced areas of old and new Darkhan, with only about 500 m3/d being consumed by the more than 25,000 who live in the ger areas, of which most is provided through the piped network to water kiosks, and about 90 m3/d by water trucks. There are a total of 35 water kiosks serving the ger areas, of which 18 are served from the water supply network and 17 by water tanker. The tankers mainly serve kiosks in areas near the Kharaa River (baghs 1, 2 and 3) where water supply pipes cannot easily be installed due to the high water table.

[1] Us Suvag figures on raw water abstraction 2013.
[2] Reported by Us Suvag, Head of Laboratory Services.
[3] For instance in the area of Mangirt where the proportion of non-revenue water is estimated at 80%.

6 The centrally planned urban core areas are served by a reticulated water supply network which in places extends into the ger areas to provide water to water kiosks. The reticulated supply is provided through 223.2 km of pipe varying in diameter between 100 mm and 1,000 mm. The age of the network by length is: installed in 1965: 59%; in 1990: 33%; in 2005: 5%; and in 2011: 3%.

7 Average water consumption within the central serviced core areas has been measured at 175 l/cap/day in warm weather conditions (when the hot water system is not in operation) and a further 40 l/cap/day, making a total of up to 215 litres/capita/day during cold weather conditions when the hot water system is operated. This includes the system leakage currently estimated at about 40 per cent. In the ger areas average per capita water consumption is estimated at around 10 to 20 l/cap/day4. Figure A1.1 below shows the estimated water balance for the city.

The Sewerage System

8 Darkhan has a separate sewer system – sanitary sewage and surface water are served by independent networks. The sewer system of Darkhan conveys wastewater from both old and new Darkhan and the industrial estate to the central WWTP, which lies just to the north (downstream) of old Darkhan and about 500 m from the Kharaa river. The WWTP is about 650 m from the nearest dwelling – which is a ger on a recently issued khashaa plot.

9 The sewer network has of total length of 223.5 Km made up of about 97 Km of trunk main, 2 Km of rising main, and the remainder in secondary sewers and connectors. The condition of the network is variable, as many of the pipes are almost 50 years old. The age of the network by length is: installed in 1965: 65%; in 1990: 30%; and in 2005: 5%. There is no detailed information on the retention period within the sewer system, although there are no reports of septicity problems. The generally sloping topography of the core urban areas of Darkhan help in generating self-cleansing velocities in the sewer network.

10 Since the two residential areas and the industrial estate are effectively in three separate valleys, the system requires two intermediate pumping stations to convey wastewater to the WWTP (one at the industrial estate and one in old Darkhan), with a further pump station at the plant to lift the wastewater to allow gravity flow through the treatment process. All pumps operate automatically according to pre-defined levels and there are both generators and emergency overflows at the pumping stations. Despite these provisions, due to periodic breakdown of equipment reaching the end of its economic life, there are occasions when there is overflow of raw sewage to the flood pain of the Kharaa River adjacent to the pump stations. In addition, the pump station serving the industrial area is an old plant running at capacity, and the far larger-capacity new pump station is currently not operational.

11 Us Suvag maintains that some 40% of the sewer network is in need of rehabilitation or replacement, and there is evidence of significant infiltration (and thus also exfiltration) from the sewer network. It is reported[5] that there is a significant increase in inflows to the WWTP during periods of intense rainfall, indicating significant ingress of storm water into the system. This suggests there is also significant ex-filtration under normal dry conditions, which has the potential to pollute groundwater resources. Based on the differential between water consumption and sewage flows, there are estimates that infiltration of ground water and surface water into the sewer system is of the order of 15 to 25%.[6]

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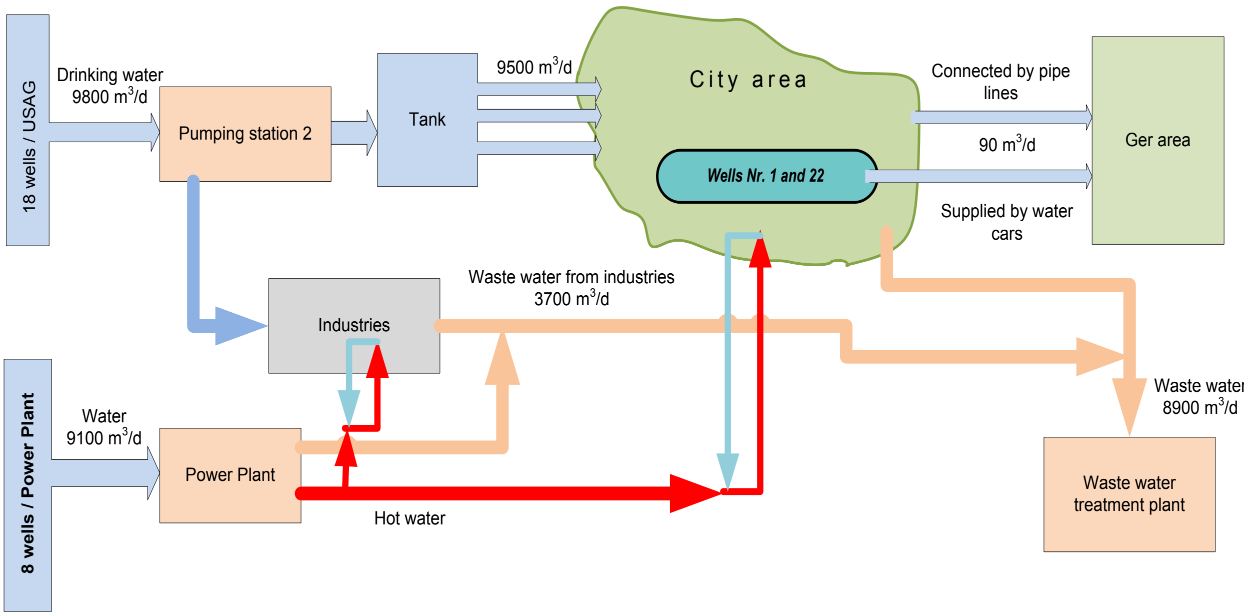
[4] Source: Milojevic, Nikola, Klaus-Jochen Sympher, Matthias Schütz, and Martin Wolf, MoMo Technical Report No 6 Integrated Wastewater Management in Central Asia – MoMo Model Region, 2011.
[5] Us Suvag flow records at CWWTP
[6] Source: Milojevic, Nikola, Klaus-Jochen Sympher, Matthias Schütz, and Martin Wolf, MoMo Technical Report No 6 Integrated Wastewater Management in Central Asia – MoMo Model Region, 2011.

12 The sewer system only serves those residents that live within the service area, estimated at between 60% and 69% of total households which are connected to the public sewer system. Of the remaining percentage (most of whom live in ger areas), a significant majority use open long-drop pit latrines for sanitation, and soakage pits for sullage disposal. However, it is also reported that 14% of the wastewater generated in the city is directly discharged into surface waters – mainly from the ger settlements.[7]

Figure A1.1: Estimated Water Balance for Water Supply to Darkhan City



Industrial Wastewater

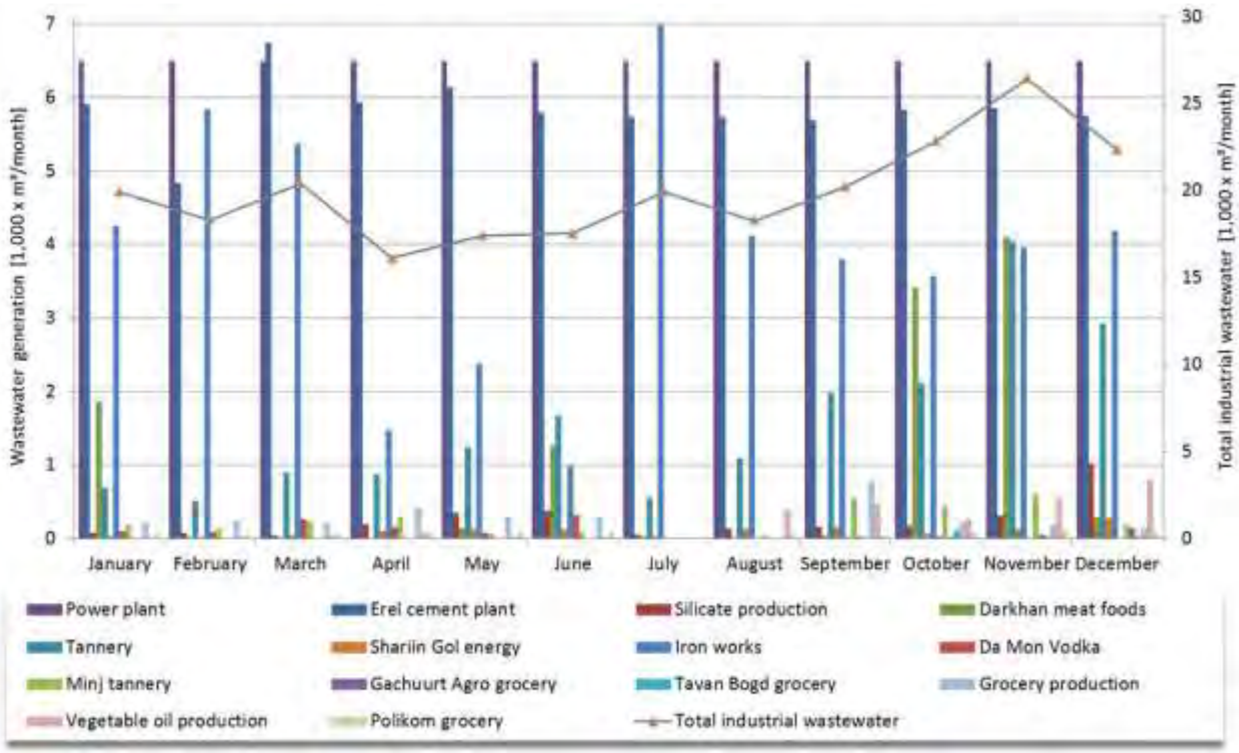
13 The industrial estate generates up to an estimated maximum of 3,700 m3/d of wastewater, although the summer average is nearer 2,500 m3/d, which enters the public sewer network. Of this amount, approximately 2.5 m3/d generated by the sheepskin tanning and dying factory is subject to pre-treatment using a coagulation and precipitation reactor which precipitates out chromium and delivers an effluent which is acceptable for discharge into the public sewer. The meat processing factory also has a pre-treatment facility for its 40 to 60 m3/d effluent which is high in BOD and nutrients. Wastewater flows from other industries are not pre-treated. Us Suvag monitors the characteristics of industrial flows into the sewer network and confirmed that all industrial flows satisfy the conditions for discharge to a public sewer, except for the meat processing factory as long as its treatment plant is out of operation.

14 Figure A1.2 below[8] shows a time series of industrial wastewater flows as reported by individual industries during 2011, although this is significantly less than the wastewater pumped as measured at pump station No 1. Us Suvag indicates that all industries discharge wastewater into the public sewer system. The left ordinate shows the monthly wastewater flow by industry, and the right ordinate depicts the monthly sum of industrial wastewater discharged. Industrial wastewater production in the winter

[7] Source: p2mberlin GmbH Integrated Water Resouce Management (IWRM) Mongolia - MoMo Project: Proposal for a pilot SBR treatment system in Darkhan City, Berlin, 2010
[8] Source: Heppeler, Jörn. Optimization of the operation of a sequencing batch reactor (SBR) – On the example of the pilot wastewater treatment plant in Darkhan, Mongolia, University of Stuttgart, Stuttgart, 2012

months (October to March) is about 20% higher on average than in the summer months (April to September).

Figure A1.2: Total and Average Industrial Wastewater Flows over 2011



Wastewater Pumping Stations

15 There are three wastewater pumping stations currently used to deliver wastewater to the WWTP, including the station at the treatment plant itself which raises wastewater to the preliminary treatment works. There is a further pumping station at the industrial estate which is not currently operational, but which needs to be brought into service as the increasing wastewater volumes justify its use.

16 Wastewater from the industrial area is pumped to the WWTP in two stages, and that from Old Darkhan and New Darkhan in a single stage from the secondary pump station (Figure A1.3). The first stage pump station at the industrial estate is operating at its capacity (reported as 160 m3/h), and under peak inflow conditions raw sewage surcharges in the wet well, sometimes to the point where it overtops the parapet. Consequently, the primary screens are ineffective, thus further adding to the risk of pump failure. It has single operating and standby pumps.

17 The unused primary pump station at the industrial estate has never been operated, despite being connected to the network and provided with pumps, power connections and a standby generator. It has a theoretical capacity of about 1,000 m3/h, but pumps and electrical equipment have been removed and significant investment is required to make it operational.

18 The secondary pump station collects wastewater pumped from the industrial area, and flowing by gravity from New Darkhan and parts of Old Darkhan. The structure is in generally good condition, but again, the pumping equipment and power connections are in an advanced state of dilapidation. In addition, overflow pipework from the pump station is in need of replacement.

19 Figure A1.3 shows the pumping arrangement. The primary pumping station for the industrial area which is currently used is approximately 200m south of the major primary pumping station which is currently unused but would need to be brought into service with increasing industrial wastewater flows.

The Central Wastewater Treatment Plant

20 The first stage of the WWTP was built during the construction phase of Darkhan in 1965, adopting Russian design and standards, and initially adopting a process of preliminary treatment followed by primary treatment in two primary clarifiers. From 1987 to 1990, a major upgrade and expansion of the facilities was completed, with the provision of: (i) new grit channels, (ii) three new primary clarifiers, (iii) secondary biological treatment based on the activated sludge process, (iv) three secondary clarifiers, and (v) effluent chlorination facilities. This mechanical and biological plant had a design capacity of 50,000 m3/d, and was complemented by a series of constructed ponds providing: (i) polishing in maturation ponds, (ii) sludge drying beds, and (iii) sand and grit disposal ponds. The original primary clarifiers were decommissioned once the new plant came on stream. It is unclear whether all three streams of the 1990 plant were ever operated since in recent years the flow has seldom exceeded 10,000 m3/d, which is one fifth of the design capacity.

21 Most elements of the system are now out of commission. Two out of three of the primary clarifiers and two out of three of the secondary clarifiers are no longer used and derelict. Any mechanical equipment from the out-of-commission units has been cannibalised to keep the one remaining unit operational. Despite this, the plant is fully operational, with the exception of the chlorination facility. However, although planned for 50,000 m3/d, the plant is currently operating at a load of about 7,000 m3/d in summer and an average of 10,000 m3/d in winter, with a reported peak flow of significantly less than 20,000 m3/d. Consequently, only one stream (out of three) of both primary and secondary clarifiers is necessary. However, all three streams of the activated sludge biological reactor are operated, resulting in excessively long aeration periods. During the month of August 2013, daily flow rates into the plant varied between 5,100 and 10,900, and averaged 7,100 m3/d.[9] The inflow rates are somewhat higher in winter due to the extensive use of hot water in apartments and institutions. Figure A1.4 shows the layout of the WWTP and indicates the units which are currently operating highlighted in blue.

[9] Us Suvag inflow records for CWWTP.

Figure A1.3: Arrangement of Sewage Pumping Stations

22 Despite being operational most of the time, the plant is in an advanced state of disrepair. Some of the original pumps are decommissioned and have been cannibalised to provide parts for remaining serviceable pumps. Most of the control equipment in no longer operational, which means that the plant is operating sub-optimally contributing to excessive operational costs and compromising effluent quality. Although most pumps are out of order, the pumping stages in the plant are kept operational by repaired pumps and new pumps brought in to replace those no longer operable. Occasional breakdown and insufficient duty and standby pump capacity causes occasional raw sewage overflow and pollution of the immediately surrounding area.

23 The operation of the mechanical treatment processes is severely compromised by the failure of the screens which allow bulky debris to enter the system and provide a potential risk to pipes and pumps. The efficiency of the sand and grease trap is doubtful as the intermittent operation of the inlet pumps results in high temporary loads on the sand and grease trap and the primary sedimentation tank – exceeding the capacity of both to do an adequate job.

24 The primary sedimentation process is sometimes overloaded as only one out of three tanks is operational, and the sedimentation process in the primary sedimentation tank appears insufficient as faeces, paper and other floating debris leave the tank. The biological treatment aeration tank is in a very poor structural condition, with parts of the concrete walls having been eroded away, resulting in very uneven spill-over at the overflow weir. Aeration is very intensive, and visual inspections suggest the aeration rate is far too high, negatively impacting on treatment and wasting energy.

25 The performance of the secondary sedimentation tank is compromised by the ineffective operation of the sludge bleed system, resulting in sludge rising and being carried over with the supernatant. If the effluent from the plant is conveyed to the maturation ponds this should result in further effluent polishing, but is in unclear as to whether this is done on a regular basis.

26 In sum, the plant is struggling to keep going, and suffers frequent breakdowns which compromise the treatment efficiency and risk pollution events. In summer and autumn of 2012 regular aeration failures were observed due to the breakdown of the blowers, which on occasion, lasted for more than one week. The repeated blackouts led to a loss of activated sludge and negatively impacted on the treatment efficiency.[10]

27 Despite these problems, the plant shows reasonably good treatment efficiency in terms of BOD and SS removal, less so in the case of COD and nutrient removal. Table A1.1 shows the performance of the plant measured by Us Suvag during 2012 and the first half of 2013. This measures parameters at the outlet from the secondary clarifier, and further treatment can be anticipated in the polishing ponds prior to discharge to the Kharaa River. It is noticeable that BOD_5 removal is consistently high at around 90% apart from in April 2013 when it dropped significantly. This could be due to the sudden warming of the weather causing a dramatic increase in anaerobic activity in trapped sludge deposits releasing BOD into the supernatant and increasing sludge carry-over.

[10] Pm2berlin, Terms of Reference Main Trunk Sewer and Central Wastewater Treatment Plant for Darkhan, Mongolia Draft, Berlin March 2013

Table A1.1: Darkhan WWTP performance in 2012 and 2013

Existing WWTP performance 2012 & January to July 2013 - Us Suvag figures												
Date	BOD_5			COD			SS			NH_4		
	Inlet	Outlet	Removal	Inlet	Outlet	Removal	Inlet	Outlet	Removal	Inlet	Outlet	Removal
2012	91.00	9.00	90%	103.00	45.00	56%	150.00	28.00	81%	2.28	0.65	71%
Jan-13	66.60	5.60	92%	182.40	42.00	77%	130.00	36.60	72%	1.40	0.37	74%
Feb-13	100.00	8.00	92%	96.00	48.00	50%	95.00	27.30	71%	1.62	0.69	57%
Mar-13	87.00	8.90	90%	86.50	44.80	48%	91.00	23.00	75%	1.40	0.78	44%
Apr-13	62.00	24.20	61%	124.80	44.60	64%	87.70	25.70	71%	1.39	0.43	69%
May-13	80.00	6.30	92%	93.00	42.00	55%	86.00	25.00	71%	1.19	0.42	65%
Jun-13	81.00	7.30	91%	141.00	25.00	82%	134.00	33.00	75%	1.24	0.37	70%
Jul-13	96.50	9.80	90%	76.80	75.00	2%	109.30	28.00	74%	0.87	0.53	39%
Average			**87%**			**54%**			**74%**			**61%**

28 Additional data were collected by the MoMo project in the summer of 2012 on the treatment efficiency achieved by the WWTP. The average results are shown in Table A1.2 below. These also show a poor performance in terms of nutrient removal, although improved performance in removing COD.

Table A1.2: Darkhan WWTP performance in 2012 and H1 of 2013

Parameter		Minimum mg/l	Mean mg/l	Maximum mg/l	Average removal rate %
COD		164	385	634	72
Total N		39	59	74	40
NH_4-N		28	41	57	49
Total P		3.4	5.9	7.5	61

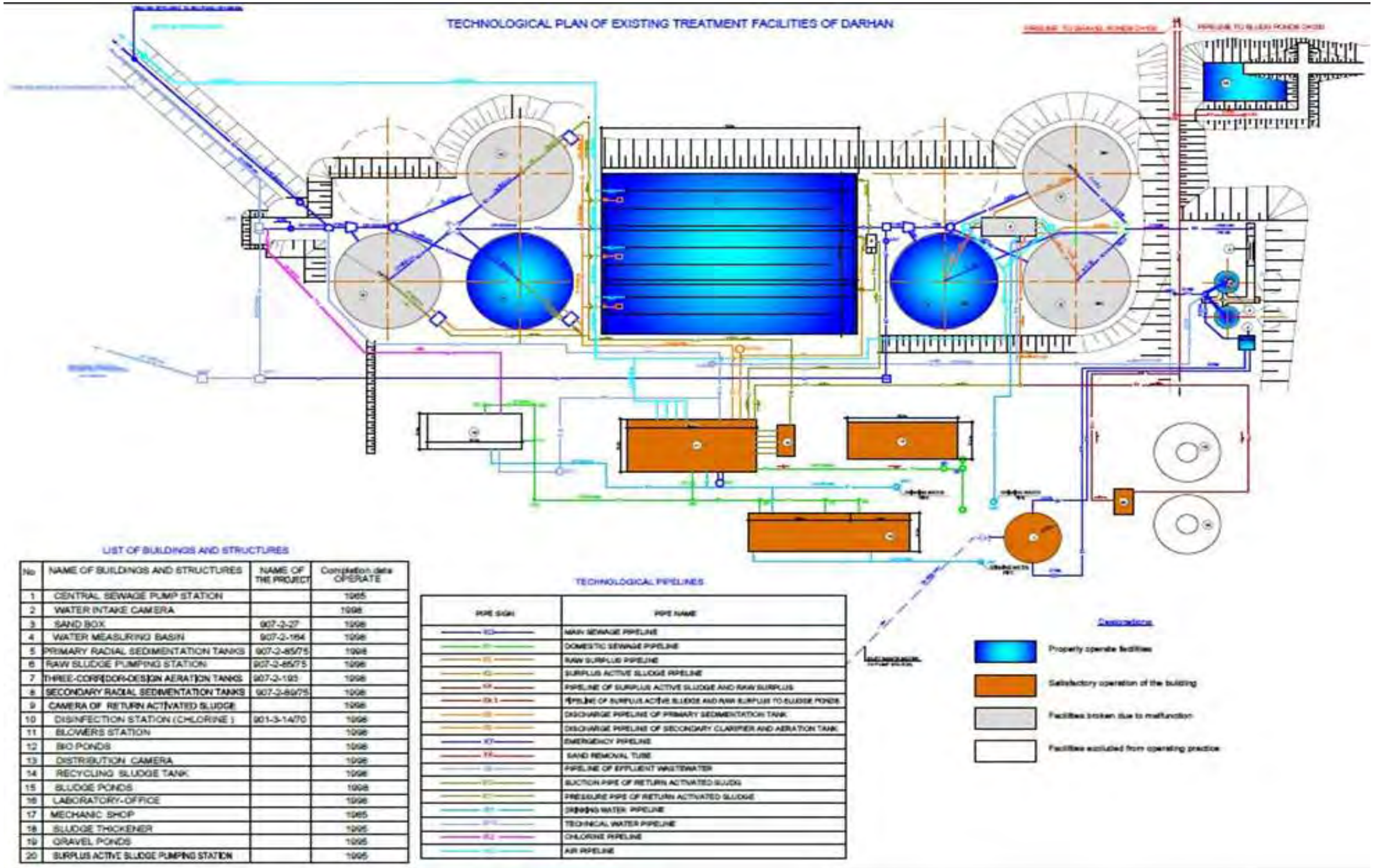
29 The Meteorological Office[11] of Darkhan-Uul *aimag* is responsible for monitoring the performance of treatment plants in the *aimag*, and the Darkhan WWTP is one of four plants operating within the aimag which are monitored for compliance with national effluent discharge standards. The results from sampling at the points of discharge from the treatment plants to the Kharaa River carried out in the summer of 2013 are shown in Table A1.3. This reveals that despite its operational problems, the Darkhan WWTP delivers an effluent which satisfies the effluent discharge standards on 80% of occasions. In doing so, it performs better than the other wastewater treatment plants in the *aimag*.

Table A1.3: Darkhan-Uul aimag WWTP discharge against quality standard

Wastewater Treatment Plant Location	Approximate Distance from Darkhan city (km)	% of effluent samples meeting Standard for wastewater discharge to water bodies (MNS 4943:2011)
Darkhan WWTP	-	80.0
Khongor Soum WWTP	25 km	36.9
Salkhit WWTP	35 km	42.9
Sharin Gol WWTP	47 km	70.4

[11] Source: Darkhan Meteorological Office Data available on http://www.icc.mn/aimag/Darkhan/

Figure A1.4: Existing Wastewater Treatment Plant (Units shown in blue are currently operational)



LIST OF BUILDINGS AND STRUCTURES

No	NAME OF BUILDINGS AND STRUCTURES	NAME OF THE PROJECT	Completion date OPERATE
1	CENTRAL SEWAGE PUMP STATION		1965
2	WATER INTAKE CAMERA		1998
3	SAND BOX	907-2-27	1998
4	WATER MEASURING BASIN	907-2-164	1998
5	PRIMARY RADIAL SEDIMENTATION TANKS	907-2-85/75	1998
6	RAW SLUDGE PUMPING STATION	907-2-85/75	1998
7	THREE-CORRIDOR-DESIGN AERATION TANKS	907-2-193	1998
8	SECONDARY RADIAL SEDIMENTATION TANKS	907-2-89/75	1998
9	CAMERA OF RETURN ACTIVATED SLUDGE		1998
10	DISINFECTION STATION (CHLORINE)	901-3-14/70	1998
11	BLOWERS STATION		1998
12	BIO PONDS		1998
13	DISTRIBUTION CAMERA		1998
14	RECYCLING SLUDGE TANK		1998
15	SLUDGE PONDS		1998
16	LABORATORY-OFFICE		1998
17	MECHANIC SHOP		1965
18	SLUDGE THICKENER		1995
19	GRAVEL PONDS		1995
20	SURPLUS ACTIVE SLUDGE PUMPING STATION		1995

TECHNOLOGICAL PIPELINES

PIPE SIGN	PIPE NAME
	MAIN SEWAGE PIPELINE
	DOMESTIC SEWAGE PIPELINE
	RAW SURPLUS PIPELINE
	SURPLUS ACTIVE SLUDGE PIPELINE
	PIPELINE OF SURPLUS ACTIVE SLUDGE AND RAW SURPLUS
	PIPELINE OF SURPLUS ACTIVE SLUDGE AND RAW SURPLUS TO SLUDGE PONDS
	DISCHARGE PIPELINE OF PRIMARY SEDIMENTATION TANK
	DISCHARGE PIPELINE OF SECONDARY CLARIFIER AND AERATION TANK
	EMERGENCY PIPELINE
	SAND REMOVAL TUBE
	PIPELINE OF EFFLUENT WASTEWATER
	SUCTION PIPE OF RETURN ACTIVATED SLUDG
	PRESSURE PIPE OF RETURN ACTIVATED SLUDGE
	DRINKING WATER PIPELINE
	TECHNICAL WATER PIPELINE
	CHLORINE PIPELINE
	AIR PIPELINE

(B) Water demand and wastewater flow projections

Water demand projections

30 The most recent work on water consumption in Darkhan[12] indicates that water consumption per capita among those with a household connection, based on raw water actually supplied, is of the order of 175 litres/capita/day. This is quite a high figure, but includes the approximately 40 per cent which is lost through system leakage. Figures for actual household consumption, which would dictate wastewater flows, are more modest, at an average daily cold water consumption of about 125 l/cap, which, with the addition in winter of the average daily warm water consumption of 40 l/cap provides a winter total of 165 litres/cap/day (gross of about of 215 litres/cap/day). One important feature of the water supply system which impacts on the wastewater volumes arriving for treatment at the WWTP, is that the source of the heated water consumed in apartments is not the Us Suvag supply system, it is the technical water extracted by the thermal power plant.

31 The 125 litres/capita/day is an average consumption figure based on analysis of both domestic and commercial users. Based on 2013 billing figures, the 11,000 household connections used an average of about 6.5 m^3/month – equivalent to about 60 litres/capita/day. In addition, the 2,000 commercial users consume an average of about 50 m^3/month, equivalent in per capita terms to about 70 litres per day. These combined provide the actual cold water per capita consumption estimate of 125 litres per day.

32 Water consumption to the industrial area is currently measured at about 3,000 m^3/day[13], with the majority of this consumed in industrial processes rather than for domestic use. There are some contradictions in the figures for industrial wastewater volumes generated, with figures provided by each industry failing to match with the much higher volumes pumped from Pump Station No. 1. In addition, future industrial demand for water is difficult to predict in the absence of clear indications of industrial development in the short-medium or long-term. However, recent trends in water supply requirements have been used to generate future projections.

33 For the *ger* areas, water supply requirements are only a fraction of the total, and this is unlikely to change dramatically. However additional projections have been made to show the likely impact on demand if water supply mains were to be progressively introduced to households in the *ger* areas.

34 Water supply projections presented in Table A1.4 are based on the above assumptions and on population growth projections of 1.5-2.0 percent per year for the period 2015-2040.[14] Further assumptions made are:

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[12] Source: Milojevic, Nikola, Klaus-Jochen Sympher, Matthias Schütz, and Martin Wolf, MoMo Technical Report No 6 Integrated Wastewater Management in Central Asia – MoMo Model Region, 2011.

[13] This excludes an estimated 8,000 cum/day of technical and make-up water used by the thermal power plant which is drawn from its own wells and does not enter the wastewater system.

[14] Based on Government's commitment to invest in the city, it is assumed that Darkhan will grow at slightly above this urban growth rate average (at 2% per annum) over the period 2015 to 2020 (moderated by the continuing more rapid growth of Ulaanbaatar and urban areas close to mining operations).In the medium-term, there could be a significant impact on population from the development of additional industries as currently proposed for Darkhan by the Government of Mongolia. It is assumed that over time, at least some of the industrial development currently planned will be established in Darkhan. However, in the absence of either confirmed funding or firm proposals at present, it is unlikely than any impact would be felt on the population for at least the next few years. In addition, the pull factors of Ulaanbaatar and mining towns will continue to exert out-migration pressure on Darkhan's workforce. Despite these pressures, population increase through natural growth and some in-migration could be expected during both the construction and operational phases for these new industrial facilities. Indications are that once operational, the additional work force would be of the order of 2,000 to 3,000, resulting in an overall population increase of perhaps 10,000 to 12,000. This would occur over several years, but it is assumed that this would mean the growth rate in Darkhan continuing at a rate slightly above the

a. Through improvements to the water supply distribution network currently being made, and through likely future management and network improvements, there will be a progressive reduction in the currently high rate of system losses. Over the next 26 years to 2040, losses are predicted to fall from the current 40% to 28%.

b. There will be a modest increase in the actual water consumption per capita by consumers served with household supplies from about 125 l/c/d in 2012 to 150 l/c/d by year 2040. This reflects a progressive increase in wealth and thus use of more water-consuming appliances, moderated by the downward pressure on consumption introduced through a continued progressive increase in tariff. This would mean that the per capita consumption in Darkhan would remain below current levels of consumption in Ulaanbaatar.

c. In ger areas there will be a moderate increase in per capita consumption only. This reflects the continuation of water supply via kiosks in view of the impracticality of the introduction of mains water supply to ger households.

d. There will continue to be a progressive rise in the "floating population" of Darkhan which is currently considered to contribute about 5,000 population equivalents (PE) of demand.

35 Table A1.4 below shows projected water consumption and demand for Darkhan city based on the assumptions outlined above. This shows water demand more than doubling between 2012 and 2040. However, it should be noted that the capacity of the existing well fields supplying raw water to Darkhan are 70,000 m^3/day – more than double this projected demand. It can be thus assumed that the 70,000 m3/day represents a sustainable yield from the well field, since this is the Water Authority-approved reserve estimation for the source.

Table A1.4: Water Demand Projections for Darkhan City for period 2015 to 2040

Year	2012	2013	2015	2020	2025	2030	2035	2040
Darkhan soum	**80,418**	**81,345**	**82,995**	**91,258**	**100,370**	**110,418**	**118,690**	**127,594**
Core Area	52,272	52,874	54,777	63,881	73,270	83,918	93,765	104,627
Ger Area	28,146	28,471	28,218	27,377	27,100	26,500	24,925	22,967
Water Supply Projections								
Core Residential Area								
Net Per capita consumption l/c/d	125	125	128	134	141	148	150	150
Losses % of extracted	0.40	0.40	0.38	0.36	0.34	0.32	0.30	0.28
Total Per capita consumption l/c/d	175	175	176	182	188	195	195	192
Total Demand (cum/day)	9,148	9,253	9,638	11,631	13,801	16,350	18,284	20,088
Industrial Area								
Total Demand (cum/day)	3,000	3,000	3,300	3,960	4,752	5,702	6,843	8,211
Ger Areas								
Per capita consumption l/c/d	15	15	16	17	18	19	20	21
Total Demand cum/day	422	427	444	474	493	506	500	484
Grand total demand (cum/day)	**12,570**	**12,680**	**13,382**	**16,065**	**19,046**	**22,558**	**25,627**	**28,783**

Source: PPTA Draft Final Report, April 2014

current average urban growth rate of 1.9%. An annual rate at 2% per annum has been assumed between 2020 and 2030, adding a population of about 20,000 to the city over that period. After this period of sustained high growth, it is assumed that the rate would decline, but remain relatively high at 1.5% for 2030 to 2035 and the same from 2035 to 2040.

36 To determine the impact on demand of mains water supply and household connections being progressively introduced to the ger areas, the projections were run with a progressive increase in numbers of ger area households connected so that by 2040 ger area residents are consuming about the same volumes of water as apartment residents. This exercise is undertaken to show the likely impact of this assumption on water demand. As shown in Table A1.5, the impact on overall demand would be relatively minor, with the demand in 2040 about 10 per cent higher than it would be with all ger residents continuing to use water kiosk supplies.

Table A1.5: Water Demand Projections Where Ger Residents Obtain Household Connections

Year	2012	2013	2015	2020	2025	2030	2035	2040
Darkhan soum	**80,418**	**81,345**	**82,995**	**91,258**	**100,370**	**110,418**	**118,690**	**127,594**
Core Area	52,272	52,874	54,777	63,881	73,270	83,918	93,765	104,627
Ger Area	28,146	28,471	28,218	27,377	27,100	26,500	24,925	22,967
Water Supply Projections								
Core Residential Area								
Net Per capita consumption	125	125	128	134	141	148	150	150
Losses	0.40	0.40	0.38	0.36	0.34	0.32	0.30	0.28
Total Per capita consumption	175	175	176	182	188	195	195	192
Total Demand (Cum/day)	9,148	9,253	9,638	11,631	13,801	16,350	18,284	20,088
Industrial Area								
Total Demand (Cum/day)	3,000	3,000	3,300	3,960	4,752	5,702	6,843	8,211
Ger Areas								
Per capita consumption l/c/d	15	15	28	41	56	72	99	125
Total Demand cum/day	422	427	779	1127	1,513	1,898	2,468	2,866
Grand total demand (cum/day)	**12,570**	**12,680**	**13,717**	**16,718**	**20,066**	**23,950**	**27,595**	**31,166**

Source: PPTA Draft Final Report, April 2014

Wastewater Flow Projections

37 The current wastewater flow is made up of contributions from the core residential areas of New Darkhan and Old Darkhan, the industrial areas around the treatment plant to the north of Old Darkhan, and the Industrial Estate to the south. There is no wastewater flow contribution from the ger areas. Wastewater inflow to the plant varies considerably by day and by season, due to variable flows from industry and increases once the hot water system is made operational. However, projections have been made based on the water supply projections presented above and on the following assumptions:

a. The proportion of water delivered by Us Suvag and consumed in apartments and homes within the serviced core area which enters the sewerage system is 80%, and will remain at this level in the future. This is consistent with international comparators for communities in similar socio-economic conditions to those observed in Darkhan;

b. The hot water provided from the thermal power plant during winter and used in apartments and homes in the serviced area will remain at the current levels of 40 l/c/d actually consumed, and the proportion of this hot water delivered to the sewer network is assumed at 75% of that consumed. This will remain the same over the projection period;

c. Industrial wastewater flows are assumed to increase at an average rate of about 3% per annum over the period 2013 to 2040. This is the area for which it is most difficult to make reliable projections, and the 2.7-fold increase over this period is somewhat higher than that projected by the *MoMo* project which predicts a doubling of industrial water demand and wastewater flows for the Darkhan region over the same period[15];

d. The current level of exfiltration losses from the sewer network are assumed at 15%. This is in accordance with the figures observed under the MoMo project[16] at the lower end of the scale. It is assumed that the amount of exfiltration will reduce over time as those sections of the sewer network which are most in need of rehabilitation or replacement are repaired or replaced. This will result in a progressive reduction in exfiltration from an average of 15% in 2015 to 10% in 2040.

38 Based on the foregoing assumptions, the projected wastewater flows for winter conditions in Darkhan (when the hot water system is on) is as follows in Table A1.6. Summer flows will be reduced by about 10% to account for the absence of the hot water contribution, although this is partially compensated for by additional cold water use.

Table A1.6: Wastewater Flow Projections for Darkhan City (m^3/d)

Year	2012	2013	2015	2020	2025	2030	2035	2040
Wasewater Projections cum/day								
From core residential area	5,227	5,287	5,587	6,842	8,240	9,909	11,252	12,555
Additional from hot water	1,464	1,480	1,534	1,789	2,052	2,350	2,625	2,930
From Industrial Area	3,105	3,105	3,416	4,099	4,918	5,902	7,082	8,499
Exfiltration	- 1,469	- 1,481	- 1,580	- 1,782	- 1,977	- 2,179	- 2,306	- 2,398
Total Wastewater Flow cum/day	**8,326**	**8,392**	**8,956**	**10,947**	**13,232**	**15,981**	**18,654**	**21,585**

Source: PPTA Draft Final Report, April 2014

39 While arrived at using a quite different methodology, the 2040 projected wastewater flow figure of about 21,500 m^3/day agrees quite closely with the design figure provided by the *MoMo* project for Darkhan. Using a design year of 2042 and a predicted effective population equivalent (PE) of 80,000 at an average contribution rate of just over 250 litres/capita per day, their average design flow is 21,200 m^3/day. The *MoMo* report makes the point – which should be reiterated here – that these projections are the best possible with the information available, but that system flexibility is important as there is a high degree of uncertainty in the projections.

40 It is considered highly improbable that the ger areas will ever be fully connected to the sewerage network. However to provide an indication of the possible impact on wastewater flows of sewer connections being extended into the ger areas, projections have been made on the basis that there would be a progressive and accelerating rate of connections – in sequence with the increase in water use as a result of the introduction of mains water supply connections as presented in Table A1.5 above. The resulting projections are shown in Table A1.7 below. As in the case of water supply projections, the impact is minimal in the short- to medium-term, but by 2040 when the ger areas would be fully sewered, the increase in wastewater flows would be of the order of 10% of total.

[15] MoMo Integrated Water Resource Management for Central Asia Model Region for Mongolia, Final Project Report, Ulaanbaatar September 2009,

[16] Source: Milojevic, Nikola, Klaus-Jochen Sympher, Matthias Schütz, and Martin Wolf, MoMo Technical Report No 6 Integrated Wastewater Management in Central Asia – MoMo Model Region, 2011.

Table A1.7: Wastewater Projections Where Ger Residents Obtain Household Sewer Connections

Year	2012	2013	2015	2020	2025	2030	2035	2040
Wasewater Projections cum/day								
From core residential area	5,227	5,287	5,587	6,842	8,240	9,909	11,252	12,555
Additional from hot water	1,464	1,480	1,534	1,789	2,052	2,350	2,625	2,930
From Ger Areas	-	-	234	451	756	1,139	1,727	2,293
From Industrial Area	3,105	3,105	3,416	4,099	4,918	5,902	7,082	8,499
Exfiltration	- 1,469	- 1,481	- 1,580	- 1,782	- 1,977	- 2,179	- 2,306	- 2,398
Total Wastewater Flow cum/day	**8,326**	**8,392**	**9,190**	**11,398**	**13,989**	**17,120**	**20,381**	**23,878**

Source: PPTA Draft Final Report, April 2014

Appendix 2: Treatment Plant Reconstruction Sequencing and Design Layout

1. The technical option recommended by the Consultants and agreed by the State and aimag Governments and ADB is the reconstruction and modification of elements of the existing wastewater treatment plant and its reconfiguration as an Integrated Fixed-film Activate Sludge (IFAS) system.

2. The current wastewater treatment plant adopts a conventional activated sludge process arrangement (see figure A2.1). Although due to the low flow-rate (averaging 10,000 cum/day as opposed to the design flow-rate of 50,000 cum/day) only one each of the three primary and secondary clarifiers is operated. However, the entire activated sludge bio-reactor is used, providing a retention time in the aeration basin in excess of one day. The proposal is to:

- i) Rehabilitate the existing pump station, inlet works, sand and gravel traps, and replace the associated pumping equipment;
- ii) Convert one of the primary clarifiers which is currently idle into a balancing tank equipped with sludge mixing equipment;
- iii) Convert one of the three aeration tanks into an integrated fixed-film activated sludge process reactor comprising three parallel streams each with three chambers representing different treatment zones. This would include provision of new blowers, pumps, fixed-film plastic media etc;
- iv) Convert one of the secondary clarifiers which is currently idle into a sludge thickening tank with associated sludge pumping equipment;
- v) Rehabilitate treatment buildings and install a sludge coagulation unit and a sludge dewatering press;
- vi) Provide ultra-violet light disinfection equipment;
- vii) Rehabilitate and equip laboratory and offices; and
- viii) Rehabilitate and prepare sludge drying beds and maturation ponds.

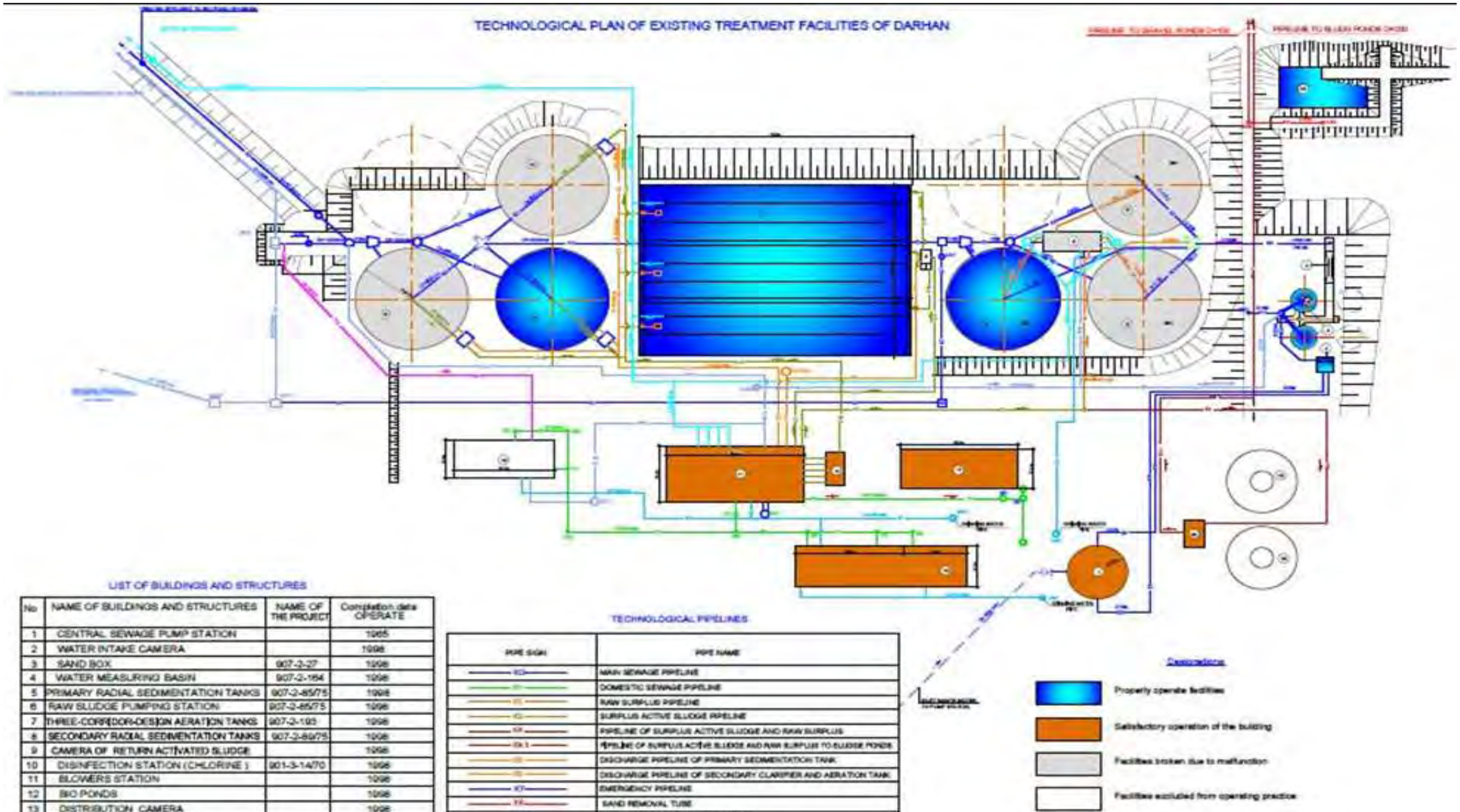
3. The arrangement during plant reconstruction, and following completion of the rehabilitation works, is shown in figures A2.2 and A2.3 respectively, and the details of plant operation and configuration are shown in figures A2.4 to A2.6.

4. The existing plant will continue to be operated during the construction period. Construction works will be carried out in sequence, involving the following steps:

- i) Preparation of site road (on the northern side of the existing plant) and preparation of lay-down area. Plant continues under normal operation (as shown in figure A2.7);
- ii) Rehabilitation and equipping of primary clarifier unit 3 as a balancing tank, and secondary clarifier unit 9 as a sludge thickening tank (in figure A2.8);
- iii) Section 6 of biological reactor closed in preparation for rehabilitation, system continues to operate with primary clarifier unit 2 and secondary clarifier unit 7, and with sections 4 and 5 of the biological reactor (in figure A2.8);
- iv) Work starts on structural rehabilitation of reactor section No. 6 to accommodate three IFAS streams, and section 5 of biological reactor is closed for a short period to allow complete rehabilitation of external wall of reactor 6 (see figure A2.9);
- v) Internal construction works on reactor 6 completed and equipment installed (see Figure A2.10);
- vi) Rehabilitation and reconstruction of grit and sand channels and pumps (one stream at a time, plus temporary sand channel arrangement) and pump station and inlet works (one stream at a time) completed, and buildings rehabilitated (see figure A2.11);

vii) The rehabilitated and reconfigured pump station, inlet works, sand and gravel removal units and units 3, 6 and 9 are commissioned, and treatment in new IFAS units commenced allowing treatment in temporary WWTP to be discontinued (see figure A2.12);

viii) Remedial works are carried out on now disused structures as necessary (mothballed for possible future use).



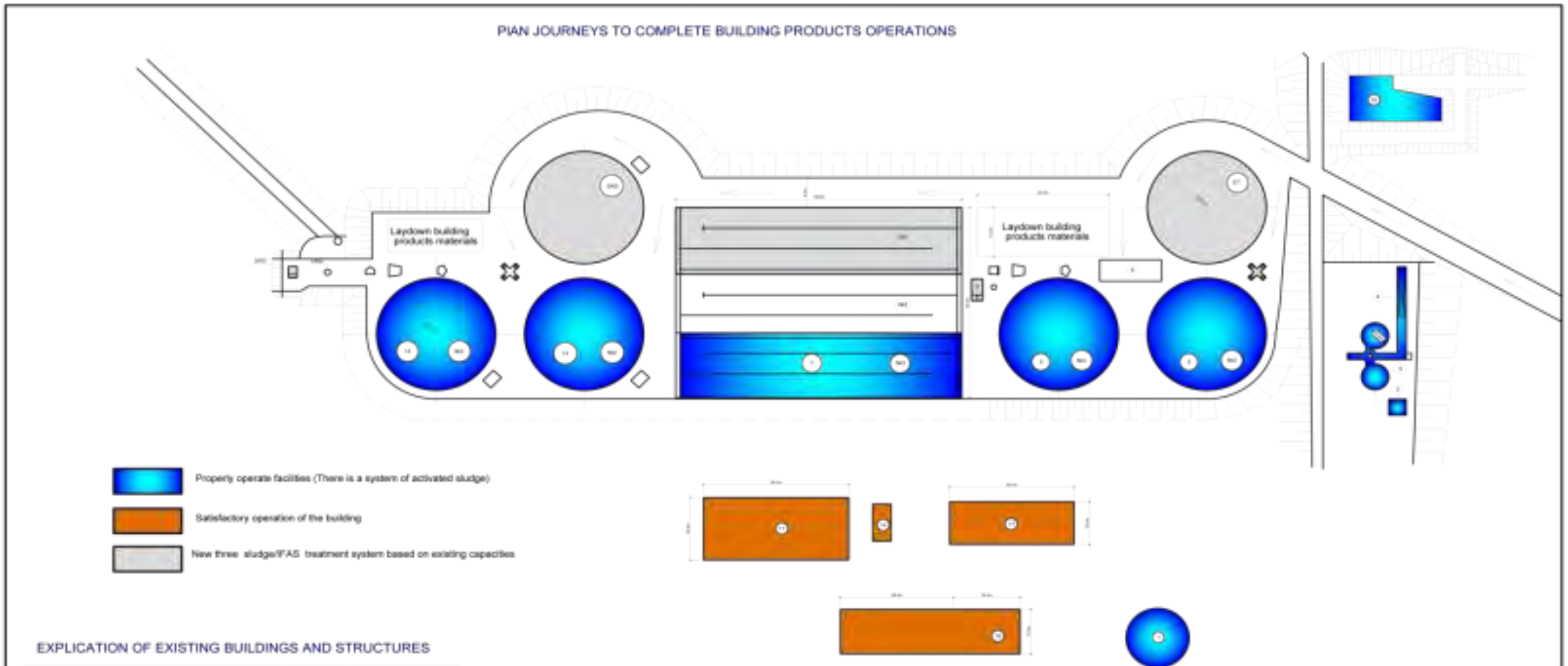
LIST OF BUILDINGS AND STRUCTURES

No	NAME OF BUILDINGS AND STRUCTURES	NAME OF THE PROJECT	Completion data OPERATE
1	CENTRAL SEWAGE PUMP STATION		1965
2	WATER INTAKE CAMERA		1998
3	SAND BOX	907-2-27	1998
4	WATER MEASURING BASIN	907-2-164	1998
5	PRIMARY RADIAL SEDIMENTATION TANKS	907-2-85/75	1998
6	RAW SLUDGE PUMPING STATION	907-2-85/75	1998
7	THREE-CORRIDOR-DESIGN AERATION TANKS	907-2-193	1998
8	SECONDARY RADIAL SEDIMENTATION TANKS	907-2-89/75	1998
9	CAMERA OF RETURN ACTIVATED SLUDGE		1998
10	DISINFECTION STATION (CHLORINE)	901-3-14/70	1998
11	BLOWERS STATION		1998
12	BIO PONDS		1998
13	DISTRIBUTION CAMERA		1998
14	RECYCLING SLUDGE TANK		1998
15	SLUDGE PONDS		1998
16	LABORATORY-OFFICE		1998
17	MECHANIC SHOP		1965
18	SLUDGE THICKENER		1995
19	GRAVEL PONDS		1995
20	SURPLUS ACTIVE SLUDGE PUMPING STATION		1995

TECHNOLOGICAL PIPELINES

PIPE SIGN	PIPE NAME
[illegible]	MAIN SEWAGE PIPELINE
[illegible]	DOMESTIC SEWAGE PIPELINE
[illegible]	RAW SURPLUS PIPELINE
[illegible]	SURPLUS ACTIVE SLUDGE PIPELINE
[illegible]	PIPELINE OF SURPLUS ACTIVE SLUDGE AND RAW SURPLUS
[illegible]	PIPELINE OF SURPLUS ACTIVE SLUDGE AND RAW SURPLUS TO SLUDGE PONDS
[illegible]	DISCHARGE PIPELINE OF PRIMARY SEDIMENTATION TANK
[illegible]	DISCHARGE PIPELINE OF SECONDARY CLARIFIER AND AERATION TANK
[illegible]	EMERGENCY PIPELINE
[illegible]	SAND REMOVAL TUBE
[illegible]	PIPELINE OF EFFLUENT WASTEWATER
[illegible]	SUCTION PIPE OF RETURN ACTIVATED SLUDG
[illegible]	PRESSURE PIPE OF RETURN ACTIVATED SLUDGE
[illegible]	DRINKING WATER PIPELINE
[illegible]	TECHNICAL WATER PIPELINE
[illegible]	CHLORINE PIPELINE
[illegible]	AIR PIPELINE

Figure A2.1: Existing WWTP layout (Operational units in blue)



EXPLICATION OF EXISTING BUILDINGS AND STRUCTURES

No	NAME OF BUILDINGS AND STRUCTURES	NAME OF THE PROJECT	Completion date OPERATE
1	CENTRAL SEWAGE PUMP STATION		1965
2	WATER INTAKE CAMERA		1998
3	SAND BOX	907-2-27	1998
4	WATER MEASURING BASIN	907-2-164	1998
5	PRIMARY RADIAL SEDIMENTATION TANKS	907-2-85/75	1998
6	RAW SLUDGE PUMPING STATION	907-2-85/75	1998
7	THREE-CORRIDOR-DESIGN AERATION TANKS	907-2-193	1998
8	SECONDARY RADIAL SEDIMENTATION TANKS	907-2-89/75	1998
9	CAMERA OF RETURN ACTIVATED SLUDGE		1998
10	DISINFECTION STATION (CHLORINE)	901-3-14/70	1998
11	BLOWERS STATION		1998
12	BIO PONDS		1998
13	DISTRIBUTION CAMERA		1998
14	RECYCLING SLUDGE TANK		1998
15	SLUDGE PONDS		1998
16	LABORATORY-OFFICE		1998
17	MECHANIC SHOP		1965
18	SLUDGE THICKENER		1995
19	GRAVEL PONDS		1995
20	SURPLUS ACTIVE SLUDGE PUMPING STATION		1995

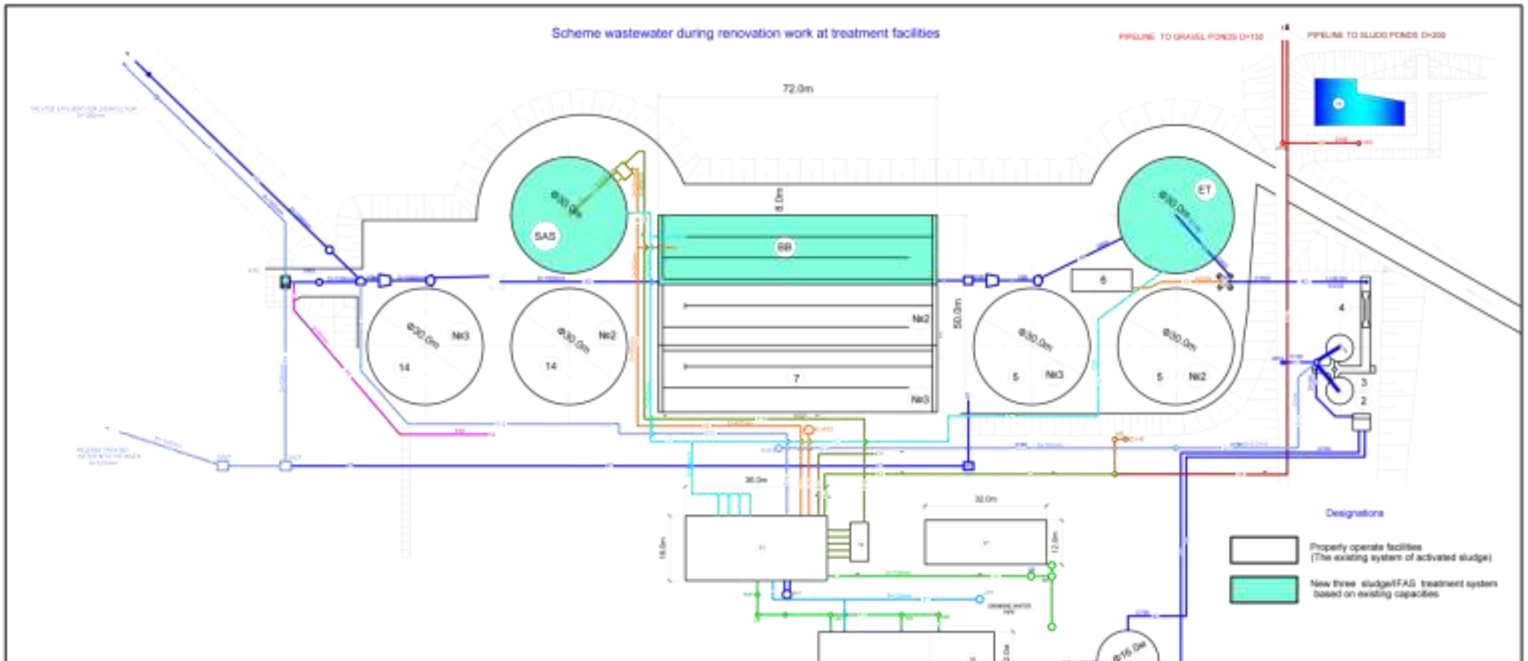
Statement of works on roads for construction work

No	Name of work	unit	number
	I EXCAVATION		
1	Dig the soil with subsequent loading onto a dump truck	m3	7930
2	Transportation ground to a distance of 5 km	m3	7930
3	Embankment fill the vertical planning	m3	7930
4	Disposition of the mound	m2	4354
5	Soil compaction by mechanical means	m3	7930
	II ROADS AND GROUNDS		
1	Device trough h = 0.43 m	m2	2488
2	Fine sand h = 0.10 m	m2	2488
3	Crushed, graded, packed in the same manner wedges h = 0.27 m	m2	2488

EXPLICATION NEW STRUCTURES

Position	Name of new structures	Notes
1	CENTRAL SEWAGE PUMP STATION	Make a major overhaul with the reconstruction of the equipment
2	WATER INTAKE CAMERA	Repair of concrete products
3	SAND BOX	Repair of concrete products and replacement of the pumping system of the pulp
4	WATER MEASURING BASIN	Repair of concrete products and replacement of water meter
ET	EQUALIZATION TANK	On the basis of the radial averager arrange the settler effluent. Repair of concrete products, dismantling of existing equipments installation mixers and submersible pumps.
BB	BLOCK BIOREACTORS (THREE BLOCKS)	Based on one section of the existing aeration arrange block [illegible] sludge system IFAS wastewater treatment. Repair of concrete products, units needed additional partitions
SAS	SLUGDE AEROBIC STABILIZER	Based on the existing secondary clarifier radial stabilizer arrange aerobic activated sludge. Repair of concrete products dismantling equipment and machinery aeration systems

Figure A2.2: WWTP Arrangement During Peak Construction Phase (Operational Units in Blue; Rehabilitated Units in Grey)



EXPLICATION OF EXISTING BUILDINGS AND STRUCTURES

No	NAME OF BUILDINGS AND STRUCTURES	NAME OF THE PROJECT	Completion date OPERATE
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8	SECONDARY RADIAL SEDIMENTATION TANKS	907-2-89/75	1998
9	CAMERA OF RETURN ACTIVATED SLUDGE		1998
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11	BLOWERS STATION		1998
12	BIO PONDS		1998
13	DISTRIBUTION CAMERA		1998
14	RECYCLING SLUDGE TANK		1998
15	SLUDGE PONDS		1998
16	LABORATORY-OFFICE		1998
17	MECHANIC SHOP		1965
18	SLUDGE THICKENER		1965
19	GRAVEL PONDS		1965
20	SURPLUS ACTIVE SLUDGE PUMPING STATION		1965

TECHNOLOGICAL PIPELINES

PIPE SIGN	PIPE NAME
K0	MAIN SEWAGE PIPELINE
K1	DOMESTIC SEWAGE PIPELINE
K2	RAW SURPLUS PIPELINE
K3	SURPLUS ACTIVE SLUDGE PIPELINE
K4	PIPELINE OF SURPLUS ACTIVE SLUDGE AND RAW SURPLUS
K4.1	PIPELINE OF SURPLUS ACTIVE SLUDGE AND RAW SURPLUS TO SLUDGE PONDS
K5	DISCHARGE PIPELINE OF PRIMARY SEDIMENTATION TANK
K6	DISCHARGE PIPELINE OF SECONDARY CLARIFIER AND AERATION TANK
K7	EMERGENCY PIPELINE
K8	SAND REMOVAL TUBE
K9	PIPELINE OF EFFLUENT WASTEWATER
K10	SUCTION PIPE OF RETURN ACTIVATED SLUDG
K11	PRESSURE PIPE OF RETURN ACTIVATED SLUDGE
B1	DRINKING WATER PIPELINE
B10	TECHNICAL WATER PIPELINE
R2	CHLORINE PIPELINE
A0	AIR PIPELINE

EXPLICATION NEW STRUCTURES

Position	Name of new structures	Notes
1	CENTRAL SEWAGE PUMP STATION	Make a major overhaul with the reconstruction of the equipment
2	WATER INTAKE CAMERA	Repair of concrete products
3	SAND BOX	Repair of concrete products and replacement of the pumping system of the pulp
4	WATER MEASURING BASIN	Repair of concrete products and replacement of water meter
ET	EQUALIZATION TANK	On the basis of the radial averager arrange the settler effluent. Repair of concrete products, dismantling of existing equipments installation mixers and submersible pumps.
BB	BLOCK BIOREACTORS (THREE BLOCKS)	Based on one section of the existing aeration arrange block bioreactors for three sludge system / IFAS wastewater treatment. Repair of concrete products, units needed additional partitions
SAS	SLUGDE AEROBIC STABILIZER	Based on the existing secondary clarifier radial stabilizer arrange aerobic activated sludge. Repair of concrete products dismantling equipment and machinery aeration systems

Figure A2.3: WWTP Arrangement Following Completion of Construction Phase and Commissioning (Operational Units in Turquoise)

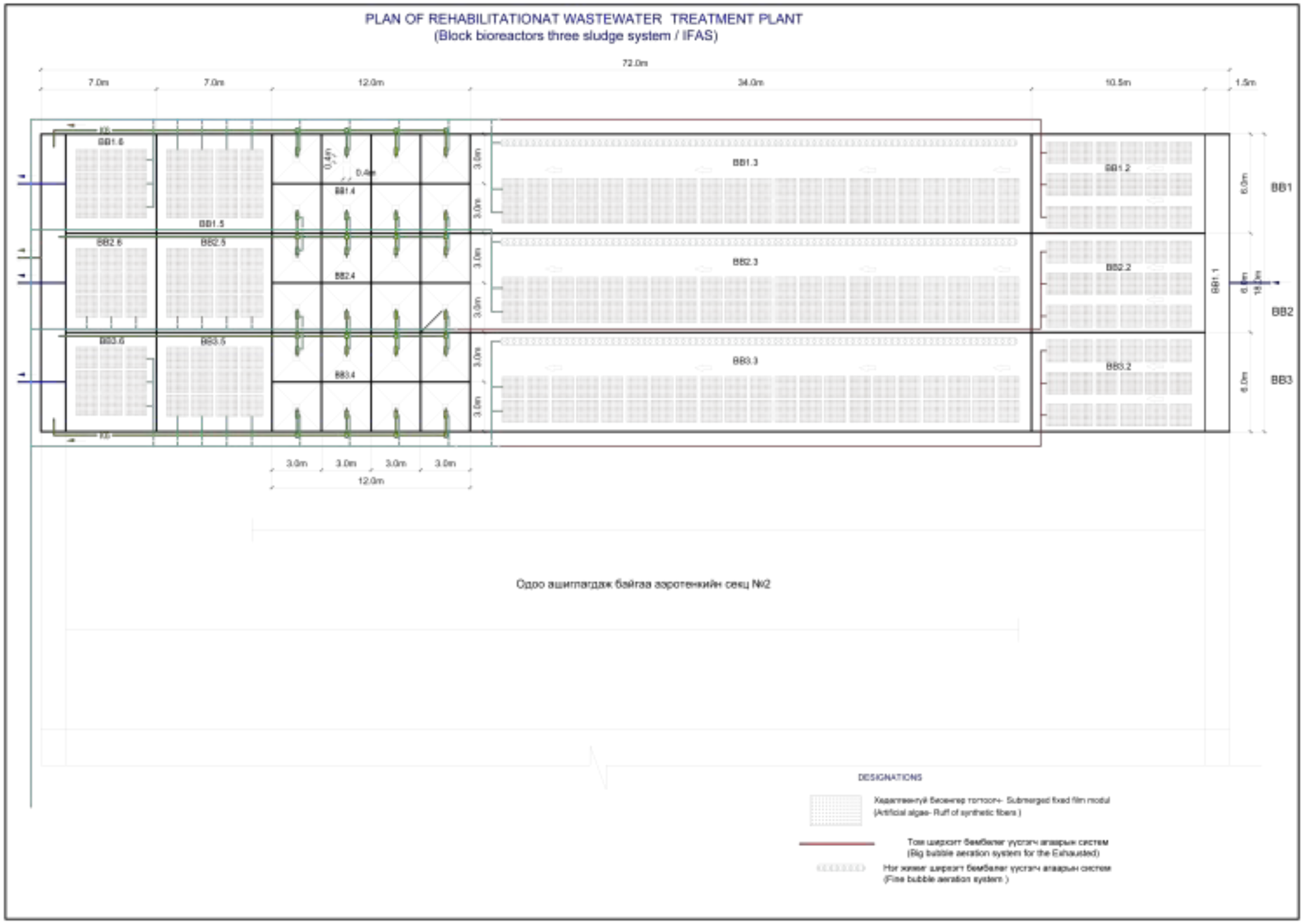

Figure A2.4: IFAS WWTP Arrangement - Two Operational Streams (8,000 cum/day each); One Standby Stream

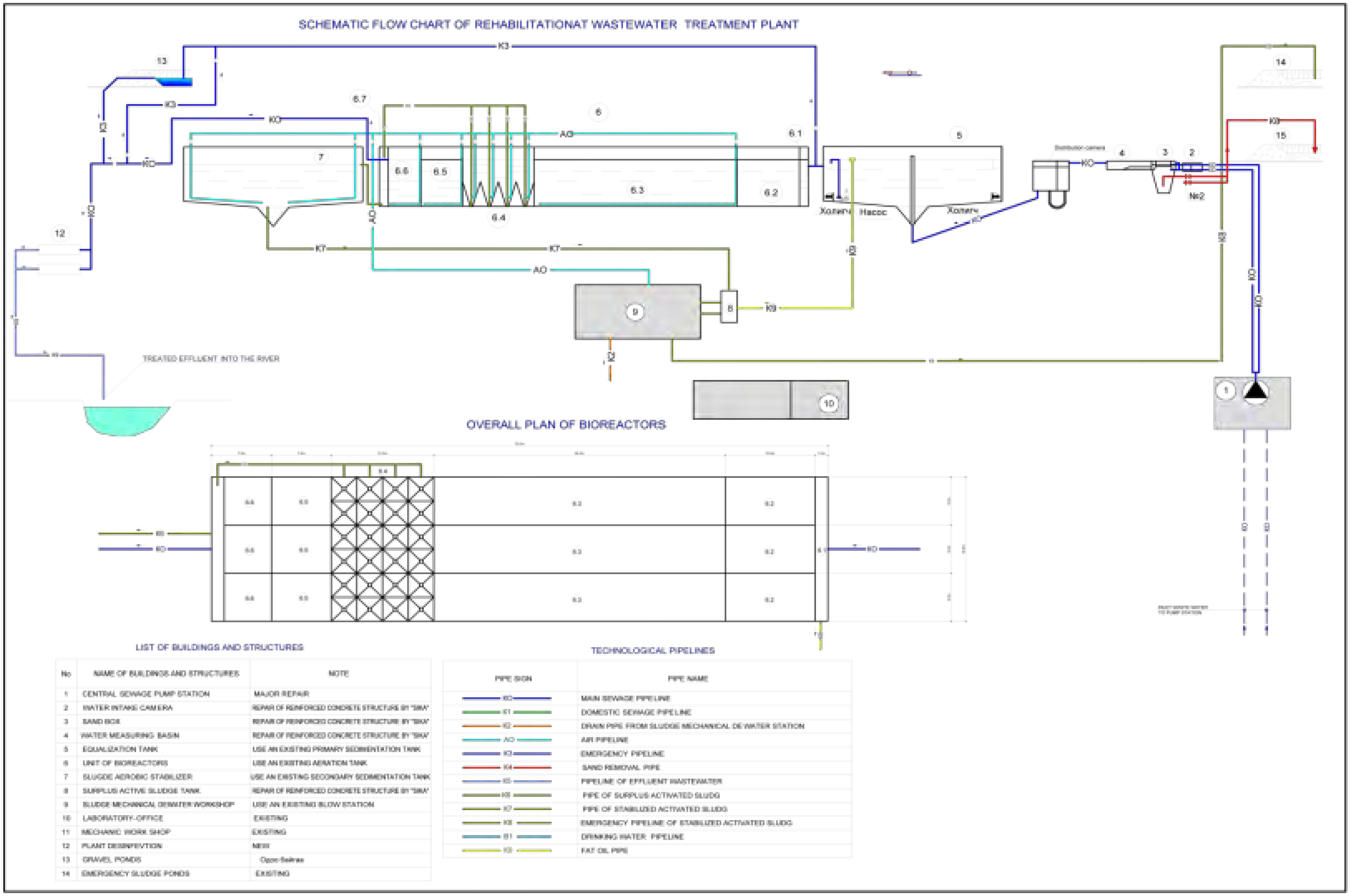

Figure A2.5: IFAS WWTP Arrangement - Schematic Layout

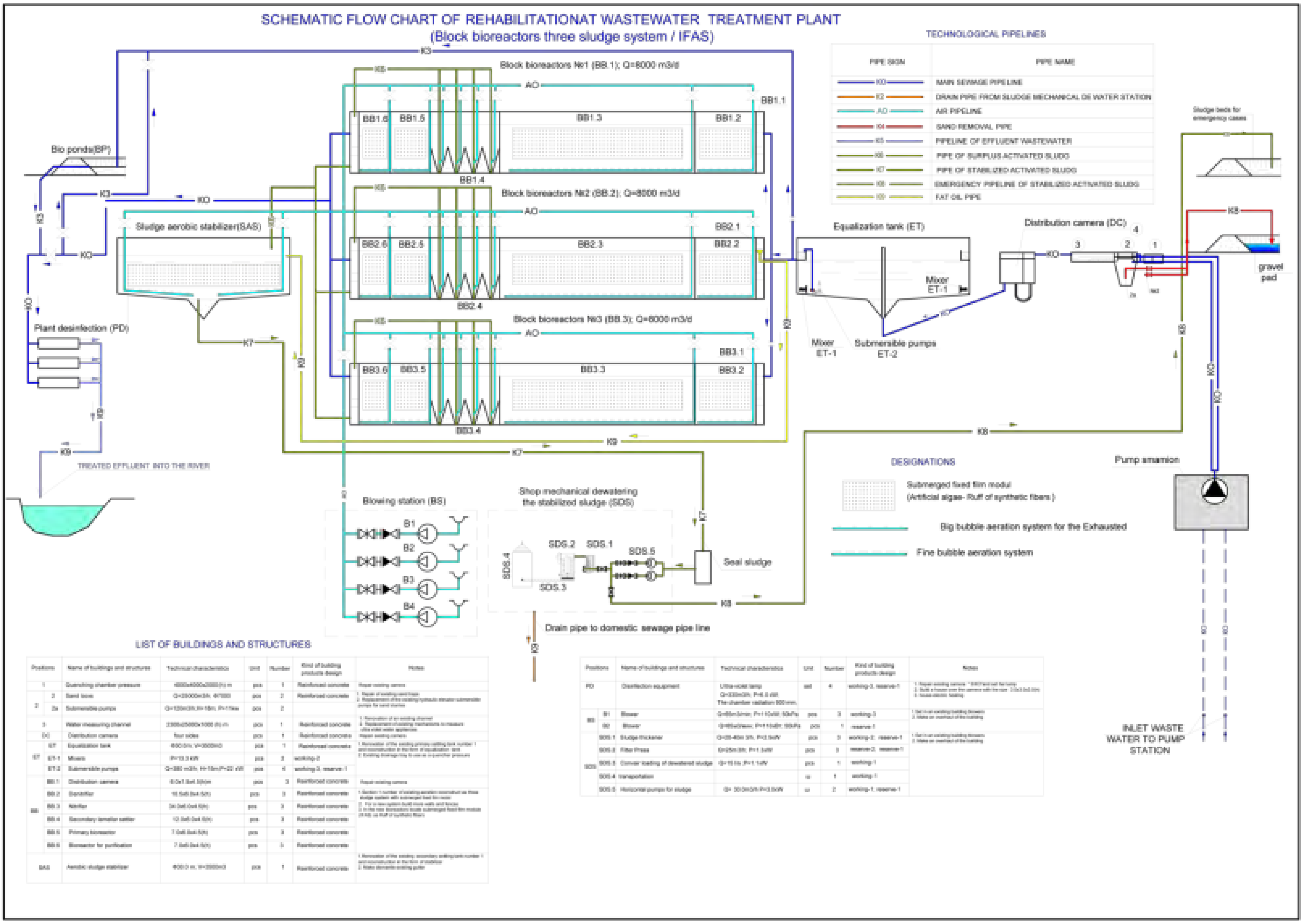

Figure A2.6: IFAS WWTP Arrangement: Schematic Flowchart

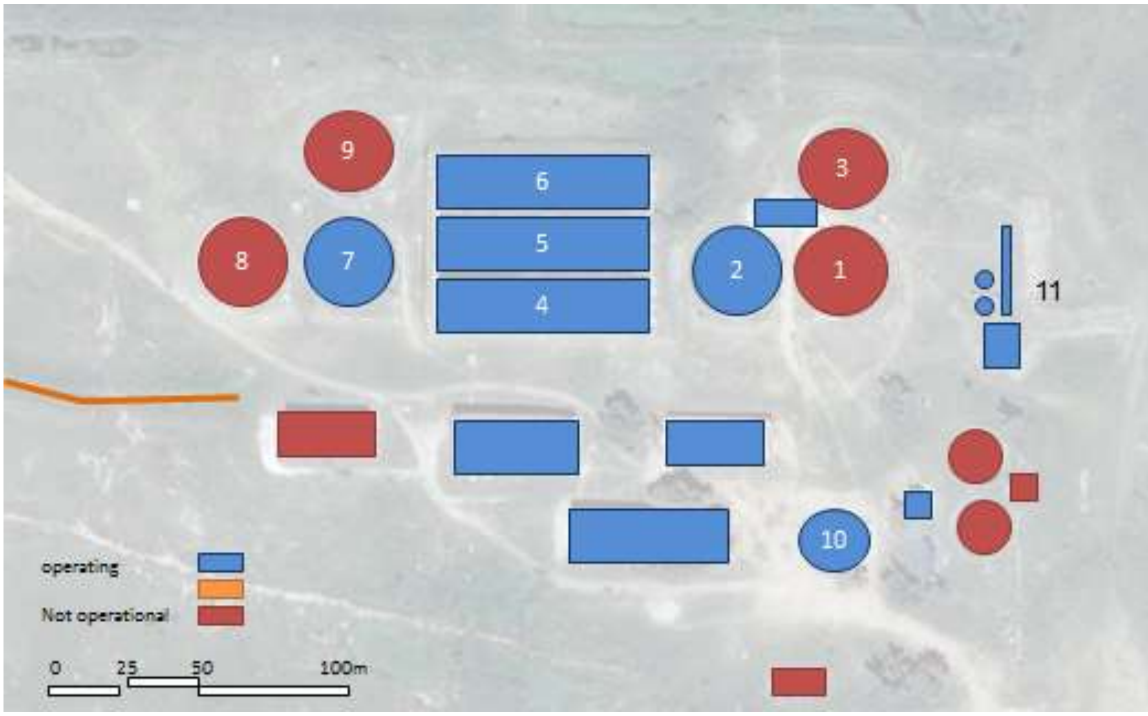

Figure A2.7: Darkhan WWTP – current operation 10, 11, 2, 4, 6 and 7

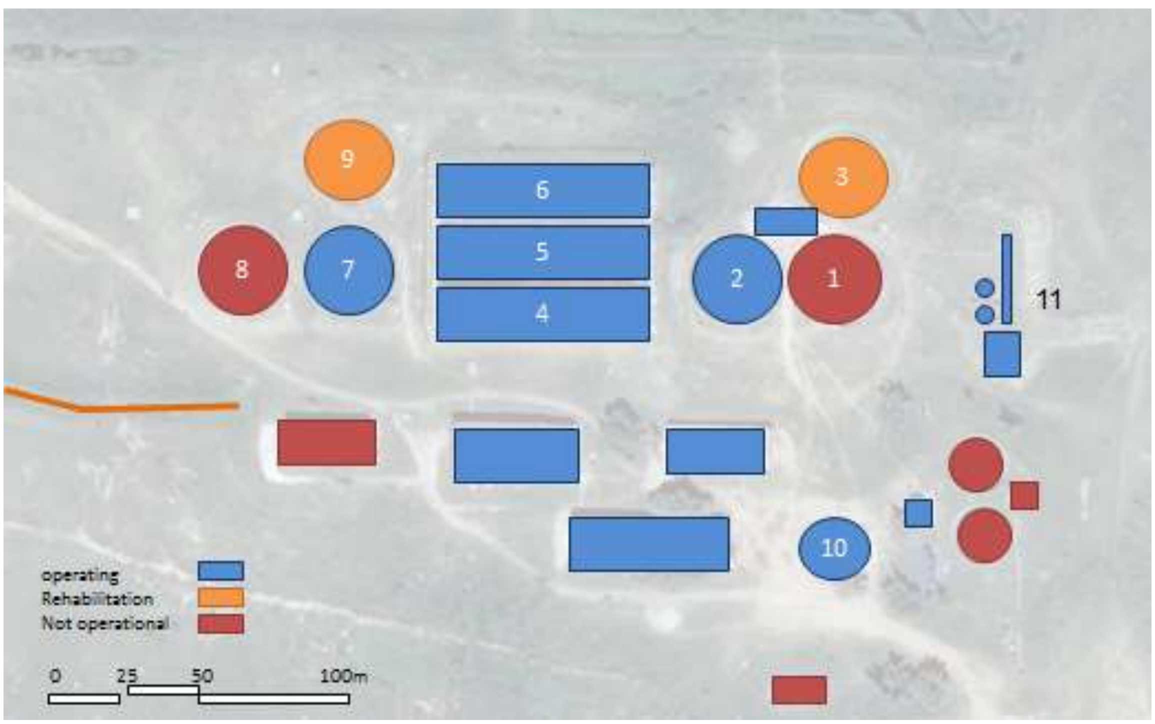

Figure A2.8: Darkhan WWTP – Rehabilitation of clarifiers 3 & 9 commenses

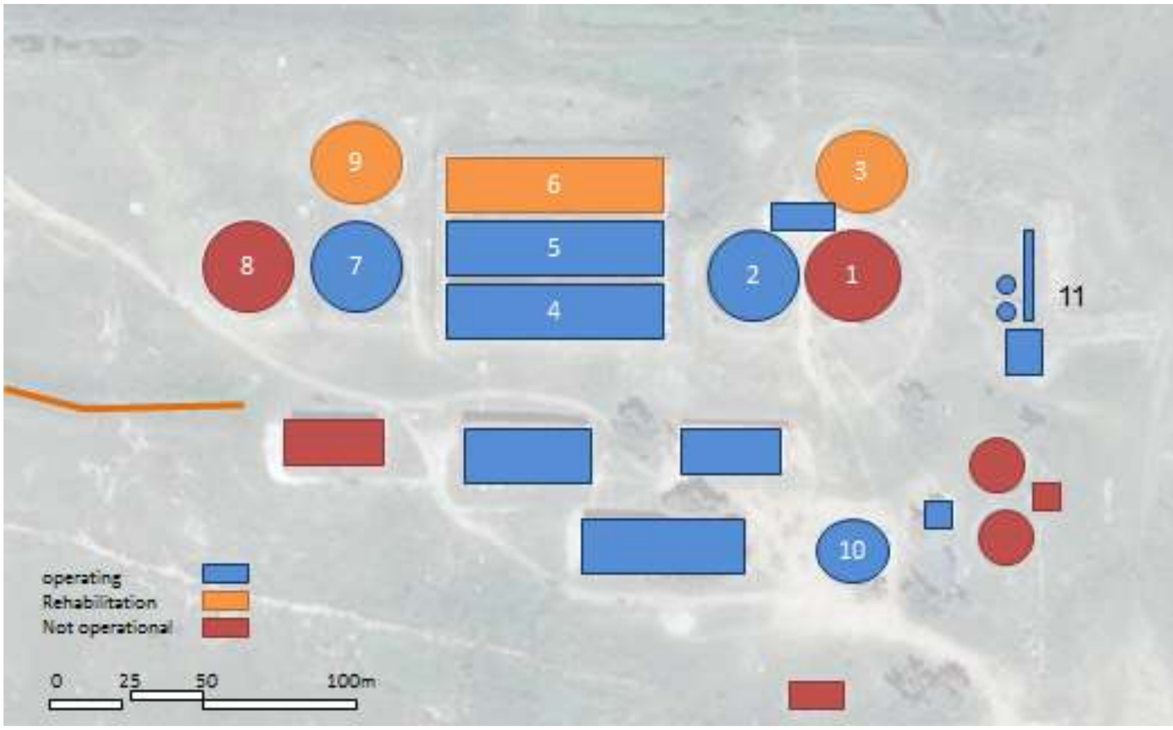

Figure A2.9: Darkhan WWTP – Rehabilitation of clarifiers 3 & 9 and bioreactor 6 emptied

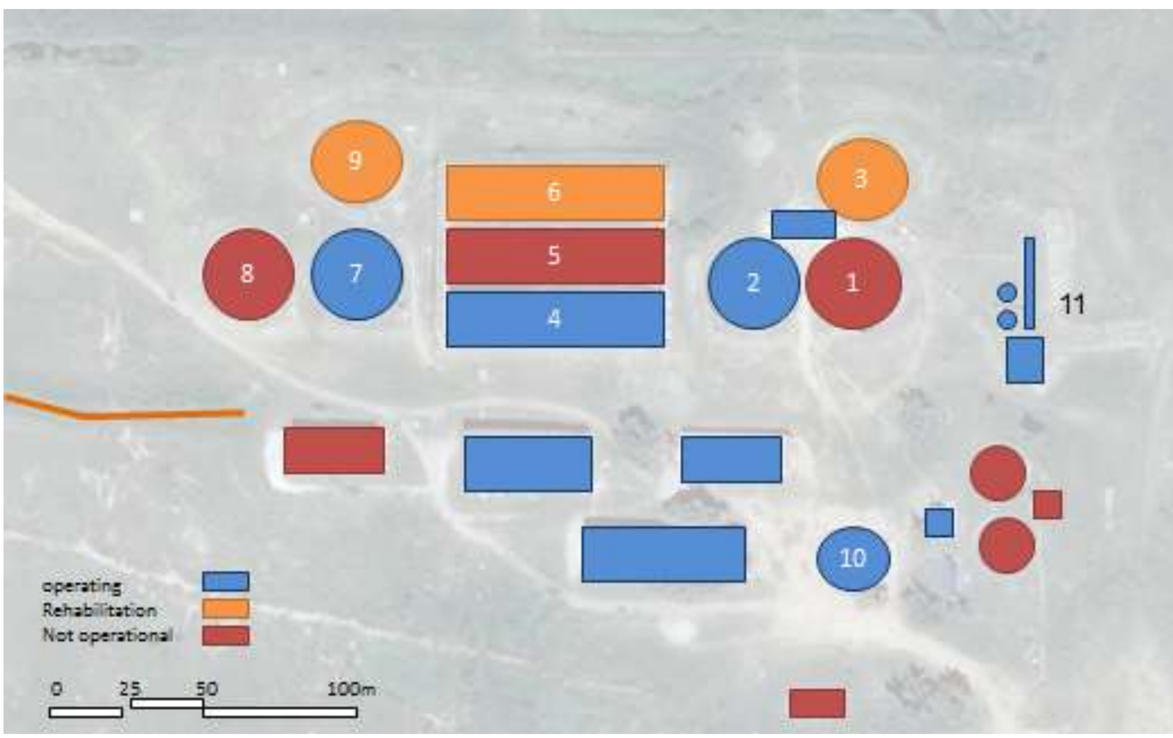

Figure A2.10: Darkhan WWTP – Rehabilitation of Units 3, 6 and 9, and Bioreactor 5 emptied

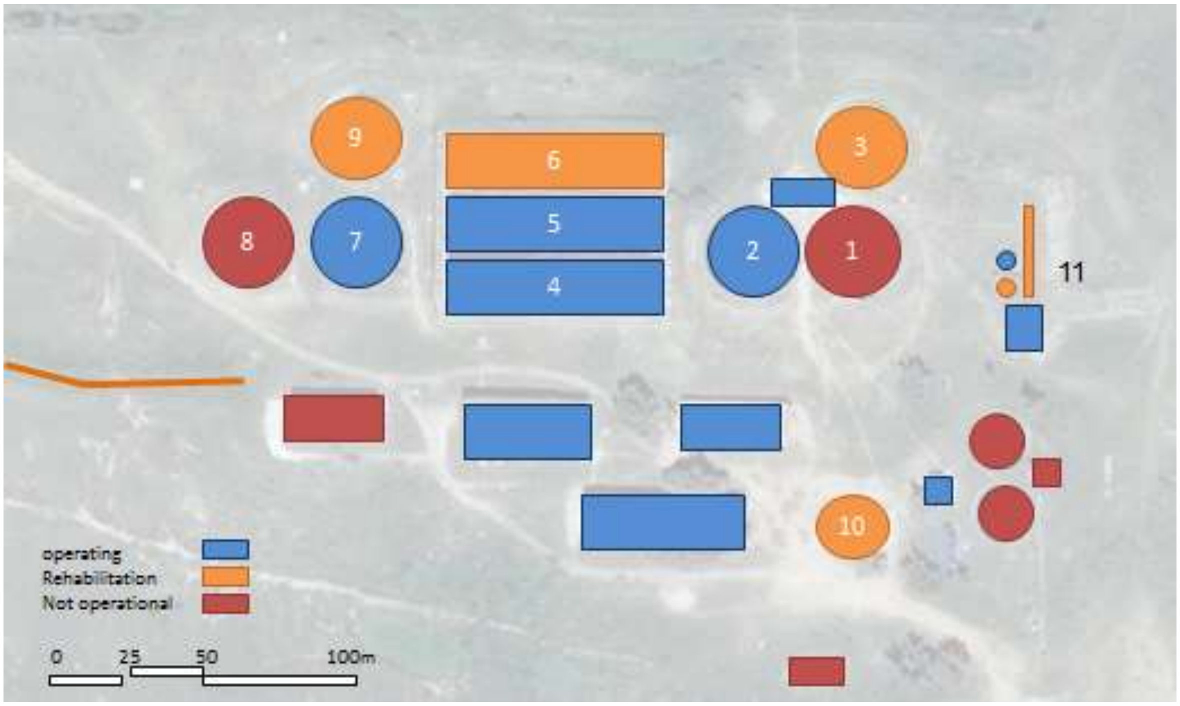

Figure A2.11: Darkhan WWTP – Rehabilitation of Buildings, Pump Station 10 and Preliminary Treatment Units 111; Equipment Installation in Units 3, 6 and 9

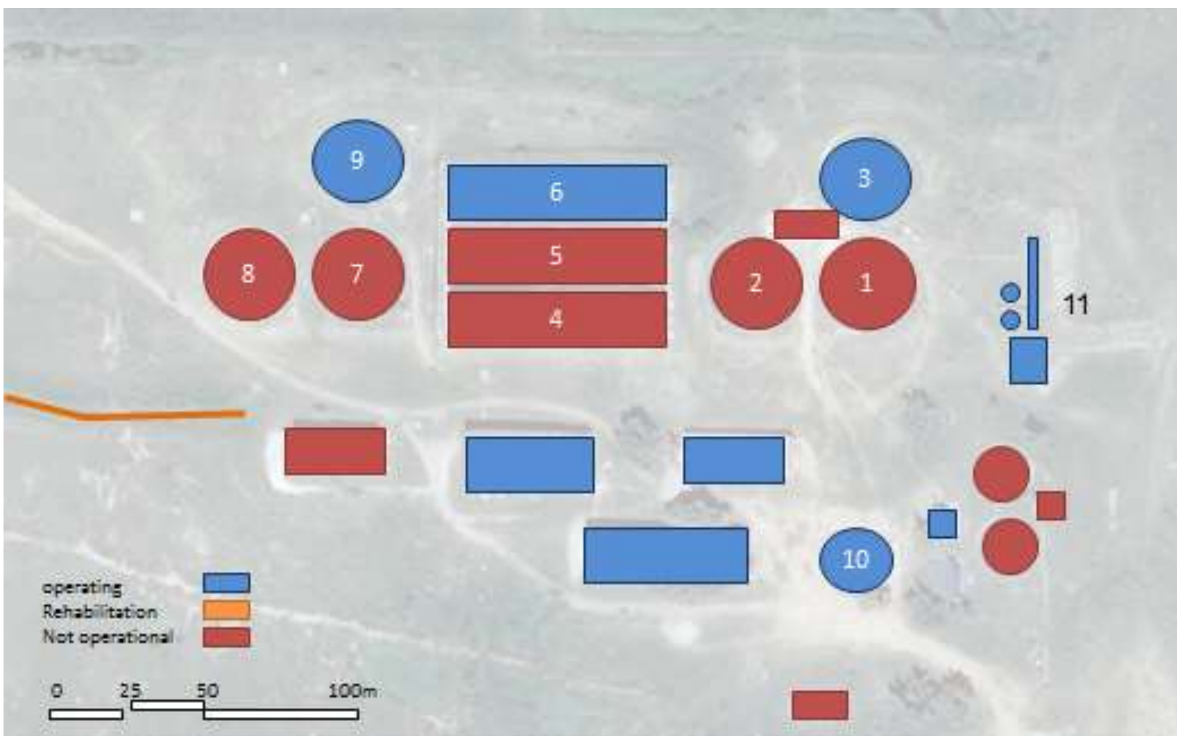

Figure A2.12: Darkhan WWTP – Fully operation IFAS in Units 10, 11, 3, 6 and 9

Figure A2.13: Darkhan WWTP – Existing units with approximate year of construction

APPENDIX 3: AUDIT OF DARKHAN WASTEWATER TREATMENT PLANT

3.1 - AUDIT BY STATE PROFESSIONAL INSPECTION AGENCY FOR EXISTING WWTP (unofficial translation)

01 April 2014 No 06/101/208 Ulaanbaatar city

TO: Housing and Public Utilities Policy Implementation and Coordination Office, MCUD

FROM: State Professional Inspection Agency

SUBJECT: Status of Central Wastewater Treatment Plant Utilization

State Professional Inspection Agency has conducted an audit to seek assessment for the existing wastewater treatment plant operation, equipment and facilities including aeration tanks and reinforcing steel and concrete quality according to the request No 8/760 on 14 March 2014 from Housing and Public Utilities Policy Implementation and Coordination Office, MCUD.

The audit team visited the site accompanied with Enkhtuya. P, Project engineer and Enkhjargal. S, Technology engineer and some other delegates on 20 March 2014.

The existing WWTP started operation in 1987 with a design capacity of 50,000 cubic meters/day.
WWTP has 6 sedimentation tanks and there are aeration tanks between the sedimentation tanks. The contractor that constructed the facilities used prefabricated concretes for the external walls in sedimentation tanks and aeration tanks.

Current wastewater inflow is low, /treatment is approximately 6,000-10,000 cubic meters per day/ and operation is inefficient and below capacity, so some equipment is not used currently.

We noted several areas requiring attention. These are summarized below:

1. Some reinforcing steel, valves, rebar, rakes, columns and metal structures in the existing sedimentation tanks and aeration tanks are rusted and destroyed and they don't meet operation requirements.
2. Many of the sidewalls of the internal concrete walls in the sedimentation tanks and aeration tanks are destroyed and leaks from the walls. There are many rebar layers have come out. All of these don't meet the standards of Construction codes of Mongolia 22-01-01*/2006, CCM52-01-10, CCM52-03-05 and MNS3996-2004, MNS228-2004, MNS0831-2006, MNS5771-2006.
3. Many of the external concrete walls made of prefabricated concrete in the sedimentation tanks and aeration tanks are destroyed and several protection columns have fallen and there are many rebar layers have come out. They don't meet the standards of Construction codes of Mongolia 22-01-01*/2006, CCM52-01-10, CCM52-03-05.

Based on the findings, we have summarized the following:

1. Top layer of corridor isolating internal walls made of prefabricated concretes in sedimentation tanks and aeration tanks are destroyed and dilapidated, there are some rebar layers have

come out, metals have rust and have some holes and have lost carrying capacity. All of these cause abnormal operation in the further.

2. It is possible to use the external concrete walls made of prefabricated and reinforced concrete in the sedimentation tanks and aeration tanks in the future if there is rehabilitation and replacement.

A copy was sent to the client./Darkhan-Us suvag company/

STAMPED
Conclusion done by ………….. /Sanjmyatav.D/ Senior inspector of construction technical monitoring
Conclusion done by ………….. /Tsevelravjaa.S/ Inspector of construction technical monitoring

3.2 - AUDIT BY SIKA COMPANY FOR EXISTING WWTP

CONCRETE REPAIR WORKS – PUMP HOUSE

- Interior Ceiling
  - Remove any loose material from the interior roof along with the paint
  - Wire brush any loose material from the exposed reinforcing steel
  - Dampen the prepared area and apply MonoTop 610MY as the bonding material with a trowel to a thickness of 1mm
  - While the MonoTop 610MY is still wet apply MonoTop 612 to a thickness of 5mm
  - As soon as the MonoTop 612 has started to set it can be smoothed with a wooden or synthetic trowel
  - **NOTE**, where steel primer is required use Sika MonoTop 610MY and if no steel use Sika Bonding Slurry
- Estimated costs
  - Materials
    - MonoTop 610MY @ 1mm = 8,500 MNT/m^2
    - MonoTop 612@ 5mm = 19,000 MNT/m^2
    - Sika Bonding Slurry @1mm = 8,000 MNT/m^2
  - Labor – 16,000 MNT/m^2

CONCRETE REPAIR WORKS – PUMP HOUSE

- Exterior Wall
  - Remove any loose material and paint from the wall in the areas to be patched
  - Square cut the area to be patched and remove the concrete to a uniform depth behind the reinforcing steel
  - Dampen the area and apply MonoTop 610MY as the bonding material with a trowel
  - While the MonoTop 610MY is still wet apply MonoTop 612 with a trowel to fill in the area to be patched. If the patch depth is more than 30mm then the MonTop 612 needs to be applied in several layers
  - As soon as the MonoTop 612 has started to set it can be smoothed with a wooden or synthetic trowel
- Estimated costs
  - Materials
    - MonoTop 610MY @ 1mm = 8,500 MNT/m^2
    - MonoTop 612 = 3,185,000 MNT/m^3
  - Labor
    - 324,000 MNT/m^3

CONCRETE REPAIR WORKS – SAND & GRIT FLUME

CONCRETE REPAIR WORKS – SAND & GRIT FLUME

- Completely remove the concrete from the center wall and along the outer wall where required
- Ensure a vertical face is present at the interface between the old and new concrete
- Refurbish the reinforcement as needed
- Install shuttering as required and use Self Consolidating Concrete (SCC) – Sika ViscoCrete 5520

- Estimated costs
  - Materials
    - SCC Concrete = 210,000 MNT/m3
  - Labor
    - 500,000 MNT/m^3

CONCRETE REPAIR WORKS – CLARIFIER


CONCRETE REPAIR WORKS – CLARIFIER

- Interior Repairs
  - Remove the concrete from the interior wall to behind the existing reinforcing
  - Square the existing concrete around the perimeter of the area to be patched
  - Refurbish the reinforcement as needed
  - Install shuttering as required and use Self Consolidating Concrete (SCC) – Sika ViscoCrete 5520
- Estimated costs
  - Materials
    - SCC Concrete = 210,000 MNT/m3
  - Labor
    - 500,000 MNT/m^3

CONCRETE REPAIR WORKS – CLARIFIER

- Exterior Repairs
  - Scabble the exterior wall in the areas where the reinforcing steel is exposed
  - Wire brush any loose material from the exposed reinforcing steel
  - Dampen the prepared area and apply MonoTop 610MY as the bonding material with a trowel to a thickness of 1mm
  - While the MonoTop 610 is still wet apply MonoTop 612 to a thickness of 5mm
  - As soon as the MonoTop 612 has started to set it can be smoothed with a wooden or synthetic trowel
  - **NOTE**, where steel primer is required use Sika MonoTop 610MY and if no steel use Sika Bonding Slurry

- Estimated costs
  - Materials
    - MonoTop 610MY @ 1mm = 8,500 MNT/m²
    - MonoTop 612@ 5mm = 19,000 MNT/m²
    - Sika Bonding Slurry @1mm = 8,000 MNT/m²
  - Labor – 16,000 MNT/m²

CONCRETE REPAIR WORKS – AERATION UNIT

CONCRETE REPAIR WORKS – AERATION UNIT

- Repairs
  - Remove the concrete from the interior wall to behind the existing reinforcing
  - Square the existing concrete around the perimeter of the area to be patched
  - Refurbish the reinforcement as needed
  - Install shuttering as required and use Self Consolidating Concrete (SCC) – Sika ViscoCrete 5520
- Estimated costs
  - Materials
    - SCC Concrete = 210,000 MNT/m3
  - Labor
    - 500,000 MNT/m^3

11

CONCRETE REPAIR WORKS – SETTLING UNIT

12

CONCRETE REPAIR WORKS – SETTLING UNIT

- Interior Repairs
  - Remove the concrete from the interior wall to behind the existing reinforcing
  - Square the existing concrete around the perimeter of the area to be patched
  - Refurbish the reinforcement as needed
  - Install shuttering as required and use Self Consolidating Concrete (SCC) – Sika ViscoCrete 5520

- Estimated costs
  - Materials
    - SCC Concrete = 210,000 MNT/m3
  - Labor
    - 500,000 MNT/m^3

CONCRETE REPAIR WORKS – SETTLING UNIT

- Sika Materials Required:

- Sika ViscoCrete 5520 SCC Concrete = 210,000 MNT/m3
- SikaMonoTop 610MY = 149,550 MNT / 25kg Bag
- SikaMonoTop 612 = 41,460 MNT / 25kg Bag
- Sika Bonding Slurry = 6,400 MNT / kg
- Sikaflex 11FC = 13,640 MNT / 300ml cartridge

APPENDIX 4: DETAILS OF PUMP STATION AND SEWER NETWORK REHABILITATION REQUIREMENTS

1. This Appendix provides a detailed description for the works required to ensure that the wastewater from the three catchment areas of Darkhan (Old Darkhan, New Darkhan and the South Industrial Estate) reach the treatment plant. It describes the priority works, including the provision of a united automated control system to assist in management of wastewater for the whole city system. The other major works are:

(i) Rehabilitation of central pumping station delivering domestic and industrial waste water into the treatment plant (this is at the treatment plant and is thus included as an integral part of the treatment plant works);
(ii) Rehabilitation of the pumping station No 2 in Old Darkhan (which conveys all wastewater from Old and New Darkhan to the Central Pumping Station);
(iii) Full rehabilitation of the South pumping station (not operational since it was built in 1989)
(iv) Provision of 1,400 m of gravity flow pipeline of 800mm and 1000 mm diameter at new south pumping station;
(v) 100 m of collectors of 600 mm diameter at new south pumping station;
(vi) About 300 m of tertiary sewers of 350 mm diameter at bagh-5, in old Darkhan (near to hospital No 2); and
(vii) Power distribution networks at secondary pumping stations (shown in Scheme 1).

Central Wastewater Pumping Station

2. The central pumping station was constructed using Russian technology in 1965. The design capacity was 2,400m³/per hour. Since the pumps were replaced by further Russian equipment in 1989, there has not been any further investment. The basic structure of the pump house is sound, so the project will carry out the following:

- Full rehabilitation of the existing building – adding surface treatments
- Full replacement of pumping facilities (duty and standby units)
- Replacement of ventilation system (including both inlet and outlet piping)
- Replacement of power supply system
- Provision of automated remote control facilities to connect with the overall remote control system panel

3. Replacement of facilities is shown in Table A4.1 below.

Wastewater Pumping Station No 2 in Old Darkhan

4. As with the Central Pumping station, the secondary pumping station was constructed using Russian technology in 1965, also with a design capacity of 2,400m³/per hour. The pumps were replaced by further Russian units in 1992, since which time there hasn't been any further investment or renovation. The basic structure of the pump house is sound, so the project will carry out the following:

- Full rehabilitation of the existing building – adding surface treatments
- Full replacement of pumping facilities (duty and standby units)
- Replacement of ventilation system (including both inlet and outlet piping)
- Replacement of power supply system
- Provision of automated remote control facilities to connect with the overall remote control system panel

5. Replacement of facilities is shown in Table A4.2 below.

South Industrial Estate Wastewater Pumping Station

6. Based on the Government's policy to establish an industrial park in the southern part of Darkhan in the late 1980s, the new south pumping station was constructed using Russian technology and equipment in 1989. Although the pump station was fully equipped for operation, it has never been used – presumably because the flow-rate never exceeded the capacity of the smaller pre-exiting pump station, which is now operating at full capacity. The design flow was again 2,400m³/per hour, but since other new industries weren't built, so the pumping station has laid idle and parts have been cannibalised to keep other facilities going. The equipment is now removed or destroyed.

7. In addition a section of 1,400m of gravity flow pipeline is not installed at the pumping station. This needs to be installed to enable the pump station to operate. There is a need to rehabilitate the pumping station since the existing station is (i) running at its full capacity; and (ii) old and dilapidated. Operation of any further industries in the industrial park which generate wastewater will cause the existing pump station to overload. The basic structure of the pump house is sound, so the project will support the following activities:

- Full rehabilitation of the existing building – adding surface treatments
- Full replacement of pumping facilities (duty and standby units)
- Replacement of ventilation system (including both inlet and outlet piping)
- Replacement of power supply system
- Provision of automated remote control facilities to connect with the overall remote control system panel

8. Replacement of facilities is shown in Table A4.3 below.

Figure A4.1: Water supply and wastewater network general scheme in Darkhan

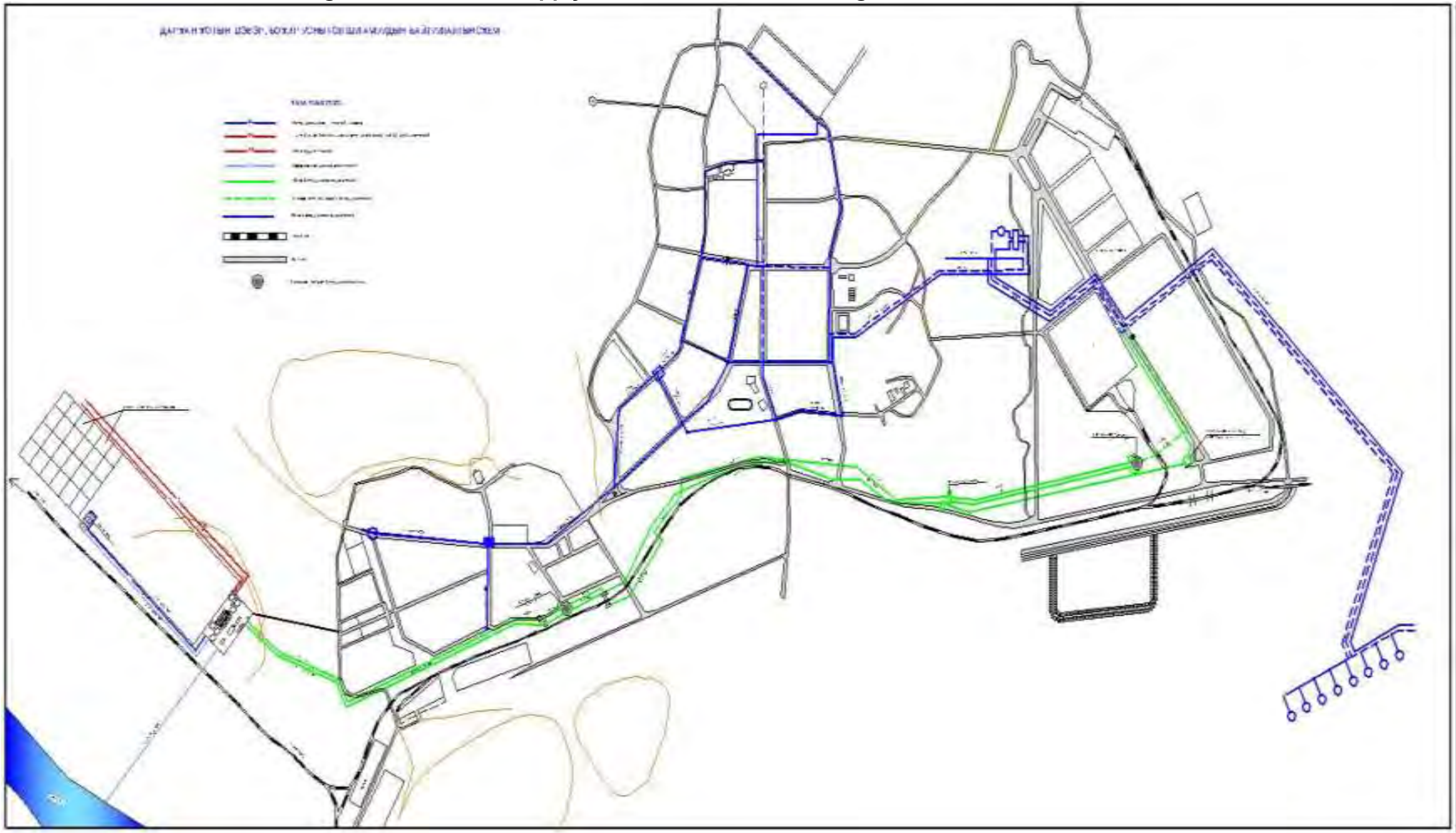

Table A4.1: Central Pump Station

№	Existing facilities						Example of facilities to be used			
	Names of facilities, series	**Date of Comm.**	**Quantity**	**Technical data**	**Manuf.**	**Current situation**	**Names of facilities, series**	**Technical data**	**Quantity**	**Manuf.**
1	Screen МГ-1000/1600	1968	2	Q=1000m³/h; N=…kw/h	Russia	Operational-1 Not operational -1 Requires replacement	Rotating screening drums Channel Monster Model CDD2410-XD2.0	Q=852m³/h N=7кw Weight:665kg	2	England
2	Sewage pump horizontal centrifugal СД800/32	1989	5	Q=800m³/h; H= 32m; N=132 kw/h	Russia	Operational-3 Not operational -2 Requires replacement	Salvatore Robuschi RD125-25	Q=500m³/h N=100kw Weight:177kg	2	Italy
3	Manual lifting					No more	Manual lifting	P=1ton	2	China
4	Exhaust ventilation						RP60-35/31-4D	Q=1750 m³/h N=3.43kw	1	Czech
5	Air intake ventilation system						RP70-40/35-4P	Q= 2855 m³/h N=2.56kw	1	Czech

Table A4.2: Secondary Pump station

№	Existing facilities						Example of facilities to be used			
	Names of facilities, series	Date of Comm.	Quantity	Technical data	Manuf.	Current situation	Names of facilities	Technical data	Quantity	Manuf.
1	Screen МГ-1000/1600	1968	2	Q=1000m³/h; N=…kw/h	Russia	Operational-1 Not operational - 1 Requires replacement	Rotating screening drums Channel Monster Model CDD2410-XD2.0	Q=852m³/h N=7kw Weight :665kg	2	England
2	Sewage pump horizontal centrifugal СД800/32	1989	5	Q=800m³/h; H=32m; N=132 kw/h	Russia	Operational-2 Not operational - 3 Requires replacement	Salvatore Robuschi RD125-25	Q=500m³/h N=100kw Weight:177kg	2	Italy
3	Manual lifting					No more	Manual lifting	P=1ton	2	China
4	Exhaust ventilation						RP60-35/31-4D	Q=1750 m³/h N=3.43kw	1	Czech
5	Air intake ventilation system						RP70-40/35-4P	Q=2855 m³/h N=2.56kw	1	Czech

Table A4.3: South Industrial Estate Primary Pump station

	Existing facilities						Example of facilities to be used			
	Names of facilities, series	**Date of Comm.**	**Quantity**	**Technical data**	**Manuf.**	**Current situation**	**Names of facilities**	**Technical data**	**Quantity**	**Manuf.**
1	Screen МГ-1000/1600		2	Q=1000m³/h; N=…kw/h	Russia	It hasn't been operational and has been deteriorated since it was constructed and the technology is outdated, so it requires replacement.	Rotating screening drums Channel Monster Model CDD2410-XD2.0	Q=852m³/h N=7kw Weight:665kg	2	England
2	Sewage pump horizontal centrifugal СД800/32		5	Q=800m³/h; H=32m; N=132 kw/h	Russia	The same condition as the above	Rotating screening drums Channel Monster Model CDD2410-XD2.0	Q=852m³/h N=7kw Weight:665kg	2	England
3	Manual lifting					The same condition as the above	Salvatore Robuschi RD125-25	Q=500m³/h N=100kw Weight:177kg	2	Italy
	Exhaust ventilation						Manual lifting	P=1ton	2	China
4	Air intake ventilation system					The same condition as the above			1	Czech
5	Manual lifting					The same condition as the above	RP60-35/31-4D	Q=1750 m³/h N=3.43kw		

Explanation: Q=2,400m³/h "new" pumping station in the industrial area mentioned above will be rehabilitated, so the existing industrial area pump station (Q=300 m³/h) (constructed in 1965) will be decommissioned once the new facility comes on stream.

Condition and Rehabilitation Inventory of Water Supply & Sewer Pipelines in Darkhan

Table A4.4: Main Water Supply pipelines and branch water supply pipelines in use and under rehabilitation

Pipeline material	Diameter	Length	Year of construction	Years of operation	Status of Operation	Explanation and location
steel pipe steel pipe plastic pipe	DN500-600 DN500-600 DN500-600	4.7km 20km 0.3KM	1965 1990 2011	48 23 2	In use	Replacement along the road, at back of block IV-1 in New Darkhan
cast-iron pipe	DN500-600	30km	1965	48		
cast-iron pipe	DN500-600	1km	1990	23		
steel pipe	DN400-300	2km	1965	48		
steel pipe	DN400-300	8km	1965	48		
steel pipe	DN100-250	29km	1965	48		Partial replacement of DN100, and replacement of DN200 to HDPE pipelines funded by ADB loan in bagh-7
steel pipe	DN100-250	0.12km	2010	3		
plastic pipe	DN100	2.7km	2005	8		
steel pipe	DN200	0.14km	2010	3		
steel pipe	DN200	0.74km	2010	3		
steel pipe	DN200	0.14km	2011	2		
steel pipe	DN200	30km	1990	23		
cast-iron pipe	DN150-250	54km	1965	48		

Table A4.5: Water supply pipelines in districts

Pipeline material	Diameter	Length	Year of construction	Years of operation	Status of Operation	Explanations and position
steel pipe steel pipe steel pipe	DN50 DN50 DN50	3km 6.5km 1km	1965 1990 2005	48 23 8	In use	Replacement of DN50 in necessary pipelines
steel pipe steel pipe	DN80 DN80	1km 3km	1965 1990	48 23		
steel pipe steel pipe	DN100 DN100	12.5km 5.6km	1990 2005	23 8		
plastic pipe	DN150	7.9km	2011	2		Replacement funded by Japanese grant In bagh-5,6
	Total: 223.2km					

Table A4.6: Main sewer pipelines and branch sewer pipelines

Pipeline material	Diameter	Length	Year of construction	Years of operation	Status of Operation
steel pipe	DN600-1000	0.1km	1965	48	In use
concrete pipe	DN600-1000	41km	1990	23	
steel pipe	DN400-300	2km	1965	48	
steel pipe	DN400-300	0.5km	1990	23	
cast-iron	DN300-400	6km	1965	48	
clay	DN100-250	32km	1965	48	
cast-iron	DN200-250	11.8km	1965	48	
Clay	DN200-250	27.5km	1965	48	
Asbestos cement	DN200-250	3.5km	1965	48	
Clay	DN150	35km	1965	48	
cast-iron	DN150	0.6km	1965	48	

Table A4.7: Sewer pipelines in districts

Pipeline material	Diameter	Length	Year of construction	Years of operation	Operational or not
cast-iron cast-iron cast-iron	DN50 DN50 DN50	14.2km 8km 3.7km	1965 1990 2005	48 23 8	In use
cast-iron cast-iron cast-iron	DN100 DN100 DN100	12.4km 5km 7.2km	1965 1990 2005	48 23 8	
cast-iron	DN150	13km	1990	23	
	Total: 223.5km				

APPENDIX 5: WASTEWATER TREATMENT PLANT ALTERNATIVE ANALYSIS

5.1 - Framework for Technology Evaluation and Selection

1 A three-stage process has been adopted for the evaluation of potential wastewater treatment options for Darkhan, and selection of the preferred approach. In the first stage, a broad range of treatment options is considered against a set of criteria covering the operational characteristics and likely costs (capital and operational) of systems of the required treatment capacity operating under Darkhan environmental and socio-economic conditions. During the first stage evaluation, most options have been eliminated from further consideration as a result of: (i) their unsuitability for operation under Darkhan conditions; (ii) high levels of operational risk; and/or (iii) high capital or operational cost.

2 In the second-stage evaluation, those technologies which appear to provide the most cost effective solution to wastewater treatment were subjected to further scrutiny with a view to identifying an optimal treatment solution for Darkhan conditions. To this shortlist were added two technologies recommended for further consideration by the MCUD Technical Committee for Water and Wastewater Infrastructure.

3 In the third-stage evaluation, two possible approaches (using some of the existing structures, or constructing an entirely new facility), and three technologies (step-feed activated sludge, sequencing batch reactor and integrated fixed-film activated sludge) were evaluated and a preferred option was selected.

5.2 - First-stage Options Evaluation

4 Based on broad international practice in wastewater treatment technologies in cold and temperate climates, a long-list of possible treatment technologies was drawn up for first-stage evaluation. This list excluded a number of technologies which are in use in more temperate climates but which would not function in the extreme cold experienced during the long and deep winters in Darkhan, or are excluded for other operational reasons, such as only being suitable for low wastewater volumes. The systems excluded from further consideration at this stage are:

(1) The trickling filter variety of biofilm systems: Such systems are better suited to lower flow rates and would likely become inoperable due to freezing during the deep winter unless covered,

(2) Extended aeration systems involving long retention times in aeration basins (such as Aerated Lagoons): Operational problems are likely due to freezing in quiescent parts of the lagoons during deep winter conditions unless units are covered, which would become prohibitively expensive for the large reactor areas involved (and necessitated by surface aeration).

(3) Upflow Anaerobic Sludge Blanket Process: Insufficient experience at full scale operation and not suitable for use in cold climates due to sensitivity of anaerobic process to low temperature (obligate anaerobic methane-forming bacteria which are necessary to avoid odour associated with the intermediate products of anaerobic treatment cease to function at about 15 deg C).

5 The systems which are considered in the first stage evaluation are those which could have application under operating conditions experienced in Darkhan. These are:

(1) Waste Stabilization Ponds (facultative and maturation ponds in series);

(2) Constructed or Managed Wetlands;

(3) Extended aeration oxidation ditch (or Carrousel) extended aeration systems;

(4) Conventional or modified (e.g. Anoxic/Oxic) activated sludge process systems;

(5) Sequencing Batch Reactor systems;

(6) Membrane bioreactor and reverse osmosis technologies;

(7) Biofilm systems – submerged and part-submerged (such as rotating biological contactors).

6 These systems are evaluated against a range of criteria to determine which are likely to offer the best solution under Darkhan conditions in terms of costs and operating efficiency. The criteria used in the evaluation are:

(1) Experience of operation of similar wastewater treatment technologies elsewhere in Mongolia, both positive and negative; and also whether featuring in consideration as a potential process for adoption by other urban communities in Mongolia;

(2) Experience of operation elsewhere in the region, or under similar climatic, economic and technical environments as Darkhan, and at similar flow rates;

(3) Likely biological treatment performance in removal of BOD5, COD and SS;

(4) Likely nutrient removal efficiency – particularly nitrogen and phosphorous removal;

(5) Likely treatment efficiency in removal of bacterial indicator organisms;

(6) Shock-loading resilience: ability to handle fluctuation in influent volume and composition - particularly to chemical agents likely to be present in (pre-treated) industrial wastewaters;

(7) Approximate land requirement and ability to be accommodated within the footprint of the existing plant (thus avoiding land acquisition and resettlement issues);

(8) Approximate capital costs for civil works equipment and related plant costs;

(9) Likely energy requirements for operation;

(10) Possible energy recovery opportunities – such as through bio-gas from sludge digestion;

(11) Likely operational and maintenance costs;

(12) Sludge volume and handling characteristics;

(13) Operational complexity: need for sophisticated real-time IT-based management systems, number and complexity of moving parts and exposure of appurtenances;

(14) Potential for odour or noise nuisance, or provision of a favourable environment for insect or disease vector breeding;

(15) Aesthetic considerations: ability of plant to fit well with surroundings;

(16) Resilience to harsh winter operating conditions;

(17) Expansion potential: ability of plant capacity to be increased on a modular basis as flow rates increase; and

(18) General observations and result of evaluation: overall summary of evaluation and assessment of suitability for further consideration.

7 The evaluation is summarised at **Table A5.1**. Based on this evaluation, other outliers can be eliminated:

(1) Waste stabilisation ponds systems and constructed wetlands offer simple, cheap, robust and resilient processes for wastewater treatment but: (i) use large areas of land; (ii) would function poorly in winter and early spring; (iii) risk odour and insect vector breeding; and (iv) offer only poor nutrient removal performance.

(2) At the other end of the spectrum, membrane bio-rectors and reverse osmosis plants: (i) are expensive to construct and very expensive to operate and maintain; (ii) involve complex operational

systems; (iii) do not have a history of successful use in environments similar to that of Darkhan; and (iv) offer very high quality effluents – but unnecessarily higher quality than is required for discharge to the Kharaa River.

(3) Biofilm technologies vary widely and are eliminated from further consideration as stand-alone systems because: (i) there is not an established biofilm technology which has been used in Mongolia or is widely used elsewhere in the region; and (ii) the ability of biofilm systems to operate under cold winter conditions or respond to shock loadings is not well established. However, they continue to be considered in combination with activated sludge technologies.

Table A5.1: Comparative Treatment Data for Treatment Processes[1]

Item	Waste Stabilization (Oxidation) Ponds	Constructed Wetlands	Extended Aeration: Oxidation Ditch (Carrousel)	Conventional or Modified A/O Activated Sludge	Sequencing Batch Reactor	Membrane Bioreactor & Reverse Osmosis	Biofilm Technology (submerged or exposed)
Use elsewhere in Mongolia	Extensive (small systems)	Few (small systems)	No	Yes	Several (small systems for private companies)	No	No
Use in cold climates	Extensive	Some (small systems)	Some (but not in very cold climates)	Extensive	Several (developed environments)	Few (small systems)	Some (small systems)
BOD_5, COD & SS Removal (%)	75-85	75-90	75-85	90-95	90-95	95-98	75-90
NH_4, P Nutrient Removal (%)	Small	Small	Moderate	Moderate to High	High	High	Moderate
Faecal Coliforms Removal (orders)	Log 2-4	Log 2-4	Log 2-3	Log 1-3	Log 1-3	Log >4	Log 1-3
Handling hydraulic and organic load fluctuations	Good	Good	Fair	Fair to Good	Good	Good	Fair to Good
Land Requirement (approx.m^2/cum/day)	40.0	25.0	2.0	1.0	0.75	0.25	0.75
Total Capital Cost (US$/cum/day)	150	300	900	800	800	1,200	700
Power Requirement (kWh/cum treated)	Minimal	Minimal	1.3	1.0	0.9	1.5	0.5
Opportunities for energy recovery	Low	Moderate	Moderate	High	High	Moderate	Moderate
Total O&M Cost (US$/ cum)	0.05	0.05	0.4	0.35	0.4	0.8	0.4
Sludge production and handling.	Low/Easy	Low/Easy	Moderate/ Easy	Moderate/ Hard	Moderate/ Hard	Moderate/ Hard	Moderate/ Hard
Operational Complexity Characteristics	Simple	Simple	Moderate Skill/Complexity	Moderate/Skilled/Complex	Highly Skilled/Complex	Highly Skilled/Complex	Moderate Skill/Complexity
Potential odour, insect and vector Nuisance.	Yes:	Yes	Moderate	Minor	Least	Least	Moderate
Aesthetics with surroundings	No	No	No	Fair	Best suited	Best suited	Best suited
Winter operational resilience	OK but poor performance	OK but poor performance	Moderate	Good	Good	Good	Moderate
Potential for modular expansion	Possible	Difficult	Difficult	Moderate	Simple	Simple	Moderate
General observation and evaluation result	Area required very large to accommodate cold periods & nuisance during spring thaw – not a practical solution for Darkhan	Area required very large to accommodate cold periods. More widely used for smaller communities – not a practical solution for Darkhan	Possible option but no Mongolian experience, susceptibility to very cold conditions and poorer nutrient removal than other options	Already used in Mongolia and in region, performance good except nutrient removal in conventional plants. Modifications can improve nutrient removal	Already used in Mongolia (at a small scale) and in region. Good performance and adaptable, but requires relatively sophisticated operating system	High capital and operating costs and requires complex operational controls. High level of treatment performance not necessary in Darkhan	May have application but little experience in region or in cold climates. RBC can be effective but better suited to smaller plants.

[1] This data is taken from a wide range of sources and as such is approximate, particularly the cost information which is purely indicative, and based on an assumed medium-sized facility (say 10,000 cm/day capacity). The purpose is to help narrow the options down to those two or three treatment technologies most appropriate for the situation in Darkhan

5.3 - Second-stage Options Evaluation

8 This first stage process leaves three basic technologies which are considered to offer the best options for application in Darkhan: (i) the activated sludge process in its various forms – modified in accordance with the specific treatment requirements; (iii) the sequencing batch reactor system; and (iii) the oxidation ditch or Carrousel extended aeration system. In addition, the Membrane Bio-rector (MBR) and Moving-bed Bio-reactor (MBBR) were further considered at the request of the MCUD Technical Committee on Water and Wastewater Infrastructure, which evaluated the consultant's preliminary recommendations. The Committee requested that the consultant look again at these options. Each of the systems is described in terms of its operational parameters, and an evaluation is carried using a combination of quantitative and qualitative criteria. A summary of findings is presented below.

9 The oxidation ditch is included at this stage, largely because it is understood to be the preferred technology for the CWWTP extension in Ulaanbaatar, and as a result has also been considered for the new treatment plant and Nisekh. However, it is considered that this system does not represent as good an alternative for Darkhan as either the modified activated sludge or SBR technologies, or other systems which use elements of these two. While from a technical point of view, the system would be able to achieve the required treated effluent quality standards, there are process disadvantages when compared to the modified ASP, SBR and related systems, under the operating conditions experienced in Darkhan. As an extended aeration system, the oxidation ditch aerobically stabilises the activated sludge. This has the advantage that no additional and separated sludge stabilization is required, but has the disadvantages that; (i) the extended aeration systems means that about 25% more energy is used than in either conventional activated sludge or SBR systems; and (ii) the aeration tank volumes required are about 4- 5 times those required by either the modified activated sludge or SBR systems.

10 A further disadvantage of the oxidation ditch system when operating in cold climates is that since the aeration takes place at the surface, the aeration tank depth cannot exceed approximately 3.50m. This combination of large volume requirement and restriction on depth means a very large footprint and thus equally large exposed liquid surface area, leading to rapid cooling of the liquor in winter and thus the risk of freezing. The only way to maintain the required temperature in these circumstances is to enclose the reactor – at a very high capital cost.

11 A further consideration is the option for some energy recovery through anaerobic sludge digestion – an option which is not open in the case of an extended aeration system – and the benefits from dewatering an anaerobically digested (as opposed to aerobically digested) sludge. Under optimal conditions, provided that anaerobic sludge stabilization follows the activated sludge process, about 60% of the total energy required for the operation of the entire WWTP can potentially be recovered and utilized to defray energy costs[2]. Furthermore, during the anaerobic digestion process the sludge quantity is reduced by about 30% which in turn reduces the cost for dewatering and final disposal. Additionally, anaerobically digested sludge can be much more efficiently dewatered than aerobic sludge, which consequently reduces the final disposal cost still further.

12 Further detailed analysis of the potential for use of the MBR system reinforced the original conclusion. The analysis indicated that while the degree of treatment achieved can be very high, the system suffers from the following disadvantages under Mongolian conditions:

(1) Where there are occasional system failures - for instance due to power cuts - the micro filters become clogged and require constant cleaning resulting in high maintenance costs;

(2) The membrane cartridges need to be changed often, are imported, and are consequently very expensive; and

(3) To operate micro filters, vacuum pumps are required and these are considerably more expensive to operate than using secondary sedimentation tanks for clarification.

[2] This is a theoretical figure, and there is some doubt as to whether the low levels of BOD found in Darkhan wastewater will support an anaerobic digestion and bio-gas recovery investment – this will be investigated further during the TA.

13 The MBBR system is similar to the IFAS, except in that floatable media are used rather than fixed media. A disadvantage of the use of floatable media is that the ability of biomass to cling to the media is reduced, thus in turn reducing the intensity of biomass activity. Thus the IFAS is considered preferable to the similar MBBR system, and the MBBR system is excluded from further consideration.

14 These factors combine to eliminate the oxidation ditch (or Carrousel) option, MBR and MMBR systems from further consideration. Consequently, the treatment systems which are evaluated in greater detail in stage three of the evaluation are:

(1) Option 1: The rehabilitation of (parts of) the existing activated sludge system to provide enhanced operation and treatment using a modified activated sludge technology (IFAS);

(2) Option 2: A new modified activated sludge system adopting the step-feed activated sludge process to promote nutrient reduction;

(3) Option 3: A new sequencing batch reactor system; and

(4) Option 4: A new modified activated sludge treatment plant adopting IFAS technology.

15 In general, activated sludge systems do not provide a high level of nutrient removal, but the step-feed ASP, IFAS and SBR processes are designed to improve the nutrient removal performance of the system, so this should not constitute a problem in achieving the required discharge standards.

16 Each of these systems produces a well mineralised sludge which can be readily dewatered, or offers the possibility for anaerobic digestion and thus energy recovery. However, in view of the low sludge volumes and problems encountered in maintaining temperatures sufficient for sludge digestion in winter, this approach is not recommended at this stage. Also, while the addition of anaerobic digestion to generate bio-gas as a resource to reduce energy should be beneficial, there is doubt as to the applicability and efficiency of biogas digesters under Mongolian conditions where relatively high water consumption (150 l/c/d) and low organic loads (27 g/c/d) lead to low BOD_5 and SS concentrations in raw sewage (BOD_5 90-95mg/l, SS ~150mg/l).

5.4 - Third-stage Options Evaluation

17 Based on the second stage evaluation, four options emerged as those most suitable for application in the city. These are discussed and evaluated below, and summarised in Table A5.2 below.

Option 1: Rehabilitation of Existing Activated Sludge Plant

18 The existing WWTP is generally in a poor state of repair. Virtually all mechanical units are beyond their economic life and many of the structures are beyond economic repair. Investigations were conducted on the main structural units which showed that while some elements are structurally sound, and can be rehabilitated, others are not capable of economic rehabilitation. This information is presented in Appendix 4.

19 However, some of the units are still structurally sound, and the significant over-design of the existing plant (50,000 cum/day as against actual flows averaging < 10,000 cum/day) means that the more sound units could be rehabilitated and used as part of a renewed modified activated sludge treatment plant using IFAS technology. A suggested design has been made for this renewal and conversion, and this is set out in Appendix K. This would require surface treatments to the clarifier units and a major reconstruction of the aeration tank, plus complete replacement of mechanical and electrical equipment. This approach would generate savings in capital works over a brand new plant.

20 There would be some complications in adopting the rehabilitation approach. The first would be the arrangements which would need to be made during the re-construction of those units which would be used as part of the new operating system. An advantage of the construction of a new plant would be that operation of the old plant would continue while the new plant was constructed. In the case of rehabilitation, additional costs would be incurrent in redirecting wastewater to a temporary treatment facility (probably other elements of the existing

plant which are currently unused) to be used during the re-construction. A further disadvantage would be that because of its configuration, the rehabilitated plant would not lend itself to modular expansion as easily and cost-effectively as a new plant. However, again, use can be made of existing structures which would be surplus to requirements in the first stage of development.

Option 2: New Modified Activated Sludge Plant (Step-feed activated sludge)

21 The design of a proposed new activated sludge step-feed process WWTP for Darkhan has largely followed the adopted for the Nisekh WWTP in Ulaanbaatar.[3] The advantages of the step-feed ASP technology are that it provides a high level of treatment without the same level of operational complexities inherent in SBR system. Furthermore, raw sludge and excess activated sludge can be used to produce energy through sludge digestion which is both environmentally-friendly and can provide energy through the bio-gas produced which offsets some of the energy costs of operation

22 The potential disadvantages of the system are that when extending the capacity of the WWTP there will be a need for additional primary and secondary sedimentation tanks, aeration tanks and other basins, which will add to the cost of modular capacity enhancement. It will also require increases to the number of sewage pipelines and other interconnecting pipework and appurtenances. The existing plant does not lend itself to conversion to a step-feed activated sludge process as well as it does to the IFAS system

Option 3: New Sequencing Batch Reactor Plant

23 The SBR effectively carries out the series of treatment processes involved in the activated sludge process in a single reactor. Its primary benefits are: (i) the amount of excess sludge is reduced, which in turn reduce sludge-handing problems; (ii) because all of the operations are carried out in a single tank, the reactor footprint can be minimized; and (iii) the operation of the system is fully-automated. This means that the aeration device has a timing unit which varies aeration intensity and duration in accordance with the characteristics of the incoming wastewater. This means that there is no need to plan for peak capacity loadings and operation is flexible and operates with optimal efficiency at any inflow level and concentration within the maximum design flow.

24 However, there are also a number of disadvantages with the SBR system. A higher level of sophistication is required because the timed phases in the bioreactor are controlled with an automatic timing unit. Consistent with the automated nature of the process, there is a higher level of maintenance associated with more automated switches, valves and shut offs. Under Mongolian (and certainly Darkhan) conditions there is the potential of higher cost of operation and maintenance of automated facilities, higher risk of sub-optimal operation, and a higher risk of breakdown. The system is not robust to long operational interruptions and with a power-cut induced break in flow rate for, say 6-8 hours during anaerobic conditions and with low water temperatures (say 10°C) there may be long-term damage to the microbiological population which can seriously damage operation performance and take a long time to correct. There is also increased risk of freezing during the quiescent phase of operation.

25 There are also issues of constructability. The SBR requires good quality heat-insulation and extensive use of polypropylene which may add to material cost, to lead times for construction materials, and to the period for construction required under Mongolian conditions.

Option 4: The Hybrid - Modified Bioreactor & Activated Sludge Plant – the Integrated Fixed-film Activated Sludge (IFAS) system

26 The IFAS system is widely used in Russia and in other locations in the People's Republic of China and Europe, but is not as well known internationally as either the modified step-feed ASP or SBR. Its advantages are that it both reduces the volume of sludge and improves the final purification result as a result of the progression of microbiological processes (the IFAS). The system can be adapted to more or less automated control, and the reactors can be united into a single construction block, thus reducing the total reactor volume and area, thus in

[3] Environmentally Sound City Development in Ulaanbaatar, Feasibility Study Report, Final Version, Gitec and Mongol Erdem, Ulaanbaatar August 2011.

turn reducing operational complexities and costs. It can also operate on more of a modular step-feed arrangement to provide additional operational flexibility.

27 The main disadvantages of the IFAS system are that since all treatment functions are in separate tanks, it occupies more space than the SBR system, although has a similar footprint to the step-feed ASP. In addition, while the operation is partially automated, the absence of a fully automated system for managing aeration time means that operational costs are marginally higher than for the SBR system at the flow rates anticipated in Darkhan. However, it offers a more robust treatment system which does not rely so heavily on automated controls as do the SBR and step feed ASP systems.

5.5 - Evaluation Results – the Optimal Technical Solution

28 The options analysis does not present a clear "winner" in terms of the qualitative and quantitative evaluations. The rehabilitation of the existing treatment plants as a modified ASP using IFAS technology is the cheapest option in capital cost terms, but potentially presents more challenges in terms of: (i) dealing with the period of construction (further costs will need to be added to provide for treatment during reconstruction); and (ii) providing a system which is suitable for straightforward and cost-effective modular expansion. A further consideration is that the reduced construction requirements in terms of concrete and other materials will reduce the carbon footprint in the short term (i.e. of the construction), but additional energy requirements over the new SBR plant optimally operated offsets this saving in the longer-term. A further advantage of reusing elements of the existing WWTP is that the new plant can be constructed within the footprint of the existing plant.

29 Based on this analysis, there is little between the other three new systems in terms of cost and performance. The step-feed activated sludge is slightly more expensive and has slightly higher operational cost than the other two systems. However, it comes closest to the "tried and tested" conventional activated sludge process in terms of operation, and thus offers some security that it can be successfully operated under Mongolian conditions.

30 The other two systems provide solutions which emerge as the most cost effective, (assuming that the rehabilitation of the existing plant is disregarded) with little to choose between them. The SBR technology is finding increasing application in many parts of the world – but was considered and rejected under the extensive studies looking at systems for: (i) Nisekh in Ulaanbaatar; (ii) the extension of the Ulaanbaatar CWWTP, and (iii) the Orkhon WWTP extension. It works well when the automated systems work well and the level of supervision is high, but presents an addition level of operational risk over options which have more in common with the more familiar conventional ASP system.

31 The version of the IFAS system knows as the "3-sludge" system which is proposed, has emerged from Russian experience, is widely used in Russia, and variations are adopted in the People's Republic of China, and in Europe, Japan and Saudi Arabia. This option was not considered at all in the evaluations of potential treatment plants for Ulaanbaatar and Orkhon mentioned in the previous paragraph. There is limited experience of the system outside Russia, and although some elements of the system have been successfully introduced to a small plant in Mongolia (at Zunmod) it is relatively untried in Mongolia and elsewhere. Consequently, its adoption could pose a high risk. However, ultimately it is a variation on the activated sludge process with some benefits over the step-feed ASP process in terms of the amount of interconnecting pipework, valves and number of inspection chambers, and provides simpler operation than the SBR. The basic principles of the IFAS and related MBBR technology are widely applied elsewhere globally.

Table A5.2: Detailed Evaluation of Shortlisted Treatment Methods

Item	Evaluation Criteria	Modification and Rehabilitation of existing Activated Sludge Plant as IFAS system	New modified Step-feed process Activated Sludge Plant	Standard Sequencing Batch Reactor System (as recommended by MoMo)	Integrated Fixed-film Activated Sludge Process (IFAS)
1	**Estimated total capital costs (Capital works, equipment and other costs) for a plant treating 20,000 cum/day in US$ million**	12.25	19.30	16.35	16.70
2	**Estimated annual operational cost (Power, staff, chemicals and other) in US$ million per annum**	0.592	0.631	0.541	0.567
3	**Estimated total economic lifetime costs over 25 years in MNT per M^3 treated**	4,724	5,664	5,358	5,278
4	**Financial lifetime cost in MNT per M^3 treated**	1,633	1,645	1,528	1,664
5	**Economic Internal Rate of Return (EIRR)**	40.0%	29.6%	32.1%	32.9%
6	**Financial Internal Rate of Return (FIRR)**	3.2%	2.6%	3.7%	2.6%
7	**Operational simplicity or complexity, e.g. need for PC-based SCADA control system, number of moving parts and complexity and exposure of appurtenances**	Operation would be streamlined to use only one stream of primary and secondary clarifiers which would be converted to bio-reactors in accordance with the IFAS system. Other elements would remain unused. There would still be an assortment of external reactor connections etc. which would be exposed and thus present continued operational risk.	The opportunity exists to minimize the need for external pipework by planning the configuration of reactors to minimize number of structures. The process is complex and requires a degree of automated control, although treatment is reasonably robust in cases where control is not as finely managed (is sub-optimal).	The system is reasonably compact and so does not involve a great deal of external pipework. The system works in an automatic mode and is controlled by a relatively complex PC-based SCADA system. There is a risk of automatic system failure, in which case the effluent quality is likely to be significantly adversely affected. Backup systems are needed	The system is modification of conventional ASP with additional steps and can be configured so as to minimize external pipework. The system can operate in either an automated or a manual mode. Since the timing of phases is not as critical as in other options, treatment efficiency can be maintained in cases where operational controls are not so carefully managed
8	**Successful operation proven elsewhere in Mongolia, or at least in the region, and in similar climatic, economic and technical environments, and similar flow rates**	The existing plant works reasonably well, and is based on a technology used elsewhere in Mongolia (e.g. Erdenet and Ulaanbaatar) which has provided a reasonable level of treatment when operated well, although low levels of nutrient	No step-feed ASPs working on Mongolia, but there are a number of modified activated sludge processes operating with significant variation in treatment efficiency. Team visited WWTPs at Sukhbaatar in Selenge and Zunmod in Tov	The SBR pilot plant at the Darkhan treatment plant was said to be working well, but the performance results are not available with Us Suvag. Some operational problems with the pilot were experienced during winter. While widely	The IFAS system is widely used in Russia in its “3-sludge” form, but is not well known in this form elsewhere. It is a modification of an activated sludge-type process which is widely adopted elsewhere and has been adopted in Mongolia

Item	Evaluation Criteria	Modification and Rehabilitation of existing Activated Sludge Plant as IFAS system	New modified Step-feed process Activated Sludge Plant	Standard Sequencing Batch Reactor System (as recommended by MoMo)	Integrated Fixed-film Activated Sludge Process (IFAS)
		removal. It is considered that the plant could be adapted to operate under a modified activated sludge process – the IFAS process – well, but this may present an operational risk in its reuse of structures.	where a modified activated sludge systems were operating: the first not well, but the second providing a high level of treatment. Thus due to variability in operation and not design issues.	used in more economically advanced and warmer environments, SBRs have yet to find widespread use in the region, or in Mongolia (except for relatively small private plants)	for smaller plants. Some elements included in plants at Sukhbataar and Zunmod.
9	**Probable treatment efficiency (BOD, COD, SS & NH_4 removal) in climatic extremes likely to be experienced in Darkhan**	BOD=10.0mg/l COD=20mg/l SS=10.0mg/l NH4=0.4mg/l	BOD=20.0mg/l COD=50mg/l SS=50.0mg/l NH4=6.0mg/l	BOD=20mg/l COD=50mg/l SS=50mg/l NH4=6.0mg/l	BOD=6.0mg/l COD=15mg/l SS=6.0mg/l NH4=0.4mg/l
10	**Sludge handling characteristics – minimization of sludge problems**	If operated as an IFAS system the dry sludge produced is about one half of that produced from the activated sludge process.	Sludge volumes produced from this process are less than for conventional ASP but relatively high.	The volume of dry sludge produced from the system is about two thirds of that produced from the conventional ASP.	The volume of dry sludge produced from the system is about one half of that produced from the conventional ASP.
11	**Shock-loading resilience – particularly to chemical agents likely to be present in (pre-treated) industrial wastewaters**	The system is robust in treating wastewaters with variable characteristics provided they meet with the standards for discharge to public sewers	The system is robust in treating wastewaters with variable characteristics provided they meet with the standards for discharge to public sewers	The system has the benefit that it can adjust the intensity of treatment to deal with variability in inflow characteristics.	The system is robust in treating wastewaters with variable characteristics provided they meet with the standards for discharge to public sewers
12	**Energy efficiency, (construction and operational phases and opportunities for energy recovery (e.g. methane biogas recovery)**	Energy saving on construction. Annual electricity consumption amounts to about US$ 0.123 mil.	Annual electricity consumption amounts to about US$ 0.127 mil.	Annual electricity consumption amounts to about US$ 0.122 mil.	Annual electricity consumption amounts to about US$ 0.123 mil.
13	**Suitability for incremental expansion**	Would be more difficult to extend than a new plant as the configuration is dictated by the existing structures, but could just use additional disused elements of existing plant on rehabilitation.	Relatively easily extended by the construction of additional parallel treatment streams if designed for modular expansion, although pipework complexity.	Relatively easily extended by the construction of additional parallel treatment streams if designed for modular expansion.	Relatively easily extended by the construction of additional parallel treatment streams if designed for modular expansion.
14	**Operational resilience in extreme winter climate**	The existence of significant underground pipeline networks increases the risk of freezing and interruption to treatment in	There is a moderate amount of underground pipework which risks operational problems in winter, but not if well located.	Minimal interconnecting pipework but pilot plant at Darkhan suffered freezing problems in the winter, but	System minimizes the need for interconnecting pipework.

Item	Evaluation Criteria	Modification and Rehabilitation of existing Activated Sludge Plant as IFAS system	New modified Step-feed process Activated Sludge Plant	Standard Sequencing Batch Reactor System (as recommended by MoMo)	Integrated Fixed-film Activated Sludge Process (IFAS)
		extreme conditions, but OK in past.		these may have been due to small size	
15	**Likely creation of odour or other nuisance**	No odor if working properly.	No odor if working properly.	No odor if working properly.	No odor if working properly.
16	**Constructability**	Complicated by the need to rehabilitate existing structures	Relatively straightforward, although more complex than IFAS	Straightforward for structural elements, less so for mechanical equipment and controls	Relatively straightforward
17	**Suitability for risk reduction through D&B or DBOT modality**	Nature of works required would not lend it to DBOT modality easily due to rehab of structures.	Would be suitable for DBOT-type modality	Would be suitable for DBOT-type modality	Would be suitable for DBOT-type modality
18	**Major Risks associated with each option:**	• Extensive use of existing structures increases risk of structural failure of basins & reactors • Use of existing configuration of structures means that new WWTP cannot adopt optimal layout • Inter-connecting pipework increases risk of winter freezing • Incremental development relatively difficult but inexpensive if using existing structures • Need for interim treatment arrangements during construction (use of other existing plant structures) • Contractors or suppliers my limit warranty period based on use of existing structures	• Susceptible to reductions in treatment efficiency under high or low loading rates. • Configuration of structures and interconnecting pipework means that new WWTP cannot readily be extended. • Extensive inter-connecting pipework increases risk of winter freezing • Step-feed process adds to complexity and cost	• Operational complexity increases risks of operational failure or treatment problems • Treatment efficiency susceptible to wide variations in flow unless large balancing tank in front of reactor • External experts required for the maintenance of sophisticated technical equipment • Flexibility in arranging phases requires sophisticated computer-based control system, demanding extensive external support and training of the operating staff on commissioning: high cost & risk of failure	• Relatively untried technology increases operational risks, although based on well-tried principles • Need for optimal treatment conditions requires the use of relatively sophisticated computer-based control system.
19	**Risks associated with contracting out works**	Contractors may be reluctant to undertake works, or to	Well known system and should attract wide interest from	Well known system and should attract wide interest from	Relatively less well known process could restrict

Item	Evaluation Criteria	Modification and Rehabilitation of existing Activated Sludge Plant as IFAS system	New modified Step-feed process Activated Sludge Plant	Standard Sequencing Batch Reactor System (as recommended by MoMo)	Integrated Fixed-film Activated Sludge Process (IFAS)
		guarantee works, because of doubts on viability of structures	contractors	contractors	international contractor interest and responsiveness
20	**View of Expert Technical Committee on Water and Wastewater Treatment and Steering Committee**	Existing structures should be used where possible if certified by competent authorities	This process is well understood but could be developed further based on Mongolian experience and conditions.	This system may face operational problems as not used before at this scale in Mongolia	This system is preferred as it is relatively simple modification of ASP and thus the most suitable for Mongolian conditions
21	**View of experts from ADB's RSDD**	There is value to reusing existing structure and providing new plant within existing plant footprint. Full extent of damage to structures can only be fully assessed once the whole facility is emptied. In-situ partial demolition and reconstruction on same footprint an option but adds risks, complexity and potentially costs.	Step-feed arrangement relatively costly in terms of both capital and operating costs. New facility optimises new technology and minimizes risk, but creates potentially more negative impacts due to footprint and need to deal with decommissioned existing structures.	Concern that operational complexity could compromise performance New facility optimises new technology and minimizes risk, but creates potentially more negative impacts due to footprint and need to deal with decommissioned existing structures.	Not well known but technology appears sound as based on ASP technology. New facility optimises new technology and minimizes risk, but creates potentially more negative impacts due to footprint and need to deal with decommissioned existing structures.

5.6 - Cost Estimates for Options

32 Base capital and operating costs for the options considered are provided in Tables A5.3 and A5.4 below. These base capital and operational costs were used to calculate the total costs (including all add-on costs) used in Table A5.2 above.

Table A5.3: Treatment Plant Base Capital Costs in US$ million

Item	Capital Cost Item	Modification and Rehabilitation of existing Activated Sludge Plant as "three sludges" system	New modified Step-feed process Activated Sludge Plant	Standard Sequencing Batch Reactor System (as recommended by MoMo)	Modified Batch Reactor Activated Sludge Process (three sludges system)
1	Site Preparation	0.015	0.015	0.015	0.015
2	Earthworks	0.050	0.470	0.470	0.470
3	Main pump station rehabiliation -works	0.050	0.050	0.050	0.050
4	Main pump station rehabiliation -equipment	0.370	0.370	0.370	0.370
5	Civil works construction	1.200	6.640	4.000	4.320
6	Treatment Mechanical Equipment	6.200	5.744	6.245	6.200
7	Electrical equipment & control panels	0.280	0.350	0.280	0.280
8	automatic control of sewage disposal system	0.172	0.172	0.172	0.172
9	Interconnecting pipe works	0.100	0.500	0.250	0.250
10	Commissioning & adjustment works	0.150	0.150	0.150	0.150
11	Project management and supervision costs	0.040	0.040	0.040	0.040
12	Miscellaneous items	0.600	0.600	0.600	0.600
Sub-total		**9.227**	**15.101**	**12.642**	**12.917**
13	Contingencies	1.384	2.265	1.896	1.938
Grand Total		**10.611**	**17.366**	**14.538**	**14.855**

Table A5.4: Annual Operational Costs for Treatment System Options

Item	Operating Cost Item	Modification and Rehabilitation of existing Activated Sludge Plant as "three sludges" system	New modified Step-feed process Activated Sludge Plant	Standard Sequencing Batch Reactor System (as recommended by MoMo)	Modified Batch Reactor Activated Sludge Process (three sludges system)
1	Staff costs	0.185	0.200	0.180	0.185
2	Energy (power) costs	0.123	0.127	0.122	0.123
3	Chemical dosing costs	0.054	0.054	0.054	0.054
4	Heating and other services	0.150	0.170	0.110	0.130
5	Laboratory and monitoring costs	0.030	0.030	0.030	0.030
6	Other operational costs	0.050	0.050	0.045	0.045
Total Annual Operating Cost		**0.592**	**0.631**	**0.541**	**0.567**

5.7 - Process Evaluation: Conclusions and Recommendation

Evaluation Conclusions

33 All treatment options would potentially provide a level of treatment of Darkhan wastewater adequate to satisfy Mongolian wastewater discharge standards. There is a strong rationale for reusing elements of the existing WWTP and upgrading the system technology and equipment within these reactors, if it can be proven that the existing structures can be rehabilitated to guarantee at least 30 years of service life. The Mongolian Government's expertise agency and a private sector company specializing in structural rehabilitation have both advised that

rehabilitation is possible.[4] However, the true condition of the structure cannot be known until the facility is completely emptied. Whichever option is selected, the reactor should be covered to avoid freezing.

34 **Costs:** The overall costs (and lifetime costs) do not differ widely, although reuse of elements of the existing plant does provide significant cost saving on capital works (approximately US$ 4 million), and makes little difference on operational cost:

(1) In economic lifetime cost terms, the rehabilitation of the existing plant as an IFAS system is the cheapest;

(2) In financial lifetime cost terms, the SBR emerges as the cheapest due to relatively lower operational costs;

(3) The reuse of the existing structures for the IFAS system generates the highest EIRR (40%) and the new IFAS systems the second highest EIRR (32.9%);

(4) The new SBR system generates the highest FIRR (3.7%) and the IFAS system using existing structures the second highest FIRR (3.2%);

35 Despite some advantages in operational costs, the adoption of the new SBR is considered risky since an SBR at this scale has not been operated under similar conditions in Asia, or elsewhere in the World, and the operation is complex. The step-feed activated sludge process has the advantage of being a modification of systems already operational in Mongolia, but is relatively expensive to construct and operate. The IFAS system is also a modification of the Activated Sludge Process already operating in Mongolia with configuration and operational adjustments to improve nitrification/de-nitrification and reduce excess sludge volumes.

36 There is some benefit to constructing a new system in that the existing system can operate until the new system is ready to be brought on-stream, but this is offset by: (i) the fact that the existing system can be rehabilitated while other currently unused stream of the existing plant are used to continue treatment; and (ii) the reconstruction of the new facility within the existing WWTP footprint.

Evaluation Recommendations

37 The recommendation is that of the consultants based on: (i) the technical review summarized above; (ii) the views of the Technical Committee; and (iii) the views of other experts in the field:

(1) Based on the fact that the existing structures have been certified by the Mongolian Expert Agency to be sound, and with rehabilitation to be capable of giving at least 30 years of life, the new WWTP should use the existing structures, redeveloped and strengthened where necessary, and modified to provide an IFAS system approach;

(2) If for any reason there is a requirement to adopt a completely new plant on a new site, then the recommended technical solution is a new treatment plant adjacent and to the south of the administration buildings of the existing plant, and adopting the IFAS system;

(3) Specific assurances should be included in the contract documentation to ensure that the works are guaranteed by the contractor, despite them involving the rehabilitation of existing structures. It will be the responsibility of the contractor to ensure that the rehabilitated structures provide the specified design life;

(4) The contractor (or consortium) carrying out the design, construction and installation works should provide operational assistance over an extended period (at least 2 years) in order to train Us Suvag operators or their plant operation contractors.

[4] See Appendix 4

5.8 - Government Consideration of Recommendations

38 The client has reviewed the evaluation prepared by the consultants. In addition, Darkhan Uul *aimag* Government and Us Suvag have been given presentations by the consultants on the treatment system evaluation and the options under consideration. The conclusions and recommendation of this group have been as set out below:

(1) In its meeting held in December of 2013, the MCUD Project Steering Committee concluded that a separate meeting involving MCUD, academia, technical experts and specialists, and Us Suvag should be convened on 27th January 2014 to select the preferred technology for the WWTP;

(2) The expert group met on 27th January 2014, and a presentation was made by the consultant team. However, the group recommended that the MCUD Technical Committee on Water and Wastewater Infrastructure should consider the options and make a recommendation;

(3) On 20th February 2014 a meeting of the MCUD Technical Committee on Water and Wastewater Infrastructure recommended: (i) that the consultants look again at moving bed bioreactor and modified bioreactor options for treatment; (ii) that the existing structures of the WWTP should be rehabilitated if proved to be feasible; and (iii) that a modified activated sludge process technology – such as the IFAS system - should be adopted which is proven suitable for Mongolian conditions;

(4) At the MCUD Steering Committee meeting held on 2nd April 2014 it was concluded that: (i) the proposed design capacity of 20,000 m3/d should be reviewed and confirmed by the consultants based on projections of future wastewater generation rates; (ii) the most appropriate and up-to-date technology should be used for the plant; (iii) the committee supported the adoption of the modified activated sludge process (i.e., Integrated Fixed-film Activated Sludge (IFAS) process) for the Darkhan WWTP, and that the existing structures should be used where feasible, and where consistent with the treatment plant adopting the most modern treatment approaches.

5.9 - Final Selection

39 As a result of this consultative process, Option 4 (IFAS) was selected, with the reuse of existing buildings. The solution is considered to be environmentally sound; in particular it will produce approximately 1/3 of the sludge as produced by SBR technology and therefore will require smaller volumes of sludge to be treated and disposed of. The effluent quality of IFAS is predicted to be sufficient to adequately meet Mongolian National Standards.

Appendix 6: Terms of Reference for General Plan to Make Darkhan a Model City

Approved by ERDENEBUREN.R
STATE SECRETARY OF MCUD

TERMS OF REFERENCE – DEVELOP THE DESIGN OF A GENERAL PLAN TO MAKE DARKHAN A NATIONAL "MODEL CITY"

1. The Plan should be based on the following relevant documents:

- "The National Program and Millennium Development Goals" approved by Parliament decree No 12 in 2008;
- "New Development medium term target program" approved by Parliament decree No 36 in 2010;
- "Mongolian Government 2012-2016 Action Program" approved by Parliament decree No 37 in 2012;
- Action plan of Mongolian Government 2012-2016 Action Program implementation approved by Government decree No 120 in 2012;
- Law on 2013 state budget;

2. Overview:

- ***Objective of the consulting services:*** The aim is to develop a plan to make Darkhan city, Darkhan-Uul aimag a Model city of Mongolia under "Smart city", "Green city" projects.
- ***Territory:*** 4,000sq.km
- ***Location:*** Darkhan is located in the north west, 220km from Ulaanbaatar, and lies in the Orkhon and Selenge's vast river valleys, along the Kharaa river bank in Burkhan valley and 700 meters above sea level. It has a continental dominated climate. It is located along the trans-Mongolian railway linking Russia and China.
- ***Current situation:*** The city of Darkhan's area is 98,000 hectares with a population of 71,784 by the 2012 census. Darkhan Thermal Power Plant Joint Stock Company (DTPP) has a capacity to heat at a rate of 1196 gcal/h and provides 48 MW of power. There are 4 Mobile Operators and several Internet Service Providers. The master plan for development of Darkhan up to 2020 was approved by Government decree No 205 in 2005.
- ***Duration of developing plans***: 2013–2028 (the first phase of planning from 2013-2018 and 2018-2028 for the long-term strategic plan)
- ***Duration of design:*** 8 months

3. Agenda for the planning solution:

- **Basic solution:**
- Develop planning solutions for the establishment of a Smart City and define the principles of development.
- Define development approaches for "Model city" under "Smart city" and "Green city" projects having suitable environment for city residents and meeting the requirements of industries and small entities in the city.
- Review legislation and carry out survey for "Model city" and develop an organizational structure for the project in the administration office.

- Prepare the plan to enable the city to host an oil refinery plant using high technology, a metallurgical factory, a construction material factory, light industries and food industries, fast-growing agriculture, transport, logistics, science and education sectors.
- Develop business action plans and policies to implement general plans stage by stage.
- Develop marketing plans and estimate all preliminary investment costs and prepare the list of required projects and programs.
- Prepare detailed investment cost and financial baselines for implementing the general plan.
- Define the land tenure and city locational requirements based on a baseline survey and comprehensive city evaluation.
- Define optimum management organizational structures to improve the city management and renew the system of land use and boundary of developed area.
- Develop a strategic plan to be aligned with: Mongolian social and economic approaches; regional and urban development; and neighboring provinces and soums' development plans, to make Darkhan at the same level of development as Ulaanbaatar.
- Include new residential zones in the general plan aligned with industrial park plans and other sectors' documentation.
- Develop and apply a new city registration and address system.

➢ **Developing economic and social infrastructure plans:**

- Set up economic sector organizational structure, work force projections, and basic category of employment according to the first phase up to 2018, and up to 2028.
- Develop plans for the number of the pre-school and school pupils in 2018 and up to 2028.
- Develop plans and estimate capacity of full hospital service with 100% for each phase by meeting requirements.
- Develop plans for the types of apartments and houses required and provide detailed housing proposals based on family needs, housing demand and supply.

➢ ***Developing streets, road, and transport network plans:*** Develop plan aligned with Mongolian roads and railways united network. Current streets, roads, transport network and engineering infrastructure will be extended as follows:

- Develop plans for traffic speed projections on main paved roads connecting Ulaanbaatar, Erdenet and Darkhan.
- Develop plans of transit facilities on highway going through Darkhan to Altanbulag and Zamin-Uud.
- Develop plans for establishing a new auto station and railway station.
- Develop plans for parking lot demand and needs.
- Develop plans for city main road network, pedestrian roads and bicycle roads.
- Develop plans for public transportation service as follows:
  - Develop optimum solution for public transportation service and management;
  - Choose and apply efficient technologies in the public transport sector and choose environmentally friendly transportation;
  - Use advanced information technologies in urban public transportation systems.

➢ ***Developing engineering network plans:*** Increase the capacity of Darkhan Thermal Power Plant in alignment with further demand and needs and establish reliable power source. Utilize heating engineering of tunnel-based networks

- Develop plans for connection of one-story-buildings and cottages to central water supply, sewage and heating networks;
- Develop plans for extension of water supply sources and review and study on replacing facilities;
- Apply bio-nanotechnologies in the city wastewater treatment plant and increase the plant's capacity. Develop plans to establish a new wastewater treatment plant in the industrial area, in the south part of the city. Develop plans to ensure effluent treated wastewater achieves 100% quality standard;
- Develop plans and prepare detailed calculations for reusing gray water, and for solar and other renewable energy;

- Develop plans for rehabilitation of Darkhan Electricity Distribution Network and substations, replacing these with modern facilities, cable lines, and valves and install auto-monitoring and remote controls.
- Develop plans for establishing Internet connection substations, applying digital system and constructing a new television tower.
- Develop plans or building flood and drain systems, and drainage lines, storm water drainage, storage ponds and extending wastewater pumping stations or constructing a new pumping station under the framework of engineering.

➢ **Developing sustainable environmental management plans:** Develop plans for applying green land to create healthy, safe and comfortable environment, protect the environment, and provide the residents with healthy food.

- Develop plans to increase the area of green land and establish parks;
- Develop plans to take measures on deforestation, sand movement by wind; Develop plans to improve water management as follows:
  - Use surface water resources;
  - Treat wastewater and recycle it;
  - Use surface water resources and reserved water or purified wastewater for uses except for drinking;
  - Use effluent treated water for heating system in Thermal Power Plant;
  - Apply treatment plant technologies in industries and small business entities to pre-treat their factory wastewater and implement the system “Polluting factories must pay”;
  - Develop plans for pond areas;
  - Set up river protection boundary;
- Develop plans for setting up protected areas along the Kharaa river bank, constructing recreational centers to create a comfortable environment;
- Develop plans for taking measures to reduce air pollution, water pollution and soil pollution in Ger districts;
- Set up waste management systems by applying high technologies based on non-polluting chemicals;
- Develop plans for waste management mechanisms/system collection and transportation and construct new waste recycling factories and power plants (produce energy by recycling waste at high temperature at centralized waste disposal sites).
- Develop plans of establishing cemeteries, crematoriums, religion teaching centers, offering centers and custom centers.

4. **Phase for design:**

➢ ***Developing design and document approval plans:*** Develop plans with the client under “Regulations on urban development documentation and expertise” based on Darkhan city economic and social projections, territory features and resources.

➢ ***Review baseline urban development plan:*** According to “Law on urban development” article 12.9, make an assessment of the territory, population, society, economy, environment, infrastructure and others to be carried out in the city.

- Geographical layout M1:5,000;
- Engineering and geology study;
- Water source study;
- Urban development comprehensive assessment;
- Engineering source and network study;
- Social and economic study;
- Evaluation of previous plan implementation

➢ ***Developing design plans:*** Develop general plans to make “Model city” of Mongolia based on baseline urban development plans and urban development complex assessment, under approved terms of references in developing design.

- Design
  - Regional development overview and city area scheme M1:25,000
  - Area overview M1:10,000
  - Urban development comprehensive assessment M1:5,000
  - Zone, road, transport network, infrastructure service M1:5,000
  - Area attributes and dedication and types of zones M1:5,000
  - Architecture and space planning M1:5,000
  - Preparation work for engineering, vertical planning and hazardous zone boundary M1:5,000
  - Design of engineering network M1:5,000
  - Heating supply M1:5,000
  - Water supply and sanitation M1:5,000
  - Electricity supply M1:5,000
  - Communication installation M1:5,000
  - City center zone plan, and panorama M1:1,000, etc.

- Explanatory notes /4 volumes/
  - Provide evidence of design and approaches adopted;
  - Assessment of engineering-ecology and landscaping;
  - Key analysis of urban development, assessment, comprehensive assessment of urban development, advantages and disadvantages and relative comparison of options, definition of impact features on development and economic analysis, etc.
- Layout M1:2,000

Recommendations from related organizations: Evaluate recommendations from aimag and soum Resident's Representatives' Meeting, aimag and soum Governor's Office and related ministries during the planning phase, engage with the communities under the procedure "Urban development plan to be discussed with community"

5. Suggestions on design and approval:

- Make proposals with the organizations on terms of reference for design stage;
- Introduce the plan and discuss with the members from urban planning and architecture meeting under MCUD;
- Enagage state expertise on general documentation assessment and make general assessment;
- Introduce the plan project and discuss with the members from science and technology committee meeting under MCUD;
- Approve the plan by Government Resolution based on law on urban development article 6.1.4.

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