NEPAL
MINISTRY OF WATER SUPPLY
DEPARTMENT OF WATER SUPPLY AND SEWERAGE MANAGEMENT

THE PROJECT FOR DEVELOPMENT OF MASTER PLAN FOR WASTEWATER MANAGEMENT IN POKHARA METROPOLITAN CITY

FINAL REPORT

(MAIN)

AUGUST 2024

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.
NIHON SUIDO CONSULTANTS CO., LTD.
NJS CO., LTD.

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Exchange Rate

1 NPR = 1.0835 JPY
1 USD = 150.899 NPR
1 USD = 139.27 JPY
(The three-month average rate from April 2022 to June 2022)

Summary

1 BACKGROUND OF PROJECT

1.1 Background

Pokhara City, situated in the western part of Nepal, serves as the capital of Gandaki Province. It holds the distinction of being Nepal's second-largest city. As of 2021, its population stands at approximately 510,000, and projections indicate that it will grow to around 850,000 by the year 2050. Pokhara City, as the largest tourist area in Nepal, attracts over one million visitors annually. Its economic potential is evident. Notably, nine lakes including Lake Phewa, situated at the heart of Pokhara have been designated as protected areas under the Ramsar Convention since 2016. However, there are growing concerns about Lake Phewa's water quality due to population expansion and socio-economic development.

Conserving the water environment around Pokhara City, especially safeguarding Lake Phewa an essential resource for tourism has become a critical issue. Unfortunately, the city lacks proper sewerage facilities. As a result, wastewater treatment primarily occurs through septic tanks or soak pits (hereinafter referred to as "septic tanks, etc."). Most local septic tanks are constructed with brick or stone masonry at the base, allowing organic pollutants from wastewater to infiltrate underground without adequate treatment.

Moreover, a portion of gray water remains untreated and is discharged into drains and lakes. This situation urgently necessitates the establishment of a comprehensive wastewater treatment system. Doing so would ensure a hygienic living environment and support economic activities for Pokhara's citizens. The current insufficient and inappropriate wastewater management contributes to water pollution in Lake Phewa and other water sources.

The Government of Nepal has outlined ambitious wastewater management goals within the framework of the "15th Five-Year Plan (2019/20 - 2023/24)" and the "Sustainable Development Goals for Water Supply and Sanitation Services in Nepal (2016-2030)." These initiatives recognize the critical importance of addressing water quality and sanitation issues across the country.

In 2014, the Department of Water Supply and Sewerage Management (hereinafter referred to as "DWSSM") unveiled the Lake Phewa Wastewater Management Project- a plan aimed at enhancing the water environment of Lake Phewa. However, the plan has not progressed due to problems with costs and land acquisition. There is also an urgent need to improve the system for operation.

Therefore, the wastewater management in Pokhara City is crucial to take prompt measures and below are the challenges.

- Development of sewerage
- Development of laws, regulations, standards, etc. related to wastewater management
- Establishment of a system for permitting installation of septic tanks, inspection, sludge removal and transportation
- Improvement of structure from permeable to impermeable septic tank
- Treatment of miscellaneous wastewater

This project aims to develop a wastewater management plan for Pokhara City and establish water environment monitoring across the entire Pokhara City area, including Lake Phewa. JICA will assist in formulating processes to enhance the capacity of the executing agencies and provide technical support.

1.2 Implementing Agency

The project implementation involves several related organizations. Additionally, JICA Expert Team (hereinafter referred to as "JET") has established the Joint Coordination Committee hereinafter (hereinafter referred to as "JCC") and the Project Implementation Unit (hereinafter referred to as "PIU"), which collaborate to implement the project.

- Responsible Agency: MoWS
- Implementation Agency: DWSSM
- Co-Implementation Agency: Pokhara Metropolitan City (PMC)

2 FORMULATING MASTER PLAN FOR WASTEWATER MANAGEMENT

2.1 Basic Policy on Wastewater Treatment

(1) MP Planning Frames

The entire Pokhara City will be encompassed by this initiative. The target population for this project is 858,000 people by 2025. The focus of our management efforts will be on wastewater from toilets as well as miscellaneous wastewater (including kitchen and shower room wastewater). The goal is to achieve a 100% of treated ratio by 2050, either by sewage or by septic tanks (bottom: impermeable).

(2) Current Status of Sewage Treatment Systems with On-site Facilities

No sewerage system has been installed, but on-site system is running. On-site facilities are mostly septic tanks (bottom of septic tank: impermeable type), and feacal sludge is collected by private firms on an on-call basis. Current challenges with this system are as follows;

- There is a risk that sewage flowing into the septic tank may permeate underground before adequate treatment because there is only one septic tank and the bottom of the septic tank is permeable.
- Lots of households have never desludged, and adequate management of desludge and treatment have not implemented. In addition, PMC does not have the necessary organization for management and has little involvement in management.
- Collected sludge is disposed at PMC's landfill disposal site, but wastewater treatment is not implemented and untreated wastewater is discharged.
- Lots of septic tanks are not equipped with inspection holes or desludge holes, and it is necessary to make a hole on the upper slab to check inside septic tank.
- With few exceptions, grey water is not subject to treatment.

(3) Wastewater Treatment System

The following sewage treatment systems are introduced to solve the above challenges;

- To allow only sewerage or impermeable septic tank
- To prohibit newly installing permeable septic tank
- To discharge effluent of septic tank in drains, agriculture land, etc. or ground through soak pit
- To treat all of sludge at WWTP or STP
- To allow continuous use of the existing (permeable) septic tanks, but to put obligation to install impermeable ones at the time of building renewal / rehabilitation

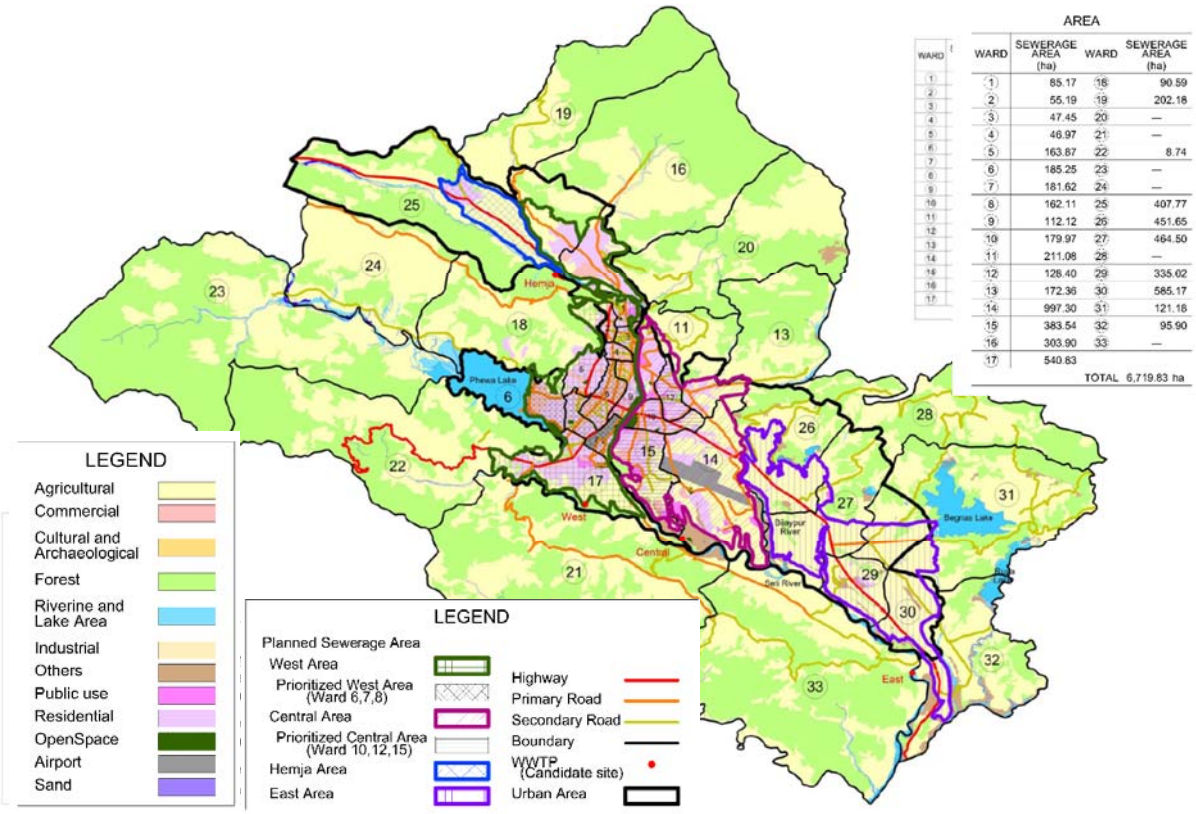
(4) Sewerage Treatment Area

In Pokhara City, the entire area will be covered, and it is divided into two zones: the sewerage area and the on-site sanitation area.

1) Sewerage Area: The sewerage area encompasses the urban zones, excluding forests and river floodplains, based on the land use situation. The sewerage treatment area will be divided into four zones based on topography and current socioeconomic conditions.

2) On-Site Sanitation Area: Beyond the sewerage area, other parts of managed by Pokhara City fall into the on-site sanitation category. Here, wastewater treatment occurs locally, emphasizing City-Wide Inclusive Sanitation (hereinafter referred to as “CWIS”).]

The locations of the sewerage treatment area and on-site treatment area are shown in Figure 2-1.



Note: Sewerage Area (Area enclosed by colour line), On-site Facility Area (Pokhara City except sewerage area)
Source: JET

Figure 2-1 Location of Sewerage Area and On-site Sanitation Area

(5) On-site Sanitation Plan

Since the change to an impermeable septic tank will have little impact on citizens in terms of construction costs, the "septic tank (bottom: impermeable type)" will be the standard, and the frequency of desludge will be every two years. Individual faecal sludge treatment plant will be constructed prior to the sewerage system, with a planned year of 2030, just before the sewerage system is put into service. In case of future increase in sludge, it will be accepted at the sewage treatment plant. The summary of the plan is shown in Table 2-1.

Table 2-1 On-site Sanitation System (MP)

Item	Contents
System	Impermeable, Anaerobic Installation of a new impermeable septic tank Treated water discharges into gutters and farmlands, or soaks into ground from permeable pit.
Procurement	Procurement of 86 vacuum cars in total (maximum of 45 vehicles annually)
Sludge Treatment Facility	Capacity: 210 m^3/day

Source: JET

(6) Off-site (Sewerage) Facility Plan

Based on the population forecast by sewage treatment zone in 2050, the designed sewerage flow is estimated, and the conventional active sludge method similar to be operated in the Kathmandu Valley is installed in each sewage treatment zone. Each sewage treatment capacity is planned as shown in Table 2-2.

Table 2-2 Treatment Capacity of WWTPs

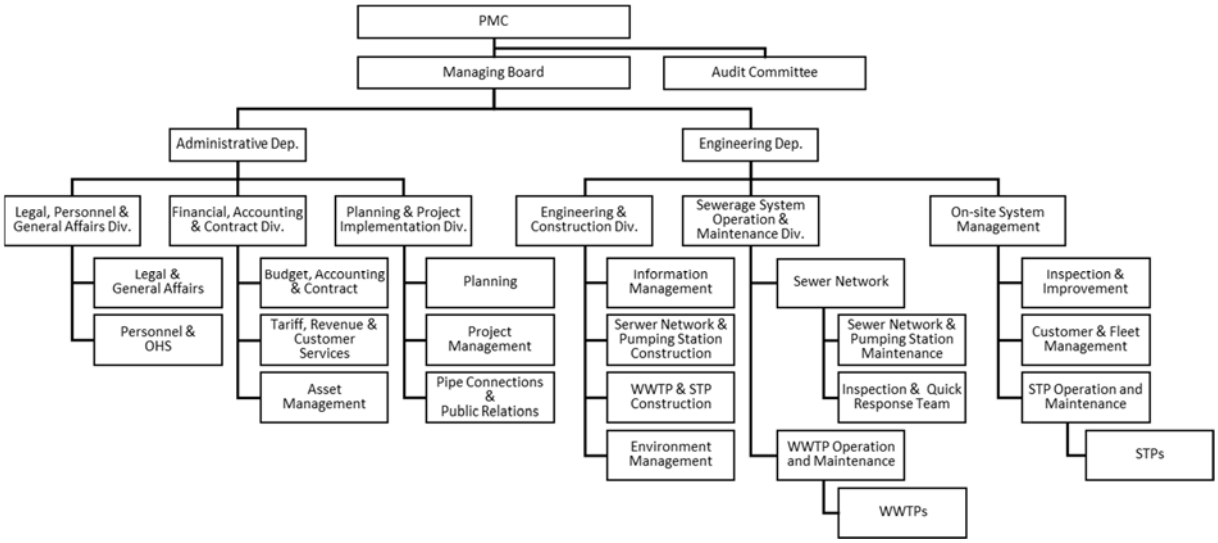
Treatment Area	Capacity (m^3/day)
West	72,500
Central	39,000
Hemja	4,500
East	18,000

Source: JET

Pokhara City is divided into four sewage treatment zones -West, Central, Hemja, and East- and a customized pipeline plan was developed for each treatment zone. All sewage systems will utilize separate sewers, and the overall transport system will rely on gravity flow. However, due to Pokhara's rugged terrain, sewage pumping stations and manhole pumps will be installed at important points in areas where it is difficult to collect by gravity.

(7) Management and O&M Plan in Pokhara City

PMC has little experience, organization, and technical capabilities in the management and O&M of sewerage facilities. Even government agencies in Nepal have little experience as well, so it is necessary to utilize private companies with technical capabilities and management know-how. Therefore, along with the adoption of a contract method in which a private company will carry out O&M management for a certain period of time using the DBO method, a Managing Board, which is independent from the existing PMC departments and can operate under independent organization, will be established to manage both sewerage and on-site treatment under the system shown in Figure 2-2.
In addition, since it is necessary to enact ordinances and improve the building permit system to promote sewer connection, septic tanks (bottom: impermeable type), and sewage treatment fee will be implemented in parallel.



Source: JET

Figure 2-2 Proposed Structure of Management and O&M Organization

(8) Draft Plan for the Monitoring System of Ramsar Wetlands in Pokhara City

PMC will implement a water environment monitoring plan to assess environmental water quality in the Pokhara City, formulate a water quality conservation plan for lakes, including measures to prevent and improve water pollution, and monitor water quality. For implementation, the PMC will establish a Water Environment Section specializing in water quality conservation, and the FWSSMP will be in charge of water quality analysis in cooperation with the PMC.

Table 2-3 Summary of the Monitoring Plan

Item	Description
Target area	All of Pokhara City (especially Lake Phewa and river, groundwater, drainage flow into Lake Phewa)
Implementation agency	PMC FWSSMP
Target period	2023 to 2050 Target year of mid-term plan: 2030 Target year of long-term plan: 2050
Target water quality	Ambient environment: lake water, river water (including water in canals, drainage, side ditches), groundwater Business wastewater: wastewater that flow into Lake Phewa and rivers etc. from discharging business (hotels, factories, businesses, sewage etc.) Domestic wastewater: effluent discharged from sewage system and on-site treatment of household

Source: JET

(9) Overview of Business Components that have Environmental and Social Impacts

The project components and environmental impacts anticipated for the project are shown in Table 2-4.

Table 2-4 Summary of Project Components

Category	Business Components	Summary
Off-site treatment	Construction of sewage treatment plants	New facility construction with land acquisition
	Construction of pumping stations	Construction of new facilities with land acquisition
	Construction of sewage culverts	Installation of pipes (trunk lines, sub-trunk lines, installation pipes, etc.) to be connected to the sewage treatment system
On-site treatment	Construction of on-site treatment facilities	Installation of individual or small-scale facilities: septic tanks, septic tanks, etc.
	Construction of sludge treatment facilities	Construction of new facilities for treatment and reuse of sludge from septic tanks, etc., with land acquisition

Source: JET

The Central WWTP has been identified as the proposed site for constructing the sewage treatment plant. The West, Central, and East areas are all situated within the Ramsar wetlands, where sewage pipes will be laid. This project aims to enhance the Ramsar wetlands' environment by minimizing sewage discharge into lakes and rivers. However, JET must also take into account the potential impact on bird habitats when selecting the sewage treatment plant's construction site.

2.2 Expenses Required for Implementation of Development Projects and Schedule

The approximate costs required for the Projects formulated in MP are shown in Table 2-5.

Table 2-5 Summary of Projects Formulated in MP

No.	Items	Contents	Period	Costs (million NPR)
1.	Construction of Individual STP	・ Pre-F/S / Basic Design ・ Detailed Design ・ Construction of Individual STP (210 m^3/day) ・ Procurement of Vacuum Cars (4 m^3×8 nos.)	2023 - 2026	777
2	Capacity Development on Wastewater Management	・ Capacity development on sewerage and on-site treatment system ・ Capacity development on water environmental management ・ Capacity development on public relations	2023 - 2025	500
3.	Sewerage Development	・	2024 - 2050	
3-1	・ West Sewerage Treatment Area Phase-1.1	・ WWTP (1/4 train of 72,500 m^3/day) ・ Trunk Sewer (8.5 km)	2024 – 2035	9,440
3-2	・ West Sewerage Treatment Area Phase-1.2	・ WWTP (2/4 train of 72,500 m^3/day) ・ Trunk Sewer (8.5 km)	2024 – 2035	9,440
3-3	・ West Sewerage Treatment Area Phase-2.1	・ WWTP (3/4 train of 72,500 m^3/day) ・ Trunk Sewer (15.9 km)	2028 – 2038	18,345
3-4	・ West Sewerage Treatment Area Phase-2.2	・ WWTP (72,500 m^3/day) ・ Trunk Sewer (15.9 km)	2028 – 2038	18,345
3-5	・ Central Sewerage Treatment Area Phase-1.1	・ WWTP (1/4 train of 39,000 m^3/day) ・ Trunk Sewer (8.2 km)	2032 – 2041	8,596
3-6	・ Central Sewerage Treatment Area Phase-1.2	・ WWTP (2/4 train of 39,000 m^3/day) ・ Trunk Sewer (8.2 km)	2032 – 2041	8,596
3-7	・ Central Sewerage Treatment Area Phase-2.1	・ WWTP (3/4 train of 39,000 m^3/day) ・ Trunk Sewer (6.7 km)	2036 – 2044	9,455
3-8	・ Central Sewerage Treatment Area Phase-2.2	・ WWTP (39,000 m^3/day) ・ Trunk Sewer (6.7 km)	2036 – 2044	9,455
3-9	・ Hemja Sewerage Treatment Area	・ WWTP (4,500 m^3/day) ・ Trunk Sewer (5.6 km)	2039 – 2047	5,193
3-10	・ East Sewerage Treatment Area Phase-1.1	・ WWTP (2/4 train of 18,000 m^3/day) ・ Trunk Sewer (7.0 km)	2042 – 2050	9,928
3-11	・ East Sewerage Treatment Area Phase-1.2	・ WWTP (18,000 m^3/day) ・ Trunk Sewer (7.0 km)	2042 – 2050	9,928

Source: JET

2.3 Economic and Financial Analysis

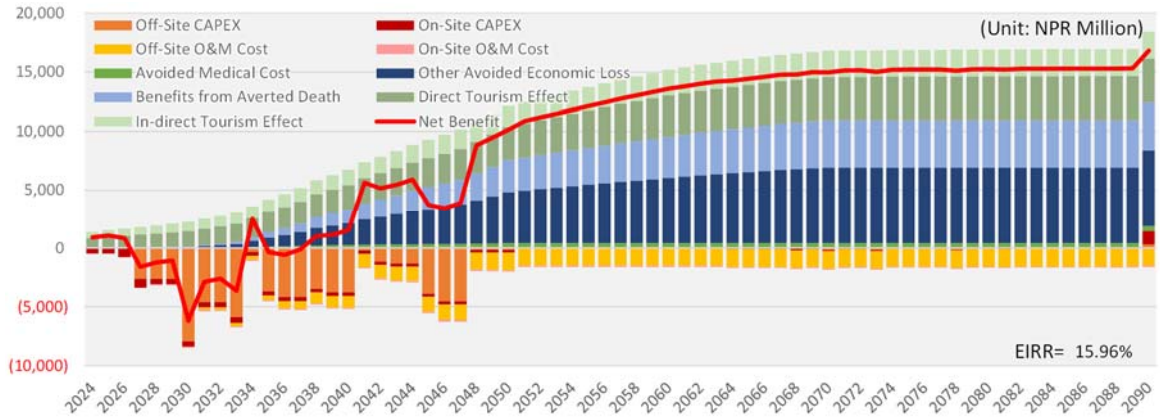
(1) Economic Analysis

The economic benefits of the project's implementation and proper wastewater management of were evaluated by comparing the economic benefits of reduced health hazards and increased value added due to increased tourism to the economic costs. The results are calculated as shown in Table 2-6 and Figure 2-3. The project of MP is economically feasible, since it satisfies EIRR > 12%, ENPV > 0, and B/C > 1.

Table 2-6 Results of Economic Analysis

EIRR: Economic Internal Rate of Return	ENPV: Economic Net Present Value	B/C Ratio: Benefit to Cost Ratio
15.96%	NPR 4,780.5 million	1.179

Source: JET



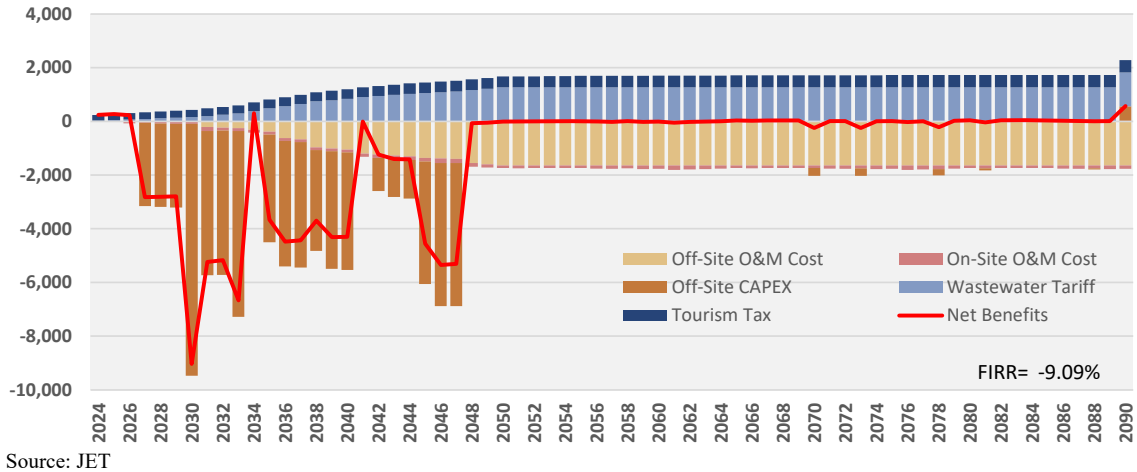
Source: JET

Figure 2-3 Cashflow for Economic Internal Rate of Return

(2) Financial Analysis

The financial adequacy of the MP projects, the was evaluated by comparing financial costs, such as construction and operation and maintenance costs of the sewage treatment facility, with expected revenues and other financial benefits, assuming grant assistance from development partners such as Japan for the construction of an individual septage treatment plant and the initial procurement of vacuum trucks. The financial benefits were assumed to be (1) revenue from sewage treatment fees averaging NPR470/month/household and (2) a tourism tax (tentative name) averaging NPR90/person/night.

As a result, it is impossible to recover the investment costs, thereby financial internal rate of return (FIRR= -9.09 %), although the revenues can generally cover the O&M costs as shown in Figure 2-4. Therefore, the MP projects were not feasible from a financial point of view. While the projects already proven to be economically feasible and worthwhile implementation from national economic point of view.



Source: JET

Figure 2-4 Cashflow of Financial Internal Rate of Return of the Master Plan Project

3 PRE-F/S OF PRIORITY PROJECTS

Pre-F/Ss were carried out for the priority projects that were selected during the formulation of the MP.

- Improvement of on-site sanitation during the transitional period of sewerage development
- Sewerage Project (West sewerage zone)
- Capacity Development for management of wastewater (sewerage and on-site sanitation, water environmental monitoring and public awareness)

Following the finalization of the 2021 Census, the population to be used in the Pre-F/S was re-projected based on the updated value as 847 thousand in 2050.

3.1 On-site Sanitation Improvement plan during the Transition Period of Sewerage Development (Priority Project 1)

In the MP, the fundamental approach was to implement off-site treatment (sewerage) in urban areas, while relying on on-site sanitation (impermeable septic tanks) in areas other than sewerage zones. However, due to the extensive preparation required for establishing the sewer network, sewage treatment will commence as early as 2031 in the West sewerage zone (Phase 1). In contrast, the East sewerage zone, which will begin service later, is projected to start sewage treatment in 2048.
On-site sludge treatment facilities to be developed will contribute to wastewater treatment during the transitional phase of sewerage development. Additionally, de-sludge vehicles will be procured.

Table 3-1 On-site Sanitation System (Pre-F/S)

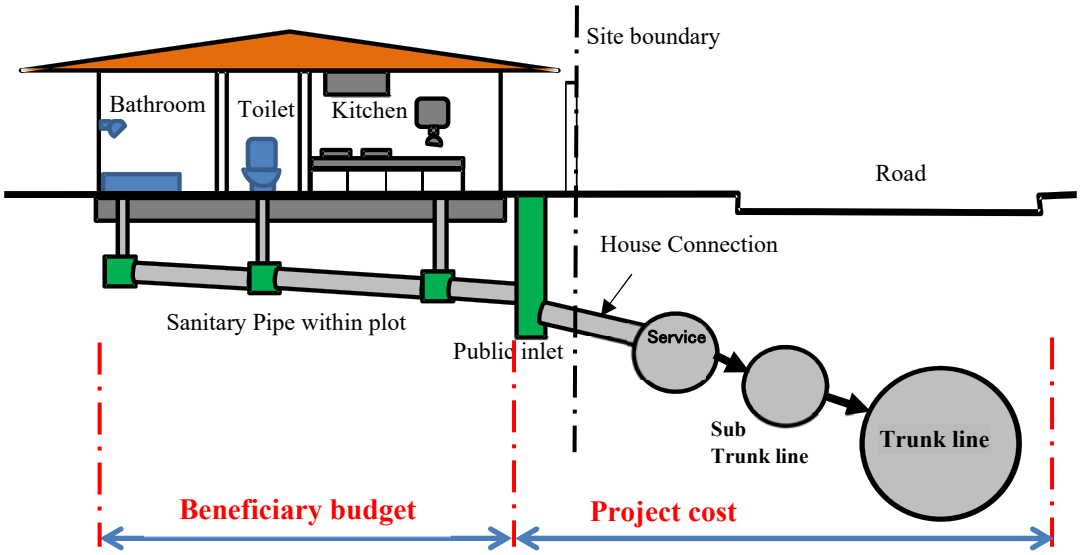
Item	Contents
System	Impermeable, Anaerobic Installation of a new impermeable septic tank Treated water discharges into gutters and farmlands, or soaks into ground from permeable pit.
Procurement	Procurement of 9 vacuum cars (as required in 2030)
Faecal Sludge Treatment Facility	Capacity: 210 m^3/day

Source: JET

The proposed site for the individual sludge treatment facility will be the former site of a closed waste landfill with a sludge disposal. The landfill was closed as part of the bird strike measures for the new international airport which opened in January 2023. The site is owned by PMC, and no new land acquisition is required. The sludge treatment facility requires bird strike measures, and the sludge treatment facility will be covered on the ponds to prevent birds. DWSSM will also need to consult with the CAAN regarding the bird strike measures.

3.2 Sewerage Plan (West Treatment Zone) (Priority Project 2)

In the MP, the Urban Area was targeted for sewerage and planned to be divided into four treatment zones. The West sewerage zone where located in the center of the city and eastern bank of Phewa Lake has been designated as a priority area for development due to factors such as urgency, development speed, beneficiary population, population density, investment efficiency, and unit treatment cost.
The sewage facility will be designed to meet the target year of 2050 based on the finalization of the 2021 Census and will comprise a sewage treatment plant with a capacity of 63,000 m^3/day and a network of sewage pipes totaling approximately 1,111 km in length.



Source: JET

Figure 3-1 Definition and Burden Classification of Pipe

3.3 Capacity Enhancement Plan for Wastewater Management (Sewerage, On-site Treatment and Water Environment Management/Public Relations) (Priority Project-3)

To ensure effective operation and utilization of the facilities planned for priority projects 1 and 2, it is crucial to enhance the technical capabilities of the DWSSM and PMC during the implementation phase of wastewater management. The capacity development for wastewater management is the followings and it is desired the technical assistants by the development partners such as Japan.

- Capacity Enhancement Plan for Sewerage and On-site Treatment
- Capacity Enhancement Plan for Water Environment Management
- Capacity Enhancement Plan for Public Awareness

3.4 Estimated Project Cost and Implementation Schedule for Priority Projects

The estimated project cost and implementation period for the priority projects are shown in Table 3-2.

Table 3-2 Estimated Project Cost and Implementation Period of Priority Projects

No.	(Data) Item	Summary	Period (years)	Estimated Cost (million NPR)
1.	On-site Treatment Improvement Plan for Transitional Sewerage Improvement	・ Pre-F/S / Basic design ・ Detailed design ・ Decomposing tank sludge stand-alone treatment facility (210 m^3/day) ・ Vacuum car procurement (4 m^3 x 9 units)	2023 - 2026	848
2.	Sewerage Plan (West Treatment District)		2024 - 2035	
2-1	West treatment area Phase-1	・ WWTP (31,500 m^3/day, 2/4 series) ・ Sewer pipe line (223.2 km) ・ Manhole pumping stations (7 units) ・ House connection, Sanitary Pipe within plot (87,689 locations)	2024 - 2035	27,598
2-2	West treatment area Phase-2	・ Sewage treatment plant (63,000 m^3/day, 4/4 series) ・ Sewer pipe line (355.1 km) ・ Manhole pumping stations (9 units) ・ House connection, Sanitary Pipe within plot (96,595 locations)	2028 - 2038	30,506
3	Capacity Enhancement Plan for Sewage Management	・ Capacity Enhancement Plan for Sewerage and On-site Treatment ・ Capacity Enhancement Plan for Water Environment Management ・ Capacity building plan for public awareness	2024 - 2027	500

Source: JET

3.5 Environmental and Social Consideration

The priority projects are to construct a wastewater treatment facility in a Ramsar wetland, which aims to reduce the discharge of wastewater into lakes and rivers. Therefore, it contributes to the improvement of the environment of the Ramsar wetland. However, it is necessary to comply with effluent standards on wastewater discharge from the facility. The impact on the water environment will be monitored through monitoring, and measures will be taken such as suspending the operation of the facility in case of abnormalities.

In terms of land acquisition, priority project 2 requires the land acquisition for a wastewater treatment plant. The acquisition of land for the site will carried out by PMC in accordance with the appropriate procedures for acquiring land for public projects.

3.6 Economic and Financial Analysis

The economic and financial analysis of both of priority project 1 and 2 are rated as economically feasible and desirable to implement from a national economic perspective. On the other hand, in the financial analysis, it is not possible to cover the investment costs with revenues from fees and other sources, and the projects are not evaluated as financially profitable. However, it is evaluated that the O&M of the projects can be covered by revenues from fees and other sources, with the central government and PMC bearing the investment costs.

(1) Economic Analysis

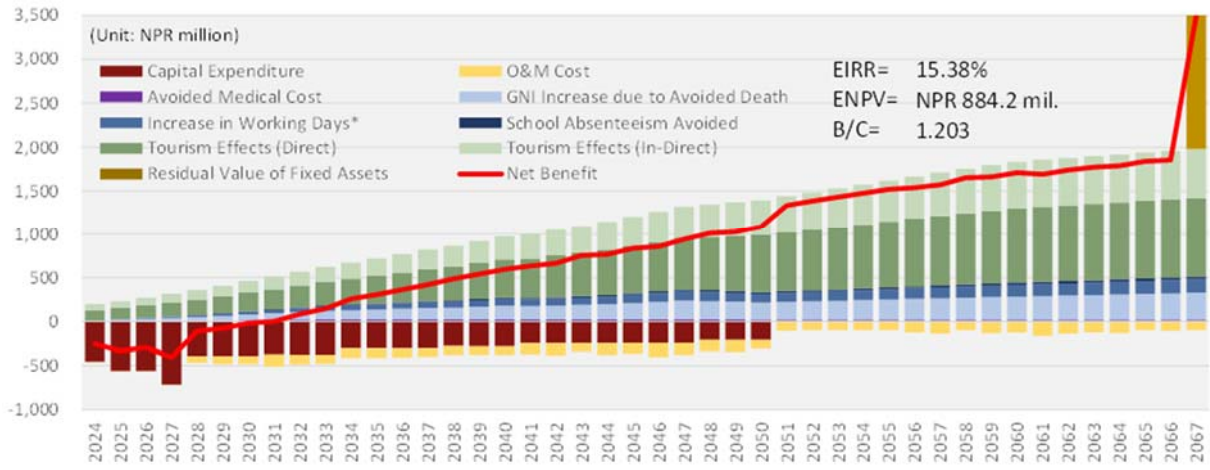
1) Priority Project 1

As economic benefits from the implementation of the project and appropriate wastewater management, the economic feasibility was evaluated by comparing the health hazard reduction from priority project 1 and the increase in added value from increased tourism to the economic costs. The results are shown in Table 3-3 and Figure 3-2, and the results indicate that priority project 1 is economically justified, since it satisfies EIRR > 12%, ENPV > 0, and B/C > 1.

Table 3-3 Results of Economic Analysis (Priority Project 1)

EIRR: Economic Internal Rate of Return	ENPV: Economic Net Present Value	B/C Ratio: Benefit to Cost Ratio
15.38%	NPR 884.2 million	1.203

Source: JET



Source: JET

Figure 3-2 Cashflow for Economic Internal Rate of Return (Priority Project 1)

2) Priority Project 2

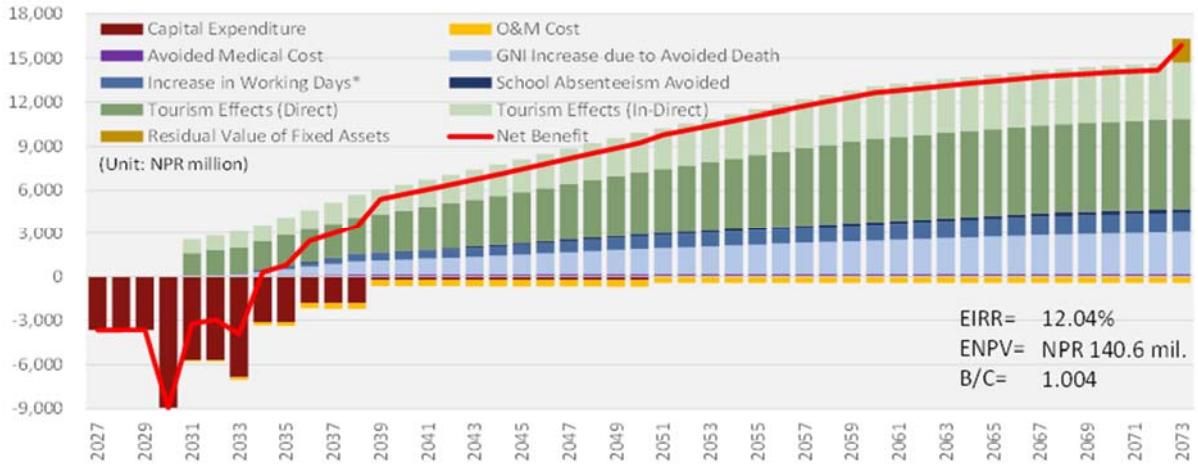
As economic benefits from the implementation of the project and appropriate wastewater management, the economic feasibility was evaluated by comparing the health hazard reduction from priority project 2 and the increase in added value from increased tourism to the economic costs. The results are shown

in Table 3-4 and Figure 3-3, and the results indicate that priority project 2 is economically justified, since it satisfies EIRR > 12%, ENPV > 0, and B/C > 1.

Table 3-4 Results of Economic Analysis (Priority Project 2)

EIRR: Economic Internal Rate of Return	ENPV: Economic Net Present Value	B/C Ratio: Benefit to Cost Ratio
12.04%	NPR 140.6 million	1.004

Source: JET



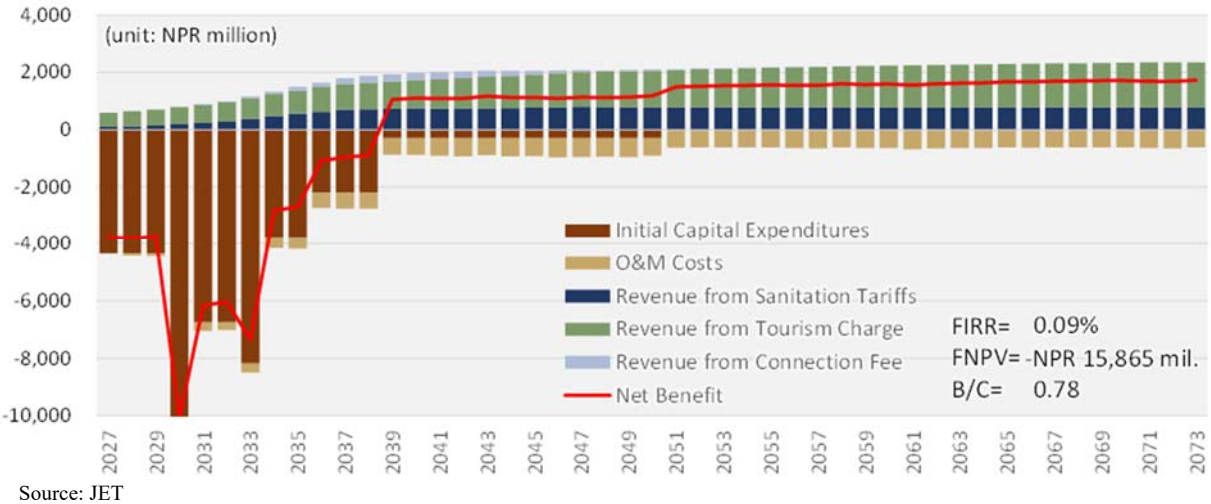
Source: JET

Figure 3-3 Cashflow for Economic Internal Rate of Return (Priority Project 2)

(2) Financial Analysis

Since priority project 1 is assumed to be a grant aid, a financial analysis comparing costs and benefits is not possible. Therefore, a financial analysis was conducted for priority projects 1 and 2 combined, and financial adequacy was evaluated by comparing the financial costs, such as initial investment and O&M costs, and the financial benefits, such as expected income, of both projects. As for the financial benefits, as in the MP, (1) the average sewage treatment fee income of NPR470/month/household was assumed, but (2) a tourism tax (tentative name) of NPR160/person/night was established to ensure a positive financial internal rate of return.

As a result, the FIRR was 0.09%, as shown in Figure 3-4. However, the weighted average cost of capital (WACC) was calculated to be 1.82%, which is larger than the FIRR, so the project will not generate enough profit to recover the initial investment. However, since the FIRR is slightly positive, it is evaluated that the income from the project is barely enough to cover the financial burden.



Source: JET

Figure 3-4 Cashflow of Financial Internal Rate of Return of the Priority Projects

4 TECHNICAL ASSISTANCE AND CAPACITY BUILDING

The objective of this project was to enhance the capacity of the PIU through the following four specific measures. The outcomes of seminars and other related activities are presented in Table 4-1 to Table 4-5.

- Mini Seminar
- Seminar
- Training in Japanese
- Training in Nepal
- Public Announcement

Table 4-1 Record of Seminar

Date	Contents	Nepal Side
December 15th, 2021	Sewerage Administration and Management in Japan	PIU 6 persons
December 24th, 2021	Duties of Sewerage Administration and Consultant works in Japan	PIU 6 persons
April 4th, 2022	Review of existing sewerage plan (Lakeside sewerage plan) and concept of sewerage MP	Project Director /Manager etc. 3 persons
April 8th, 2022	Existing condition of on-site sanitation and issues to be overcome	PIU 6 persons
April 8th, 2022	Existing condition of O&M system and lessons from Kathmandu and Biratnagar Cases	PIU 6 persons

Source: JET

Table 4-2 Seminar Achievements

Date	Contents	Nepal Side
December 15th, 2023	Interim Seminar	Ward Representative etc. 33 persons
June 17th, 2024	Final Seminar	Ward Representative etc. 70 persons

Source: JET

Table 4-3 Training Outline and Objectives

Training Name	The 1st training in Japan on Development of Master Plan for Wastewater Management in Pokhara Metropolitan City
Training Period	From Friday, April 14, 2023, through Saturday, April 29, 2023 (including travel days). Three semi-high-level staff members are on duty from Friday, April 21, 2023, to Saturday, April 29, 2023.
Number of Training Participants	7 (including 3 semi-high level staff)
Training Objectives	To contribute to the development and implementation of the Pokhara City wastewater management MP by learning about the organization, institutions, and finances of the Japanese sanitation system and improving their knowledge of sanitation.

Source: JET

Table 4-4 Training Outline and Objectives

Training Name	Training in Nepal on Development of Master Plan for Wastewater Management in Pokhara Metropolitan City
Training Period	From Sunday, February 18, 2024, through Thursday, February 22, 2024 (including travel days).
Number of Training Participants	5 persons
Training Objectives	The training program will be conducted to learn about the operation and maintenance of the existing sewage treatment facilities in Nepal, to improve knowledge of local sewage management methods, etc., as well as to clarify issues faced by existing facilities and reflect proposed measures in the planning content of the development of a master sewage management plan for Pokhara.

Source: JET

Table 4-5 PAWG's Activity Record

Activity	Date	Summary
The 1st Public Awareness Working Group for wastewater management (PAWG) meeting	Jan. 31, 2023	・PAWG kickoff ・Discussion on an annual public awareness plan (draft) ・Discussion on the PR short movie finalization
The 2nd PAWG meeting	Feb. 7, 2024	・Activity planning including community meetings ・the PR movie preview
Community meeting (Ward 15)	Feb. 7, 2024	・Community meeting at Ward 15 (central zone)
The 3rd PAWG meeting	Feb. 14, 2024	・Finalization of the PR movie ・Review of the community meeting ・Planning of stakeholder meetings for the priority projects ・Discussion on the annual public awareness plan for the next fiscal year

Source: JET

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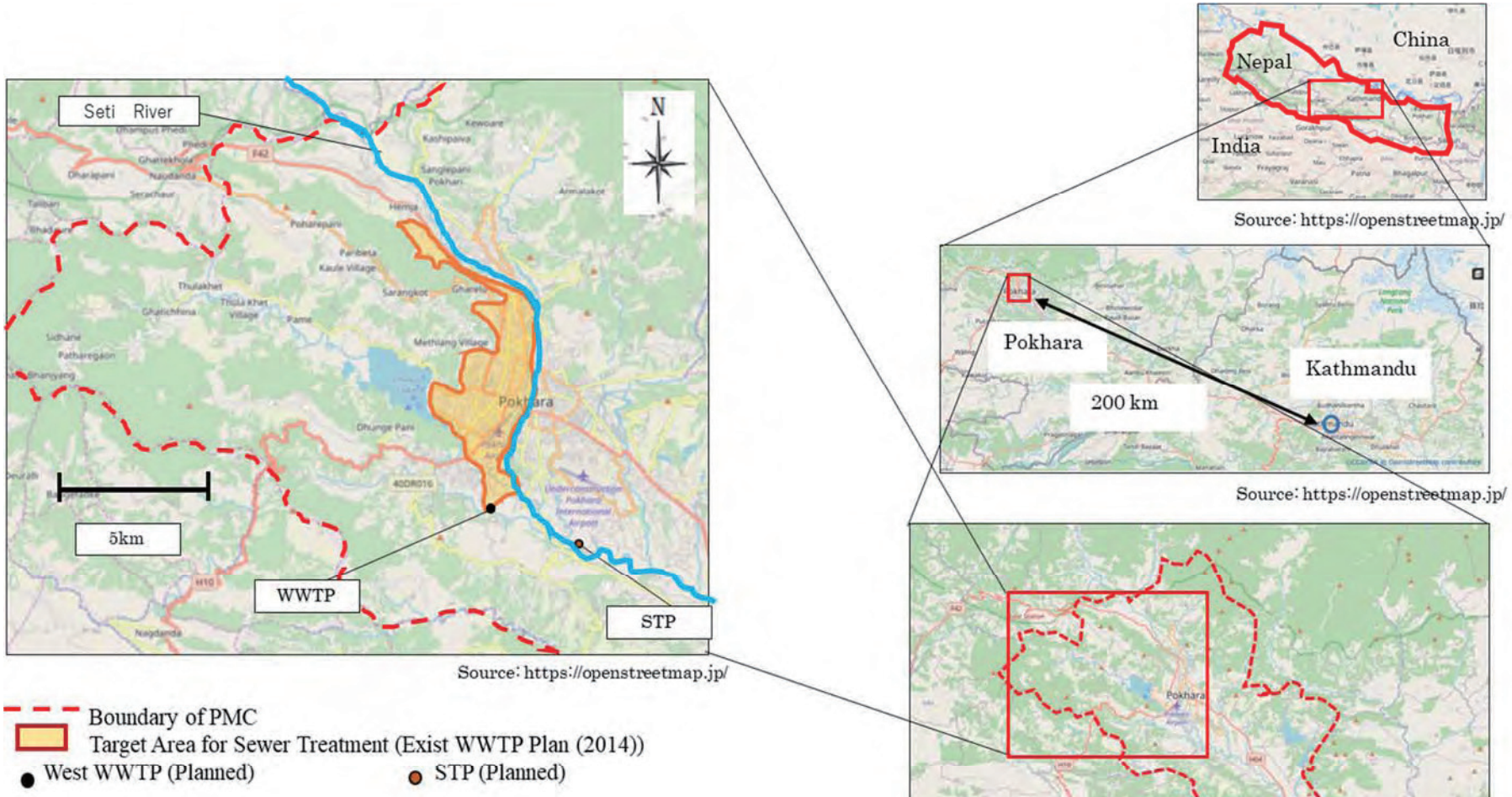
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Project Area

Abbreviation

B/C Ratio	Benefit-Cost Ratio
BES	Brief Environmental Survey
CBS	Central Bureau of Statistics
C/P	Counterpart
DALY	Disability-adjusted life year
DWSSM	Department of Water Supply and Sewerage Management
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
EPA	Environmental Protection Act
EPR	Environmental Protection Rules
F/S	Feasibility Study
FIRR	Financial Internal Rate of Return
FOG	Wastewater from Kitchens of Hotels and Restaurants, especially Fats, oils, and Grease
FWSSMP	Federal Water Supply and Sewerage Management Project
GDP	Gross Domestic Product
GNI	Gross National Income
IEE	Initial Environmental Examination
JCC	Joint Coordination Committee
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
KUKL	Kathmandu Upatyaka Khanepani Limited
KVWSMB	Kathmandu Valley Water Supply Management Board
LAPA	Local Adaptation Plans for Action
LCD	Litter per Capita per Day
LCDA	Lake Conservation and Development Authority
MoFE	Ministry of Forest and Environment
MoUD	Ministry of Urban Development
MoWS	Ministry of Water Supply
MP	Master Plan
NPR	Nepalese Rupee
NWSC	Nepal Water Supply Corporation
PID	Project Implementation Directorate
PIU	Project Implementation Unit
PMC	Pokhara Metropolitan City
SCF	Standard Conversion Factor
SDGs	Sustainable Development Goals
SEA	Strategic Environment Assessment
STP	Faecal Sludge Treatment Plant
WHO	World Health Organization
WSMB	Water Supply Management Board
WUSC	Water Users and Sanitation Committee
WWTP	Wastewater Treatment Plant

PART-A INTRODUCTION

A1 Background and Outline of the Project

A1.1 Background of Project

Pokhara City is located in the western part of Nepal and is the capital of Gandaki Province. It is the second largest city in Nepal and its population is approx. 510,000 in 2021 and is to increase to about 850,000 by 2050.

Since Pokhara City is the biggest tourist area and more than one million tourists visit the city every year, it has an economical potential aspect in Nepal. Nine lakes, including Lake Phewa which is located in the center of Pokhara City, were registered as protected areas under the Ramsar Convention in 2016. However, there is concern that the water quality of Lake Phewa will be polluted due to population growth and the development of socio-economic conditions. Conservation of the water environment around Pokhara City, including Lake Phewa which is an important resource for tourism, is a major issue. Since sewerage facilities are not developed in the City, wastewater is treated in septic tanks or soak pits (hereinafter referred to as "septic tanks, etc."). Most of the local septic tanks are made of brick or stone masonry at the bottom, and organic pollutants in the wastewater infiltrate underground without sufficient treatment. In addition, a part of the gray water is untreated and discharged into drains and lakes, so it is an urgent issue to establish a proper wastewater treatment system to maintain a sanitized life and economic activity environment for citizens. Insufficient and inappropriate wastewater management causes water pollution in Lake Phewa and other water sources.

The Government of Nepal has set high-level goals for wastewater management in the "15th Five-Year Plan (2019 / 20 - 2023 / 24)" and "Sustainable Development Goals for Water Supply and Sanitation Services in Nepal (2016-2030)". In 2014, the Department of Water Supply and Sewerage Management (hereinafter referred to as "DWSSM") announced the city's sewerage improvement plan (Lake Phewa Waste Water Management Project) for the purpose of improving the water environment of Lake Phewa. However, the plan has not progressed due to the following problems. There is also an urgent need to improve the system for operation.

- Insufficient budget for facility construction.
- It is difficult to acquire land for construction of wastewater treatment plant (WWTP).
- It took longer time for approval of EIA. (Approved in March 2021)

A1.2 Purpose of the Project

Under these circumstances, the Nepalese government requested JICA in July 2019 to support the formulation of a master plan (hereinafter referred to as "MP") for wastewater management in Pokhara City.

From October 2020 to January 2021, JICA conducted a detailed plan formulation survey related to the support, and held discussions with the Nepalese side regarding the system and contents of the MP formulation project. As a result, an agreement (record of discussion) on the implementation of the MP formulation project was signed between JICA and the Ministry of Water Supply (hereinafter referred to as "MoWS") on April 21, 2021.

Based on the agreement, this project will formulate a plan for wastewater management in Pokhara City and water environment monitoring in the entire Pokhara City area including Lake Phewa. JICA will support in process formulation for improving the capacity of the executing agencies and provide technical assistance.

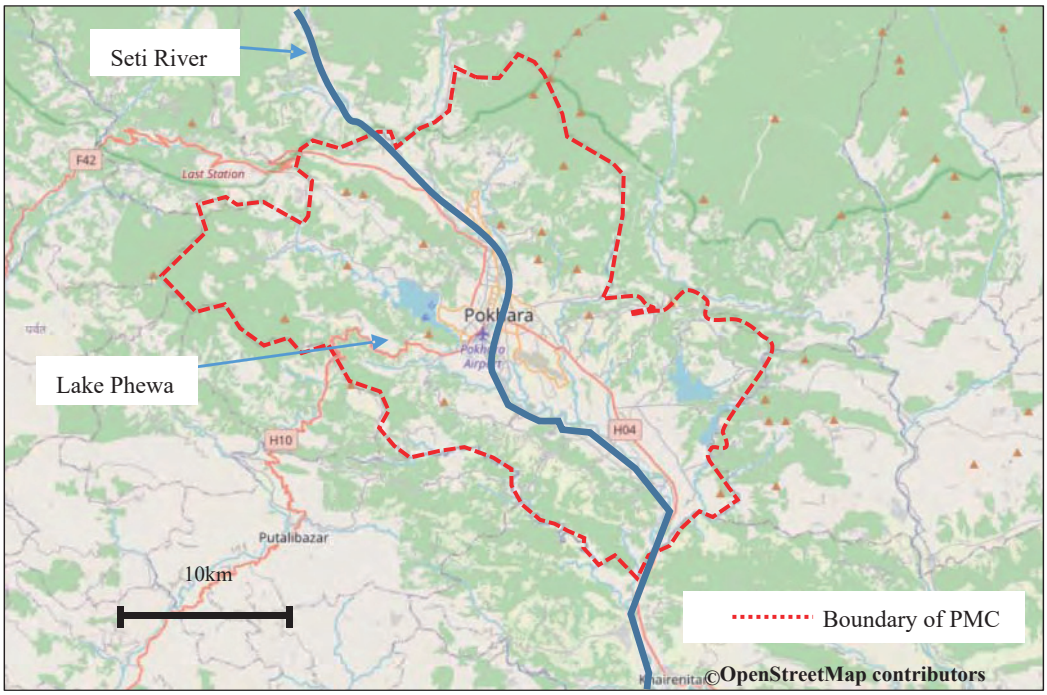
A1.3 Phase of the Project

The project is conducted for three years from September 2021 to August 2024. In addition, the three years are divided into two (2) phases as follows.

- 1st Phase (September 2021 to June 2023): collecting the current information and formulating MP
- 2nd Phase (July 2023 to August 2024): Pre-F/S for priority projects

A1.4 Project Area

The project area of the project is Pokhara City (area of about 460km^2) as shown in Figure A1-1. According to the census in 2021, the total population is about 513,000.



Source: JET

Figure A1-1 Project Area

A1.5 Implementing Agency

The project implementation and related organizations are as follows, and the Joint Coordination Committee (hereinafter referred to as "JCC") and the Project Implementation Unit (hereinafter referred to as "PIU") described in the next section are formed. They implement the project in cooperation.

Resposible Agency:	MoWS
Implementation Agency:	DWSSM
Co-Implementation Agency:	Pokhara Metropolitan City (PMC)

A1.6 Project Organization

In this Project, (1) the JCC makes the final decision of the project, and (2) the PIU works for the daily practice of research, planning, and design in this project.

As shown in Figure A1-2, JCC formulates an annual plan, approves changes as necessary, confirms the progress and achievement of the project, approves the wastewater management MP, selects priority projects, and makes discussions to reach consensus with stakeholders on the overall policy. The JCC meetings were held by the members of the JCC in both the Nepalese and the Japanese sides as shown in Table A1-1.

In addition, PIU is composed of the Federal Water Supply and Sewerage Management Project (hereinafter referred to as "FWSSMP"), which is a branch office of DWSSM, and engineers from PMC. PIU manages the Project based on the following items, and the main counterparts (hereafter referred to as "C/P") and PIU members have been listed in Table 1-6 2 and Table 1-6 3 respectively since August 2022.

- DWSSM, FWSSMP and PMC formulate their MPs which correspond to their development goals respectively and make them practical instead of formulating MPs by JICA.
- DWSSM, FWSSMP and PMC request and investigate important unpublished and unorganized data to relevant agencies, although JET has obtained relevant published data.
- Making PIU as a project team a joint meeting and activity organization of DWSSM, FWSSMP and PMC.
- Director General (DG) of DWSSM leads as Project Manager.

The main C/Ps shown in Table 1-6 2 are very busy, and the geographical distance between Kathmandu and Pokhara continues to make it difficult to communicate with each other. Therefore, the following matters have been agreed with the C/P organizations, and have been improved.

- Securing budget for DWSSM to visit Pokhara city.
- Appointing representatives for the Project Director, Project Manager, and Project Co-Manager respectively.
- Agreement with PMC is necessary for various issues and proposals. However, it is necessary to agree to MoWS and DWSSM finally. Therefore, JET will increase their stay in Kathmandu.

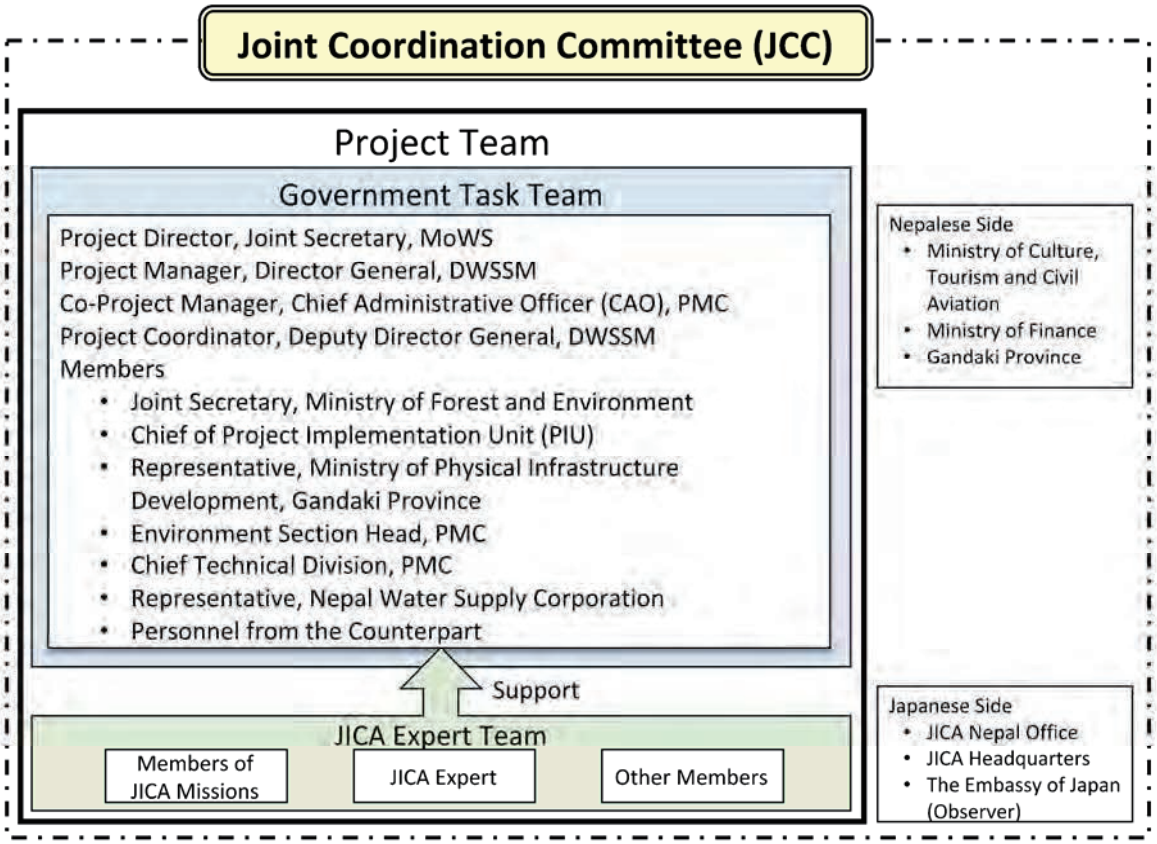
Table A1-1 JCC Meetings

No.	Date	Agenda
1st JCC	3rd February 2022	・ Inception meeting
2nd JCC	3rd June 2022	・ Population Forecast ・ Goal of MP ・ Candidate Sites of WWTP based on Zoning of Sewerage Area ・ Training in Nepal / Japan ・ Improvement of Communication / Meeting System
3rd JCC	12th Aprile, 2023	・ Confirmation of MP draft ・ Selection of priority projects
4th JCC	25th July, 2023	・ Modification of project implementation period
5th JCC	17th June, 2024	・ Confirmation and agreement on draft/final report

Source: JET

The PIU is composed of engineers from the Federal Water Supply and Sewerage Management Project (FWSSMP) of the DWSSM Pokhara Branch and PMC.
PIU operated the project based on the following matters. The main C/P and PIU members from August 2022 are as shown in Table A1-2 and Table A1-3.

- JICA will support the formulation of the MP to ensure that it is practical by aligning the development goals of DWSSM, FWSSMP, and PMC. JICA will also work to ensure that the MP relates to both DWSSM and PMC.
- Published relevant data has been obtained, but important unpublished and unorganized data will be requested and investigated by DWSSM, FWSSMP, and PMC from relevant agencies.
- The PIU will be a cross-organizational joint meeting and activity body for DWSSM, FWSSMP, and PMC.
- The Director General (DG) of DWSSM will lead the project as manager.



Source: JET

Figure A1-2 JCC Project Organization

Table A1-2 Main C/P Members

	Name	Organization	Position
Project Director	Ms. Meena Shrestha	MoWS	Joint Secretary
Project Manager	Mr. Ramakant Duwadi	DWSSM	Director General
-	Mr. Dhanraj Acharya	PMC	Mayor
-	Ms. Manju Devi Gurung	PMC	Deputy Mayor
Co-Project Manager	Mr. Birendradev Bharati	PMC	Chief Administrative Officer

Source: JET

Table A1-3 PIU Members

	Name	Organization	Position
PIU Chief	Mr. Narayan Kafle	FWSSMP	Superintendent Engineer
PIU	Mr. Shekhor Chandra KC	FWSSMP	Senior Divisional Engineer
PIU	Ms. Sunam Thapa	FWSSMP	Engineer (Water supply)
PIU (Focal Person)	Mr. Suresh Raj Acharya	FWSSMP	Engineer (Sewerage)
PIU (Focal Person)	Mr. Raju Regmi	PMC	Chief Water Supply, Sewerage and Irrigation Section
PIU	Mr. Dhruba Raj Bhattarai	PMC	Engineer, Water Supply, Sewerage and irrigation Section
PIU	Mr. Narayan Prasad Adhikari	PMC	Administration Section

Source: JET

In addition, the main C/Ps shown in Table A1-2 were busy, and the geographical distance between Kathmandu and Pokhara made it difficult for the parties involved to communicate with each other. Therefore, we agreed with the C/P organization on the following matters and responded flexibly to the situation.

- Allocate the budget for DWSSM to visit Pokhara city.
- Deputies will be appointed for each of the Project Director, Project Manager, and Project Co-Manager.
- Coordination of various issues and proposals will require consultation and agreement with the PMC, followed by agreement with the MoWS and DWSSM in Kathmandu. JET will also ensure that they stay in Kathmandu for as long as possible and communicate with both institutions.

A1.7 Japanese Expert Team (JET)

The members involved in the project on the Japanese side are as shown in the Table A1-4.

Table A1-4 JET Members

Name	Assignment	Organization
Katsumi FUJII	Team Leader/ Comprehensive Wastewater Management Planning	YEC
Hideyuki IGARASHI	Deputy Team Leader/ Sewerage Collection System	YEC
Kazuhiro ASADA	Sewerage Planning	NSC
Haruhiko NAKAO	Faecal Sludge Collection System	NJS
Takashi FUJI	Sewerage Treatment/ Faecal Sludge Treatment/ Resource Recovery Planning	NJS
Akio NATSUI/ Yasuaki KONDA	Facility Designing	NJS
Yukinori KAWASHIMA	Operation and Maintenance Planning	NSC
Kenji YAMADA	Construction and Procurement Planning/ Cost Estimation	YEC
Yoshinosuke HAMADA	Water Environment Monitoring Planning	YEC
Takashi SAKAKIBARA	Organization and Institution	YEC
Takeshi YAMASHITA	Economic and Financial Analysis	NSC
Kazuhiro ISHIURA (until July 2022) Kentaro Toda (from August 2022)	Environmental and Social Consideration	YEC
Yuriko KUDO	Public Awareness	YEC
Koki KISHIKAWA	Sewerage Collection System-2/ Coordination	YEC

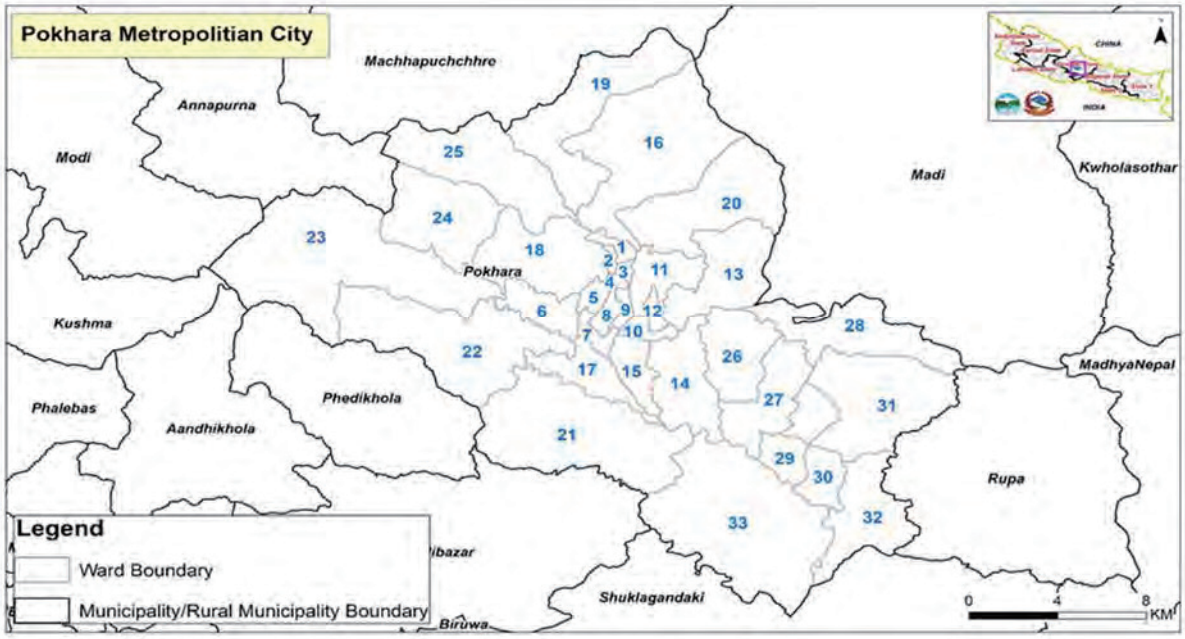
Note: YEC: Yachiyo Engineering Co., Ltd., NSC: Nihon Suido Consultants Co., Ltd., NJS: NJS Co., Ltd.,
Source: JET

A2 Existing Conditions and Plans of the Project Area

A2.1 Overview of Pokhara City

Pokhara City is located about 200 km west of the capital Kathmandu and in the hills of central Nepal. It is also the capital of Gandaki Province and is the second largest city in Nepal after Kathmandu in terms of population and economy. It is located in Kaski district, Gandaki province.

According to the transition of the Nepalese government to the federal system, integration with 18 neighboring local governments was implemented from 2014 to 2017, and the current city area is about 460 km^2. In addition, administrative management is carried out where is divided into 33 Wards as shown in the Figure A2-1.



Source: First 3-year Periodic Plan, 2022, PMC

Figure A2-1 Wards Location Map of Pokhara City

The average altitude of Pokhara City is 827m, and within about 50km, there are the Annapurna Mountains, which is a series of 8,000m-class mountains such as Mt. Dhaulagiri and Mt. Manaslu. Therefore, it is world-famous as a gateway to mountaineering in the Himalayas, and it is said that there are about one million tourists a year without accurate statistics.

A2.2 Natural Conditions

A2.2.1 Geographical Conditions

Pokhara City is located in a valley comparatively smaller than Katmandu, and is spread from about 20 km in a north-south direction and 30 km in an east-west direction. It slopes from the northwest to the southeast, and the altitudes of the northwestern part of the city, the eastern shore of Lake Phewa, which is the center of the city, and the southeastern part are about 1,500 m, 800 m, and 600 m, respectively. There are large undulations and height differences in some mountainous areas.

A summary of recent earthquakes in Nepal is shown in Table A2-1.

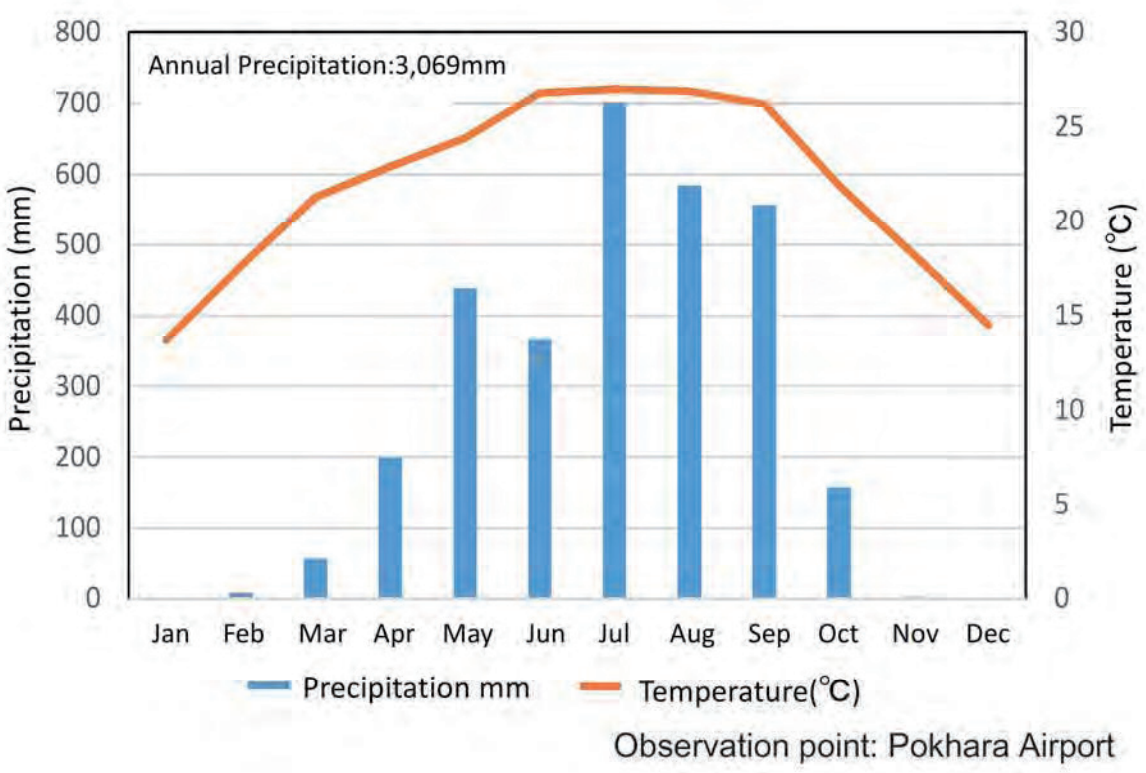
Table A2-1 Summary of Recent Earthquake in Nepal

No.	Date	Location	Magnitude	Damage
1	November, 2023	Jajarkot	5.7	An estimated 600 households were affected.
2	November, 2022	Doti	6.6	14 people are reported to have been killed or injured.
3	May, 2015	Dolakha	7.3	117 people were reported to have died.
4	April, 2015	Gorkha	7.8	8,200 people are estimated to have died.

Source: prepared by JET

A2.2.2 Meteorological Conditions

As typical climate data in the center of Pokhara City, meteorological data in 2018 (monthly rainfall and average temperature) are shown in Figure A2-2. The average temperature is about 25 degrees Celsius from June to September in summer and about 15 degrees Celsius from December to January in winter. Rainfall is high during the monsoon season (July-September).

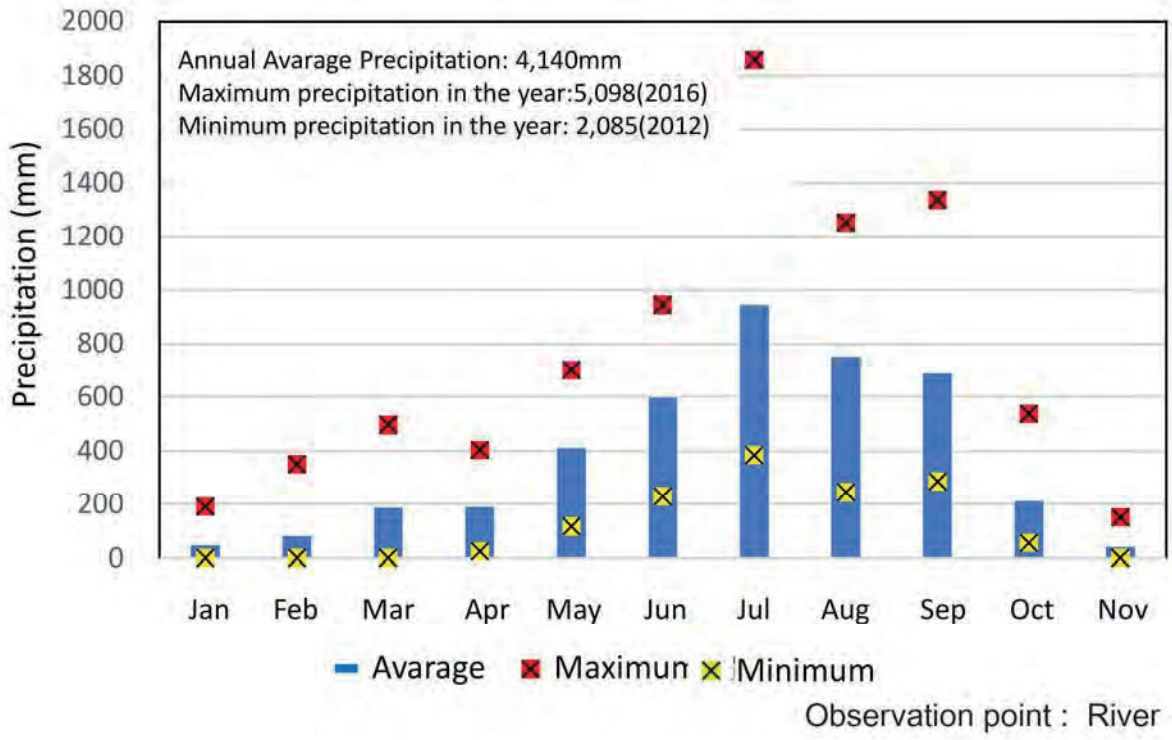


Source: Department of Hydrology and Meteorology

Figure A2-2 Monthly Rainfall and Average Temperature in Pokhara City in 2018

A2.2.3 Rainfall

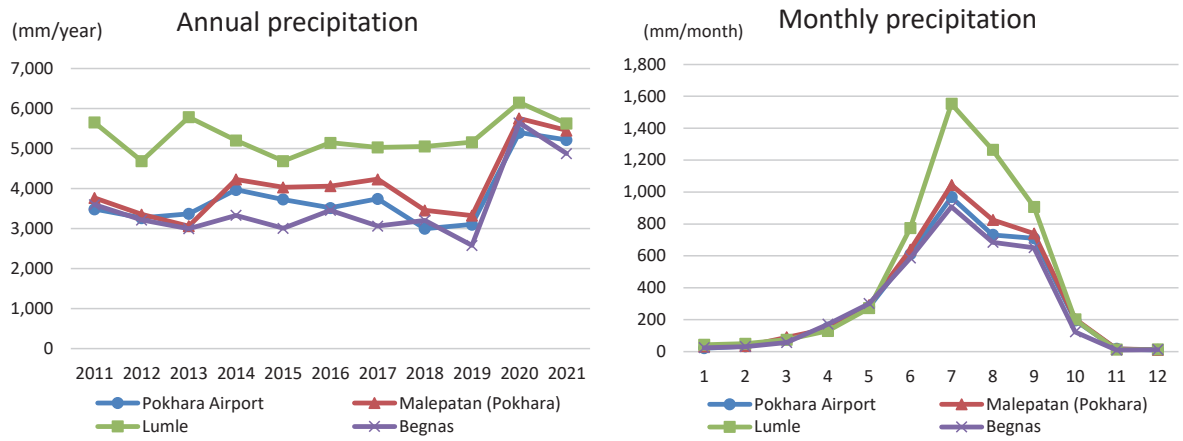
According to long-term data on precipitation in Pokhara City, the monthly average rainfall in Rivan in the upper stream of the Seti River, which flows through Pokhara City, is shown in Figure A2-3. In northern Pokhara City, the average annual rainfall from 2009 to 2019 exceeds 4,000 mm, which is much higher than about 2,000 mm in Kathmandu and about 500 mm in the Tarai Plain.



Source:Department of Hydrology and Meteorology

Figure A2-3 Monthly Rainfall in the Northern Part of Pokhara (Rivan) from 2009 to 2019

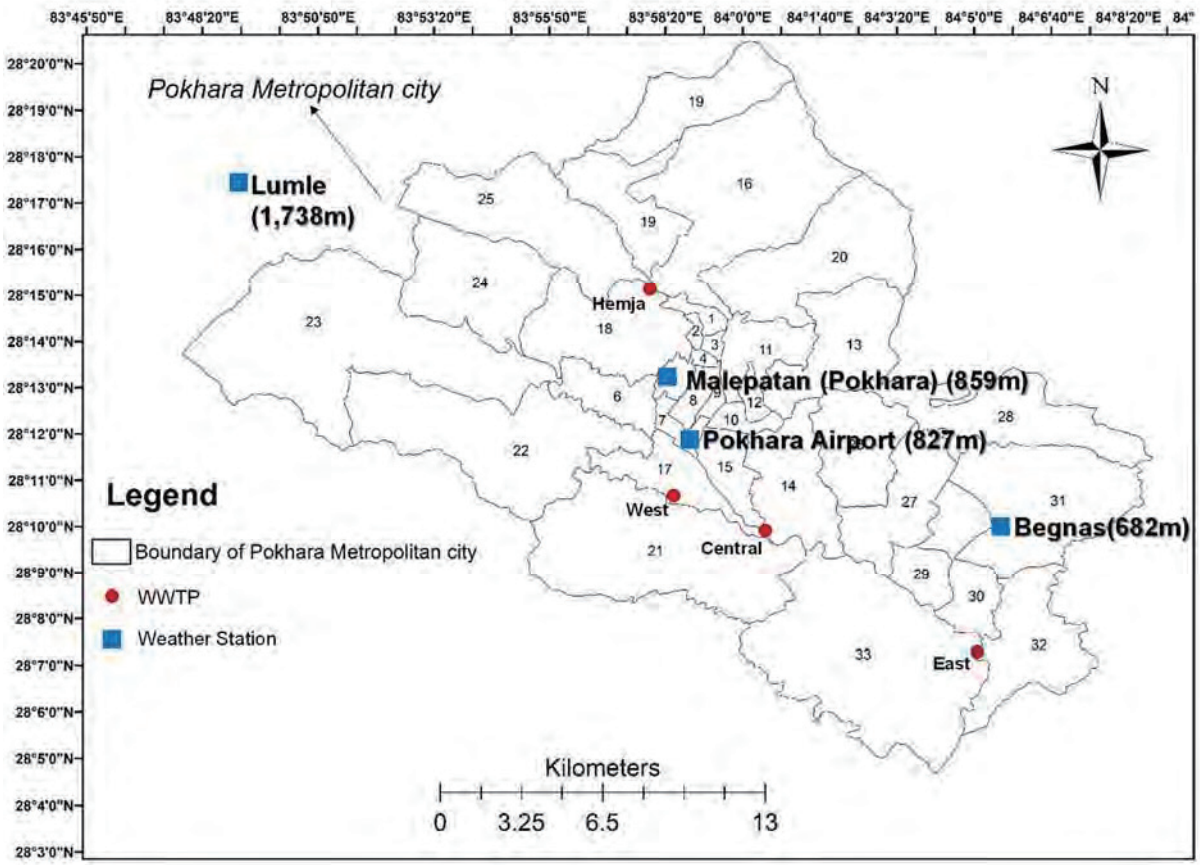
The average monthly and annual rainfall in Pokhara and its suburbs for the period 2011-2021 is shown in Figure A2-4. Rainfall data were collected at the four meteorological stations shown in Figure A2-5. In 2020 and 2021, rainfall during the rainy season is extremely high at the three lower elevation sites (except Lumle) compared to previous years.



Note: Data for October-December 2020 in Begnas is missing

Source: Department of Hydrology and Meteorology, Ministry of Energy, Water Resources and Irrigation

Figure A2-4 Monthly and Annual Precipitation in Pokhara City (2011-2021 Average)



Source: JET

Figure A2-5 Location Map of Weather Stations

Table A2-2 provides an overview of recent heavy rainfall disasters in countries surrounding Nepal. In October 2021, heavy rains in Nepal and northern India caused floods and landslides that killed more than 200 people. In addition, in 2022, serious heavy rainfall damage occurred in China, India, Bangladesh, and Pakistan, countries surrounding Nepal. These damages are concentrated between June and October, when monsoon rains bring heavy rainfall. In particular, the large-scale flooding in Pakistan in August and September 2022 is believed to be caused by glacial lake outburst floods, which occur when glaciers in the Himalayas melt due to high temperatures and rainfall.

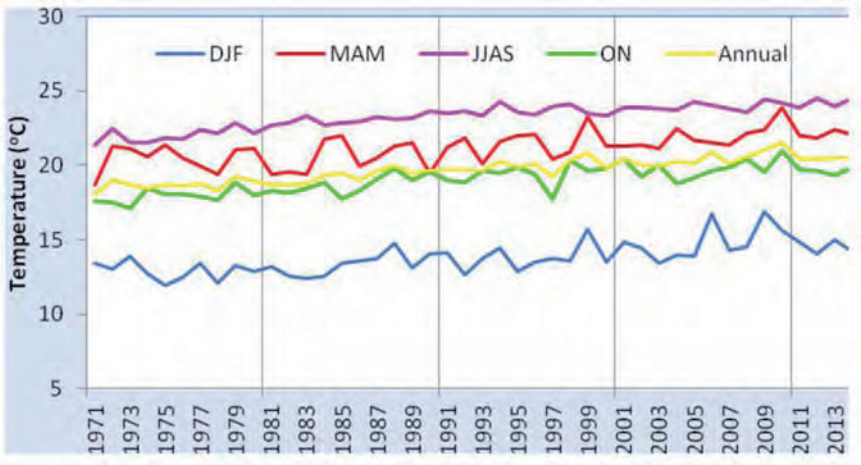
Table A2-2 Overview of Recent Heavy Rainfall Disasters in Countries Surrounding Nepal

No.	Date of Occurrence	Location	Type of Disaster	Damage and Situation
1	August – September 2022	All of Pakistan Northern India	Floods and landslides (glacial lake failure floods)	In Pakistan, about one-third of the country's land area was submerged, and more than 33 million people are estimated to have been affected.
2	June – August 2022	Western and southern China	Floods and landslides	Torrential rains in southwestern China and other regions caused flood damage.
3	May – June 2022	Northeast India Bangladesh	Floods and landslides	Heavy rains continued in northeastern India, displacing more than 4.7 million people in the state of Assam alone.
4	October 2021	Nepal Northern India	Floods and landslides	Heavy rains continue in northern India and Nepal, killing more than 200 people.

Source: Compiled by JET based on Japan Meteorological Agency "Extreme Weather Around the World" and News Reports from various stations

A2.2.4 Temperature

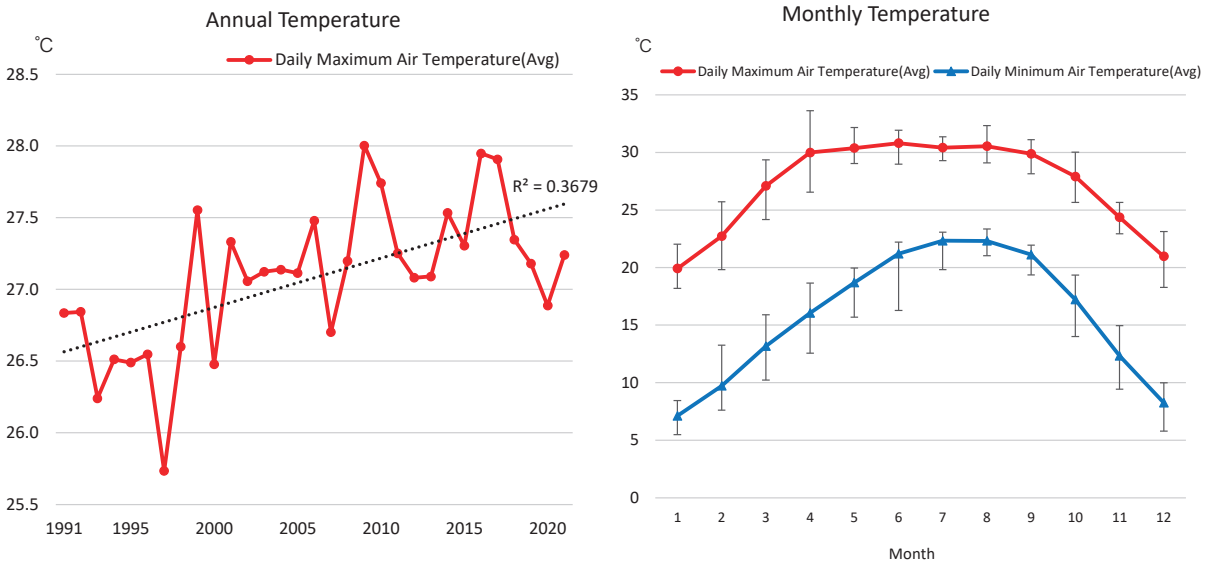
Figure A2-6 shows the change in maximum temperatures in Nepal over time, with an average annual temperature increase of 0.056°C/year from 1971 to 2013, with increases in all seasons.



DJF: Dec-Feb, MAM: Mar-May, JJAS: Jun-Sep, ON: Oct-Nov
Source: Observed Climate Trend Analysis of Nepal (1971-2014)

Figure A2-6 Change Over Time in Maximum Temperatures in Nepal

Annual and monthly temperature changes at the Pokhara Airport weather station from 1991 to 2021 are shown in Figure A2-7. The average daily maximum temperature is the lowest in January, around 20°C. The highest temperature is from April to September, around 30°C. There is no significant change in the average daily maximum temperature from April to September.
Looking at the trends from 1991 to 2001, the average daily maximum temperature has been on an upward trend, increasing by about 1°C over the past 20 years.



Note: Error bars indicate maximum and minimum values
Source: Department of Hydrology and Meteorology, Ministry of Energy, Water Resources and Irrigation

Figure A2-7 Temperatures at Pokhara Airport Meteorological Station (1991-2021)

A2.3 Social and Economic Conditions

A2.3.1 Population

(1) Existing Population Data

In Nepal, a census is conducted every 10 years by the Central Bureau of Statistics (“CBS”). From the

results of the census, as of February 2022, the population of the entire city of Pokhara in 2001, 2011, and 2021 (provisional value) can be grasped. However, with the start of the federal system, the consolidation of local governments was implemented from 2014 to 2017, and the city areas of 2001/2011 and 2021 are different. Therefore, it is difficult to properly grasp the population transition by simply comparing the census results. In addition, in order to compare with the 2021 census, the 2011 census results are published by CBS according to the current city area (Population of 753 Local Unit, CBS). The population in 2011 in the current city area is possible to grasp in Ward-based. Since the Ward-based population in 2001 was not publicly available, PMC analyzed and aggregated pre-consolidation local government data. The available population data are shown in Table A2-3and Table A2-4.

After the outline of the MP was formulated, the provisional figures for the 2021 census were finalized, and the Pre-F/S updated the population projections based on these final figures (see Section C1).

Table A2-3 Population Data (Obtained until 10 February 2022)

Item	Population		
Census year	2001	2011	2021
Old Boundary	156,312 *1	264,991 *2	No data
Additional Community in 2016	128,018	138,004 *3	No data
Total in Present Area	284,322 *6	402,995 *4	518,452 *5

Source: *1; Census 2001, Population of Nepal, CBS. *2; Statistical Year Book 2017, CBS. *3; Balance between Total and Old Boundary.
*4; Population of 753 Local Unit, CBS. *5; Provisional result of Census 2021, CBS.
*6; Analysis data of PMC

Table A2-4 Ward-Based Population in 2001 and 2011

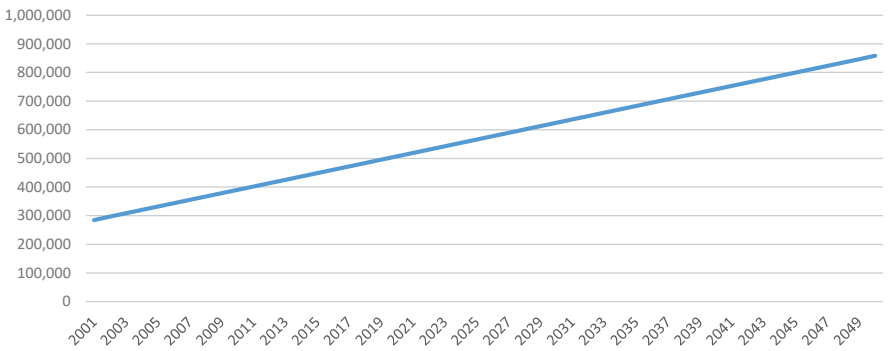
Ward	2001	2011			
	Total Population	Number of Household	Male	Female	Total Population
1	12,037	4,541	7,896	7,617	15,513
2	4,859	2,464	4,468	4,261	8,729
3	6,962	2,750	4,919	4,543	9,462
4	5,988	2,491	4,731	4,388	9,119
5	6,829	3,973	7,373	7,430	14,803
6	10,663	3,869	7,721	7,008	14,729
7	8,241	3,451	6,335	6,540	12,875
8	16,112	7,138	13,539	12,541	26,080
9	12,111	4,295	8,573	8,053	16,626
10	12,433	4,912	8,948	9,522	18,470
11	9,619	4,023	7,119	7,597	14,716
12	7,369	3,014	5,441	6,172	11,613
13	10,266	4,149	7,812	9,265	17,077
14	5,688	3,305	6,260	6,965	13,225
15	10,099	4,328	7,780	9,247	17,027
16	15,416	5,462	9,830	10,448	20,278
17	12,706	6,944	12,770	13,982	26,752
18	6,612	2,080	3,899	4,455	8,354
19	8,728	2,610	4,820	5,804	10,624
20	4,802	1,027	1,814	2,208	4,022
21	10,356	2,432	3,886	5,204	9,090
22	7,947	1,837	3,358	4,033	7,391
23	5,752	1,300	2,196	2,721	4,917
24	6,540	1,508	2,591	3,301	5,892
25	8,702	3,019	5,633	6,629	12,262
26	8,547	2,903	5,240	6,154	11,394

Ward	2001	2011			
	Total Population	Number of Household	Male	Female	Total Population
27	6,136	2,358	4,477	5,106	9,583
28	6,001	1,303	2,047	2,680	4,727
29	5,449	2,261	3,968	4,993	8,961
30	6,963	2,786	5,091	5,732	10,823
31	7,180	1,908	3,334	4,044	7,378
32	7,094	2,721	4,755	5,922	10,677
33	10,115	2,468	4,353	5,453	9,806
Total	**284,322**	**105,630**	**192,977**	**210,018**	**402,995**

Source: Population of 753 Local Unit, CBS, for 2011. PMC analysis for 2001.

(2) Population Forecast

In Pokhara City, various communities are scattered from the urban area called the core area to the suburbs and mountainous areas. In order to formulate a detailed wastewater management plan, it is inappropriate to estimate the wastewater volume by averaging the population of the entire city area. It is necessary to set the planned population at least based on the population of each Ward. Therefore, regression analysis from population data of 2001, 2011 and 2021 for the entire city area as shown in Appendix-1 predicts the populations in 2030, 2040 and 2050 will be approximately 624 thousand, 741 thousand and 858 thousand, respectively (See Figure A2-8). The population by ward and the population density by ward are estimated as shown in Table A2-5 and Table A2-6 respectively.



Source: JET

Figure A2-8 Population Forecast

Table A2-5 Ward-Based Population Forecast

Ward	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total
Habitable Area(km^2)	0.8	0.6	0.5	0.5	1.6	1.7	1.3	1.6	1.1	1.5	4.7	1.1	7.1	10.0	4.0	12.7	5.5	8.5	10.0	10.1	14.9	12.3	13.8	13.1	9.4	7.8	7.9	6.8	3.4	7.6	10.4	9.4	16.3	217.9
year	Population																																	
2001	12,037	4,859	6,962	5,988	6,829	10,663	8,241	16,112	12,111	12,433	9,619	7,369	10,266	5,688	10,099	15,416	12,706	6,612	8,728	4,802	10,356	7,947	5,752	6,540	8,702	8,547	6,136	6,001	5,449	6,963	7,180	7,094	10,115	284,322
2002	12,346	5,152	7,179	6,245	7,378	11,013	8,617	16,907	12,501	12,935	10,037	7,712	10,802	6,189	10,641	15,844	13,688	6,768	8,901	4,718	10,222	7,890	5,662	6,472	9,006	8,796	6,416	5,859	5,727	7,277	7,200	7,390	10,084	293,574
2003	12,664	5,463	7,403	6,514	7,972	11,375	9,010	17,741	12,903	13,457	10,473	8,071	11,366	6,734	11,211	16,285	14,746	6,929	9,078	4,635	10,089	7,833	5,574	6,405	9,320	9,053	6,708	5,721	6,019	7,605	7,219	7,698	10,052	303,325
2004	12,989	5,793	7,633	6,793	8,613	11,748	9,421	18,616	13,319	14,000	10,928	8,446	11,959	7,326	11,812	16,737	15,886	7,093	9,258	4,553	9,959	7,776	5,488	6,338	9,645	9,317	7,014	5,586	6,326	7,948	7,239	8,020	10,021	313,602
2005	13,323	6,142	7,871	7,085	9,306	12,134	9,851	19,535	13,747	14,566	11,402	8,839	12,584	7,971	12,446	17,203	17,114	7,260	9,442	4,473	9,830	7,720	5,402	6,273	9,982	9,589	7,334	5,455	6,649	8,306	7,259	8,354	9,990	324,436
2006	13,665	6,513	8,116	7,389	10,054	12,532	10,301	20,499	14,190	15,154	11,898	9,251	13,241	8,673	13,113	17,681	18,437	7,432	9,629	4,395	9,702	7,664	5,318	6,208	10,330	9,868	7,668	5,326	6,988	8,681	7,278	8,703	9,959	335,856
2007	14,016	6,906	8,369	7,707	10,863	12,944	10,771	21,510	14,647	15,766	12,414	9,681	13,932	9,437	13,816	18,172	19,862	7,608	9,821	4,318	9,577	7,609	5,235	6,143	10,690	10,156	8,018	5,200	7,344	9,073	7,298	9,066	9,928	347,896
2008	14,376	7,322	8,630	8,038	11,737	13,369	11,262	22,571	15,118	16,402	12,954	10,132	14,659	10,268	14,557	18,677	21,397	7,788	10,016	4,242	9,453	7,554	5,154	6,079	11,063	10,452	8,383	5,078	7,719	9,482	7,318	9,445	9,898	360,591
2009	14,746	7,764	8,899	8,383	12,681	13,807	11,776	23,685	15,605	17,064	13,516	10,603	15,424	11,171	15,338	19,196	23,051	7,972	10,214	4,167	9,330	7,499	5,074	6,016	11,449	10,757	8,766	4,958	8,112	9,909	7,338	9,839	9,867	373,979
2010	15,124	8,232	9,176	8,743	13,701	14,261	12,313	24,854	16,107	17,753	14,103	11,097	16,230	12,155	16,160	19,730	24,833	8,161	10,417	4,094	9,209	7,445	4,995	5,954	11,849	11,071	9,165	4,841	8,526	10,356	7,358	10,249	9,836	388,099
2011	15,513	8,729	9,462	9,119	14,803	14,729	12,875	26,080	16,626	18,470	14,716	11,613	17,077	13,225	17,027	20,278	26,752	8,354	10,624	4,022	9,090	7,391	4,917	5,892	12,262	11,394	9,583	4,727	8,961	10,823	7,378	10,677	9,806	402,995
2012	16,036	9,023	9,781	9,426	15,302	15,225	13,309	26,959	17,186	19,092	15,212	12,004	17,652	13,671	17,601	20,961	27,653	8,635	10,982	3,951	8,972	7,338	4,840	5,831	12,675	11,778	9,906	4,616	9,263	11,188	7,627	11,037	9,776	414,508
2013	16,558	9,317	10,100	9,734	15,801	15,722	13,743	27,837	17,746	19,715	15,708	12,396	18,228	14,116	18,174	21,645	28,555	8,917	11,340	3,882	8,856	7,285	4,765	5,770	13,088	12,162	10,229	4,507	9,565	11,552	7,875	11,397	9,745	426,028
2014	17,081	9,611	10,418	10,041	16,299	16,218	14,176	28,716	18,307	20,337	16,204	12,787	18,803	14,562	18,748	22,328	29,456	9,198	11,698	3,814	8,741	7,232	4,691	5,710	13,501	12,546	10,552	4,400	9,867	11,917	8,124	11,756	9,715	437,556
2015	17,604	9,905	10,737	10,348	16,798	16,714	14,610	29,595	18,867	20,959	16,699	13,178	19,379	15,007	19,322	23,011	30,358	9,480	12,056	3,747	8,628	7,180	4,618	5,651	13,915	12,930	10,875	4,297	10,169	12,282	8,372	12,116	9,685	449,091
2016	18,126	10,200	11,056	10,655	17,297	17,210	15,044	30,474	19,427	21,582	17,195	13,569	19,954	15,453	19,896	23,694	31,259	9,761	12,414	3,681	8,516	7,128	4,546	5,592	14,328	13,314	11,197	4,195	10,471	12,646	8,621	12,476	9,655	460,633
2017	18,649	10,494	11,375	10,963	17,796	17,707	15,478	31,352	19,987	22,204	17,691	13,961	20,529	15,899	20,469	24,378	32,160	10,043	12,772	3,616	8,406	7,076	4,475	5,534	14,741	13,697	11,520	4,096	10,773	13,011	8,870	12,836	9,625	472,183
2018	19,172	10,788	11,694	11,270	18,294	18,203	15,912	32,231	20,547	22,826	18,187	14,352	21,105	16,344	21,043	25,061	33,062	10,324	13,130	3,553	8,297	7,025	4,406	5,477	15,154	14,081	11,843	4,000	11,075	13,376	9,118	13,195	9,595	483,740
2019	19,695	11,082	12,013	11,577	18,793	18,699	16,346	33,110	21,108	23,449	18,683	14,743	21,680	16,790	21,617	25,744	33,963	10,606	13,488	3,490	8,190	6,974	4,337	5,420	15,567	14,465	12,166	3,905	11,376	13,740	9,367	13,555	9,566	495,304
2020	20,217	11,376	12,331	11,884	19,292	19,196	16,779	33,989	21,668	24,071	19,179	15,135	22,256	17,235	22,190	26,427	34,864	10,887	13,846	3,429	8,083	6,924	4,270	5,364	15,980	14,849	12,489	3,813	11,678	14,105	9,615	13,915	9,536	506,874
2021	20,740	11,670	12,650	12,192	19,791	19,692	17,213	34,867	22,228	24,693	19,674	15,526	22,831	17,681	22,764	27,111	35,766	11,169	14,204	3,369	7,979	6,874	4,203	5,308	16,394	15,233	12,812	3,723	11,980	14,470	9,864	14,275	9,506	518,452
2022	20,873	11,837	12,752	12,257	20,937	19,994	17,711	35,341	22,548	25,275	20,200	15,989	23,562	18,382	23,501	27,787	37,112	11,432	14,519	3,369	7,979	6,874	4,203	5,308	16,839	15,620	13,200	3,723	12,360	14,906	10,016	14,692	9,506	530,606
2023	21,006	12,003	12,854	12,323	21,585	20,445	18,160	35,815	22,867	25,888	20,703	16,397	24,293	19,083	24,239	28,463	38,459	11,695	14,835	3,369	7,979	6,874	4,203	5,308	17,285	16,007	13,588	3,723	12,740	15,342	10,169	15,109	9,506	542,316
2024	21,139	12,170	12,955	12,389	22,233	20,897	18,608	36,288	23,187	26,501	21,206	16,805	25,025	19,784	24,976	29,139	39,806	11,958	15,150	3,369	7,979	6,874	4,203	5,308	17,731	16,394	13,976	3,723	13,120	15,779	10,321	15,525	9,506	554,025
2025	21,272	12,336	13,057	12,455	22,881	21,348	19,057	36,762	23,507	27,114	21,709	17,212	25,756	20,485	25,713	29,816	41,152	12,221	15,466	3,369	7,979	6,874	4,203	5,308	18,177	16,780	14,364	3,723	13,500	16,215	10,474	15,942	9,506	565,735
2026	21,406	12,503	13,159	12,521	23,529	21,800	19,505	37,235	23,827	27,727	22,211	17,620	26,487	21,186	26,450	30,492	42,499	12,484	15,781	3,369	7,979	6,874	4,203	5,308	18,623	17,167	14,752	3,723	13,880	16,651	10,626	16,359	9,506	577,445
2027	21,539	12,669	13,260	12,586	24,177	22,251	19,954	37,709	24,146	28,340	22,714	18,028	27,219	21,887	27,188	31,168	43,846	12,747	16,097	3,369	7,979	6,874	4,203	5,308	19,069	17,554	15,140	3,723	14,261	17,087	10,779	16,776	9,506	589,154
2028	21,672	12,836	13,362	12,652	24,825	22,702	20,403	38,182	24,466	28,953	23,217	18,436	27,950	22,588	27,925	31,844	45,192	13,010	16,412	3,369	7,979	6,874	4,203	5,308	19,514	17,941	15,528	3,723	14,641	17,524	10,931	17,193	9,506	600,864
2029	21,805	13,003	13,464	12,718	25,473	23,154	20,851	38,656	24,786	29,566	23,720	18,844	28,681	23,289	28,662	32,520	46,539	13,273	16,728	3,369	7,979	6,874	4,203	5,308	19,960	18,328	15,916	3,723	15,021	17,960	11,084	17,610	9,506	612,574
2030	21,938	13,169	13,566	12,784	26,121	23,605	21,300	39,129	25,106	30,179	24,222	19,252	29,412	23,990	29,400	33,197	47,885	13,536	17,043	3,369	7,979	6,874	4,203	5,308	20,406	18,715	16,304	3,723	15,401	18,396	11,236	18,027	9,506	624,283
2031	22,071	13,336	13,667	12,850	26,769	24,057	21,749	39,603	25,425	30,792	24,725	19,660	30,144	24,691	30,137	33,873	49,232	13,799	17,359	3,369	7,979	6,874	4,203	5,308	20,852	19,101	16,692	3,723	15,781	18,832	11,389	18,444	9,506	635,993
2032	22,204	13,502	13,769	12,915	27,417	24,508	22,197	40,076	25,745	31,405	25,228	20,067	30,875	25,392	30,874	34,549	50,579	14,062	17,674	3,369	7,979	6,874	4,203	5,308	21,298	19,488	17,080	3,723	16,161	19,269	11,541	18,861	9,506	647,703
2033	22,337	13,669	13,871	12,981	28,066	24,960	22,646	40,550	26,065	32,018	25,731	20,475	31,606	26,093	31,611	35,225	51,925	14,325	17,990	3,369	7,979	6,874	4,203	5,308	21,744	19,875	17,468	3,723	16,541	19,705	11,694	19,278	9,506	659,412
2034	22,470	13,835	13,972	13,047	28,714	25,411	23,094	41,023	26,384	32,631	26,234	20,883	32,337	26,794	32,349	35,902	53,272	14,589	18,305	3,369	7,979	6,874	4,203	5,308	22,190	20,262	17,856	3,723	16,921	20,141	11,846	19,695	9,506	671,122
2035	22,603	14,002	14,074	13,113	29,362	25,863	23,543	41,497	26,704	33,245	26,736	21,291	33,069	27,496	33,086	36,578	54,618	14,852	18,621	3,369	7,979	6,874	4,203	5,308	22,635	20,649	18,244	3,723	17,301	20,577	11,999	20,112	9,506	682,832
2036	22,737	14,168	14,176	13,179	30,010	26,314	23,992	41,970	27,024	33,858	27,239	21,699	33,800	28,197	33,823	37,254	55,965	15,115	18,936	3,369	7,979	6,874	4,203	5,308	23,081	21,036	18,632	3,723	17,681	21,014	12,151	20,529	9,506	694,541
2037	22,870	14,335	14,278	13,245	30,658	26,765	24,440	42,444	27,344	34,471	27,742	22,107	34,531	28,898	34,561	37,930	57,312	15,378	19,252	3,369	7,979	6,874	4,203	5,308	23,527	21,422	19,020	3,723	18,061	21,450	12,304	20,946	9,506	706,251
2038	23,003	14,501	14,379	13,310	31,306	27,217	24,889	42,918	27,663	35,084	28,245	22,514	35,262	29,599	35,298	38,607	58,658	15,641	19,567	3,369	7,979	6,874	4,203	5,308	23,973	21,809	19,408	3,723	18,441	21,886	12,456	21,363	9,506	717,961
2039	23,136	14,668	14,481	13,376	31,954	27,668	25,337	43,391	27,983	35,697	28,747	22,922	35,994	30,300	36,035	39,283	60,005	15,904	19,883	3,369	7,979	6,874	4,203	5,308	24,419	22,196	19,796	3,723	18,821	22,322	12,609	21,780	9,506	729,670
2040	23,269	14,835	14,583	13,442	32,602	28,120	25,786	43,865	28,303	36,310	29,250	23,330	36,725	31,001	36,772	39,959	61,351	16,167	20,198	3,369	7,979	6,874	4,203	5,308	24,865	22,583	20,184	3,723	19,201	22,759	12,761	22,197	9,506	741,380
2041	23,402	15,001	14,685	13,508	33,250	28,571	26,235	44,338	28,622	36,923	29,753	23,738	37,456	31,702	37,510	40,635	62,698	16,430	20,514	3,369	7,979	6,874	4,203	5,308	25,310	22,970	20,572	3,723	19,581	23,195	12,914	22,614	9,506	753,090
2042	23,535	15,168	14,786	13,574	33,898	29,023	26,683	44,812	28,942	37,536	30,256	24,146	38,187	32,403	38,247	41,312	64,045	16,693	20,829	3,369	7,979	6,874	4,203	5,308	25,756	23,357	20,960	3,723	19,961	23,631	13,066	23,031	9,506	764,799
2043	23,668	15,334	14,888	13,639	34,546	29,474	27,132	45,285	29,262	38,149	30,759	24,554	38,919	33,104	38,984	41,988	65,391	16,956	21,145	3,369	7,979	6,874	4,203	5,308	26,202	23,743	21,348	3,723	20,341	24,068	13,219	23,448	9,506	776,509
2044	23,801	15,501	14,990	13,705	35,194	29,926	27,580	45,759	29,582	38,762	31,261	24,962	39,650	33,805	39,721	42,664	66,738	17,219	21,461	3,369	7,979	6,874	4,203	5,308	26,648	24,130	21,736	3,723	20,721	24,504	13,371	23,865	9,506	788,219
2045	23,934	15,667	15,091	13,771	35,843	30,377	28,029	46,232	29,901	39,375	31,764	25,369	40,381	34,506	40,459	43,340	68,084	17,482	21,776	3,369	7,979	6,874	4,203	5,308	27,094	24,517	22,124	3,723	21,101	24,940	13,524	24,282	9,506	799,928
2046	24,068	15,834	15,193	13,837	36,491	30,828	28,478	46,706	30,221	39,988	32,267	25,777	41,112	35,207	41,196	44,017	69,431	17,745	22,092	3,369	7,979	6,874	4,203	5,308	27,540	24,904	22,512	3,723	21,481	25,376	13,676	24,699	9,506	811,638
2047	24,201	16,000	15,295	13,903	37,139	31,280	28,926	47,179	30,541	40,601	32,770	26,185	41,844	35,908	41,933	44,693	70,778	18,008	22,407	3,369	7,979	6,874	4,203	5,308	27,985	25,291	22,900	3,723	21,861	25,813	13,829	25,116	9,506	823,348
2048	24,334	16,167	15,397	13,968	37,787	31,731	29,375	47,653	30,861	41,214	33,272	26,593	42,575	36,609	42,671	45,369	72,124	18,271	22,723	3,369	7,979	6,874	4,203	5,308	28,431	25,678	23,288	3,723	22,241	26,249	13,981	25,533	9,506	835,057
2049	24,467	16,333	15,498	14,034	38,435	32,183	29,823	48,126	31,180	41,827	33,775	27,001	43,306	37,310	43,408	46,045	73,471	18,534	23,038	3,369	7,979	6,874	4,203	5,308	28,877	26,064	23,677	3,723	22,621	26,685	14,134	25,950	9,506	846,767
2050	24,600	16,500	15,600	14,100	39,083	32,634	30,272	48,600	31,500	42,440	34,278	27,409	44,038	38,011	44,145	46,722	74,817	18,797	23,354	3,369	7,979	6,874	4,203	5,308	29,323	26,451	24,065	3,723	23,001	27,121	14,286	26,367	9,506	858,477

Source: JET

Table A2-6 Ward-Based Population Density Forecast

Ward	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total
Habitable Area(km^2)	0.8	0.6	0.5	0.5	1.6	1.7	1.3	1.6	1.1	1.5	4.7	1.1	7.1	10.0	4.0	12.7	5.5	8.5	10.0	10.1	14.9	12.3	13.8	13.1	9.4	7.8	7.9	6.8	3.4	7.6	10.4	9.4	16.3	217.9
year	Population Density (population / ha)																																	
2001	147	88	134	127	43	63	64	99	115	82	20	65	14	6	25	12	23	8	9	5	7	6	4	5	9	11	8	9	16	9	7	8	6	13
2002	151	94	138	133	46	66	67	104	119	85	21	68	15	6	27	12	25	8	9	5	7	6	4	5	10	11	8	9	17	10	7	8	6	13
2003	154	99	142	139	50	68	70	110	123	89	22	71	16	7	28	13	27	8	9	5	7	6	4	5	10	12	8	8	18	10	7	8	6	14
2004	158	105	147	145	54	70	73	115	127	92	23	75	17	7	30	13	29	8	9	5	7	6	4	5	10	12	9	8	18	11	7	9	6	14
2005	162	112	151	151	58	72	76	121	131	96	24	78	18	8	31	14	31	9	9	4	7	6	4	5	11	12	9	8	19	11	7	9	6	15
2006	167	118	156	157	63	75	80	127	135	100	25	82	19	9	33	14	34	9	10	4	7	6	4	5	11	13	10	8	20	11	7	9	6	15
2007	171	126	161	164	68	77	83	133	139	104	26	86	20	9	35	14	36	9	10	4	6	6	4	5	11	13	10	8	21	12	7	10	6	16
2008	175	133	166	171	73	80	87	139	144	108	28	90	21	10	37	15	39	9	10	4	6	6	4	5	12	13	11	7	23	13	7	10	6	17
2009	180	141	171	178	79	82	91	146	149	112	29	94	22	11	39	15	42	9	10	4	6	6	4	5	12	14	11	7	24	13	7	10	6	17
2010	184	150	176	186	86	85	95	153	153	117	30	98	23	12	41	15	45	10	10	4	6	6	4	5	13	14	12	7	25	14	7	11	6	18
2011	189	159	182	194	93	88	100	161	158	122	31	103	24	13	43	16	49	10	11	4	6	6	4	4	13	15	12	7	26	14	7	11	6	18
2012	196	164	188	201	96	91	103	166	164	126	32	106	25	14	44	16	50	10	11	4	6	6	4	4	14	15	13	7	27	15	7	12	6	19
2013	202	169	194	207	99	94	107	172	169	130	33	110	26	14	46	17	52	10	11	4	6	6	3	4	14	16	13	7	28	15	8	12	6	20
2014	208	175	200	214	102	97	110	177	174	134	34	113	27	15	47	18	54	11	12	4	6	6	3	4	14	16	13	6	29	16	8	12	6	20
2015	215	180	206	220	105	99	113	183	180	138	35	117	27	15	49	18	55	11	12	4	6	6	3	4	15	17	14	6	30	16	8	13	6	21
2016	221	185	213	227	108	102	117	188	185	142	37	120	28	16	50	19	57	11	12	4	6	6	3	4	15	17	14	6	31	17	8	13	6	21
2017	227	191	219	233	111	105	120	194	190	146	38	124	29	16	51	19	59	12	13	4	6	6	3	4	16	18	15	6	31	17	9	14	6	22
2018	234	196	225	240	114	108	123	199	196	150	39	127	30	16	53	20	60	12	13	4	6	6	3	4	16	18	15	6	32	18	9	14	6	22
2019	240	201	231	246	117	111	127	204	201	154	40	130	31	17	54	20	62	12	14	3	5	6	3	4	17	19	15	6	33	18	9	14	6	23
2020	247	207	237	253	121	114	130	210	206	158	41	134	31	17	56	21	64	13	14	3	5	6	3	4	17	19	16	6	34	19	9	15	6	23
2021	253	212	243	259	124	117	133	215	212	162	42	137	32	18	57	21	65	13	14	3	5	6	3	4	18	20	16	5	35	19	9	15	6	24
2022	255	215	245	261	131	119	137	218	215	166	43	141	33	18	59	22	68	13	15	3	5	6	3	4	18	20	17	5	36	20	10	16	6	24
2023	256	218	247	262	135	122	141	221	218	170	44	145	34	19	61	22	70	14	15	3	5	6	3	4	18	20	17	5	37	20	10	16	6	25
2024	258	221	249	264	139	124	144	224	221	174	45	149	35	20	63	23	73	14	15	3	5	6	3	4	19	21	18	5	38	21	10	16	6	25
2025	259	224	251	265	143	127	148	227	224	178	46	152	36	21	65	23	75	14	15	3	5	6	3	4	19	21	18	5	39	21	10	17	6	26
2026	261	227	253	266	147	130	151	230	227	182	47	156	37	21	66	24	78	15	16	3	5	6	3	4	20	22	19	5	40	22	10	17	6	26
2027	263	230	255	268	151	132	155	233	230	186	48	160	38	22	68	24	80	15	16	3	5	6	3	4	20	22	19	5	42	23	10	18	6	27
2028	264	233	257	269	155	135	158	236	233	190	49	163	39	23	70	25	82	15	16	3	5	6	3	4	21	23	20	5	43	23	10	18	6	28
2029	266	236	259	271	159	138	162	239	236	195	50	167	40	23	72	26	85	16	17	3	5	6	3	4	21	23	20	5	44	24	11	19	6	28
2030	268	239	261	272	163	141	165	242	239	199	51	170	41	24	74	26	87	16	17	3	5	6	3	4	22	24	21	5	45	24	11	19	6	29
2031	269	242	263	273	167	143	169	244	242	203	52	174	43	25	76	27	90	16	17	3	5	6	3	4	22	24	21	5	46	25	11	20	6	29
2032	271	245	265	275	171	146	172	247	245	207	54	178	44	26	78	27	92	17	18	3	5	6	3	4	23	25	22	5	47	25	11	20	6	30
2033	272	249	267	276	175	149	176	250	248	211	55	181	45	26	79	28	95	17	18	3	5	6	3	4	23	25	22	5	48	26	11	20	6	30
2034	274	252	269	278	179	151	179	253	251	215	56	185	46	27	81	28	97	17	18	3	5	6	3	4	24	26	23	5	49	27	11	21	6	31
2035	276	255	271	279	184	154	183	256	254	219	57	188	47	28	83	29	100	17	19	3	5	6	3	4	24	26	23	5	50	27	12	21	6	31
2036	277	258	273	280	188	157	186	259	257	223	58	192	48	28	85	29	102	18	19	3	5	6	3	4	25	27	24	5	52	28	12	22	6	32
2037	279	261	275	282	192	159	189	262	260	227	59	196	49	29	87	30	105	18	19	3	5	6	3	4	25	27	24	5	53	28	12	22	6	32
2038	281	264	277	283	196	162	193	265	263	231	60	199	50	30	89	30	107	18	20	3	5	6	3	4	26	28	25	5	54	29	12	23	6	33
2039	282	267	278	285	200	165	196	268	267	235	61	203	51	30	91	31	109	19	20	3	5	6	3	4	26	28	25	5	55	30	12	23	6	33
2040	284	270	280	286	204	167	200	271	270	239	62	206	52	31	92	31	112	19	20	3	5	6	3	4	27	29	26	5	56	30	12	24	6	34
2041	285	273	282	287	208	170	203	274	273	243	63	210	53	32	94	32	114	19	21	3	5	6	3	4	27	29	26	5	57	31	12	24	6	35
2042	287	276	284	289	212	173	207	277	276	247	64	214	54	33	96	32	117	20	21	3	5	6	3	4	28	30	26	5	58	31	13	24	6	35
2043	289	279	286	290	216	175	210	280	279	251	65	217	55	33	98	33	119	20	21	3	5	6	3	4	28	30	27	5	59	32	13	25	6	36
2044	290	282	288	292	220	178	214	282	282	255	66	221	56	34	100	34	122	20	21	3	5	6	3	4	28	31	27	5	60	32	13	25	6	36
2045	292	285	290	293	224	181	217	285	285	259	67	225	57	35	102	34	124	21	22	3	5	6	3	4	29	31	28	5	62	33	13	26	6	37
2046	294	288	292	294	228	184	221	288	288	263	69	228	58	35	104	35	127	21	22	3	5	6	3	4	29	32	28	5	63	34	13	26	6	37
2047	295	291	294	296	232	186	224	291	291	267	70	232	59	36	105	35	129	21	22	3	5	6	3	4	30	32	29	5	64	34	13	27	6	38
2048	297	294	296	297	236	189	228	294	294	271	71	235	60	37	107	36	132	21	23	3	5	6	3	4	30	33	29	5	65	35	13	27	6	38
2049	298	297	298	299	240	192	231	297	297	275	72	239	61	37	109	36	134	22	23	3	5	6	3	4	31	33	30	5	66	35	14	28	6	39
2050	300	300	300	300	244	194	235	300	300	279	73	243	62	38	111	37	137	22	23	3	5	6	3	4	31	34	30	5	67	36	14	28	6	39

Source: JET

(3) Economic Condition

1) Outline of National Economy

As shown in Table A2-7, GDP, which had grown by 6% in 2013/14, was dropped due to the Great Nepal Earthquake that occurred in 2015, and due to the impact of the Indian border blockage immediately after the promulgation of the Constitution. The growth rate was recorded at 0.4% in 2015/16. However, the following year, the situation of the reconstruction from the earthquake and the border restriction with India were recovered, and the economic growth rate became higher than before the earthquake. On the other hand, the impact of the new coronavirus (hereinafter referred to as "Covid-19"), which spread worldwide from the beginning of 2020, has severely affected the Nepalese economy, and the GDP growth rate in 2019/20 is -2.1%. However, economic activity was gradually resumed, and the growth rate in 2020/21 returned to 4.0%.

In terms of industry, account of agriculture, forestry and fisheries shares about 23% of GDP (2020/21). In addition, commerce, education, real estate, etc. continue as major industries. Total account of the said industries shares more than 50% of GDP (2020/21).

In terms of economic relations with other countries, Nepal has joined the South Asian Association for Regional Cooperation and the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation, and has been working to strengthen the economic power of the entire region. In particular, it has signed an India-Nepal trade agreement with India since 1991, and imports and exports are tariff-free. However, due to a large excess of imports, the trade deficit with India recorded NPR 855,178 million in 2018/19. The total trade deficit including India is 1,321,426 million NPR. (Data source: Statistical Year Book of Nepal, 2019).

Table A2-7 Basic Economic Date of Nepal

Item/Year	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
GDP in current price Unit: Million NPR	2,608,184	3,077,145	3,455,949	3,858,930	3,914,701	4,266,321
GDP in constant price (base year 2010/11) Unit: Million NPR	1,870,424	2,038,337	2,193,706	2,339,743	2,290,880	2,382,708
Growth rate of GDP (constant price) (%) Unit: Thousand NPR	0.4%	9.0%	7.6%	6.7%	-2.1%	4.0%
GDP per capita, current prices Unit: Thousand USD	107.96 (0.90)	125.96 (1.05)	141.55 (1.18)	142.75 (1.19)	140.35 (1.17)	139.15 (1.16)

Source: ※1:CBS website https://cbs.gov.np/wp-content/upLoads/2021/12/CBS-GDP2021.xlsx
※2:IMF website https://www.imf.org/en/Countries/NPL 1USD=119.96NPR (JICA Rate is adopted)

(4) Pokhara Metropolitan City (PMC)

In formulating the First 3-year Periodic Plan (2021 / 22 - 2023 / 24), which will be described later, PMC attempted to estimate the current gross Municipal Domestic Product (hereinafter referred to as “GMDP”) for the entire city area. The results are shown in Table A2-8. It also conducted a survey on the number of business establishments and employees by sector. The results are shown in Table A2-9. Although agriculture and forestry show the largest share in the national GDP tabulation, Table A2-9 shows that agriculture and forestry are very small in the activities of Pokhara. On the other hand, it can be seen that the activity share of the commercial / tourism-related industry / education sector is very large. For such results, the PMC states that the table does not reflect figures for informal activities that are not registered, and that there are about 100,000 tourism-related workers and more than 100,000 villagers' agricultural and domestic businesses workers. Therefore, it is difficult to describe the activity status of each sector with the figures shown in the table.

Table A2-8 Basic Economic Data of Pokhara

No	Item	Total Value (million NPR)
1.	Annual Income (Household)	20,295
2.	Annual Income (Business sector)	63,398
3.	Annual Product (Agriculture sector)	11,496
4.	Annual Expense (Governmental sector)	15,346
5.	Total: Estimated Gross Product (PMC area)	110,535

Source: First 3-year Periodic Plan, 2022, PMC

Table A2-9 Number of Business Establishments and Employees

No	Category	Registered Entities		Employees of the Entities	
		Number	Share	Number	Share
1.	Agriculture & Forest	315	1.12%	1,515	1.45%
2.	Manufacture	2,679	9.49%	11,143	10.67%
3.	Minerals, Energy, Water & Construction	142	0.50%	1,130	1.08%
4.	Bulk & Retail Business	15,279	54.15%	33,146	31.73%
5.	Transportation, Storage & ICT	148	0.52%	1,620	1.55%
6.	Tourism & Accommodation	5,304	18.80%	19,489	18.66%
7.	Banks, Finance & Insurance	543	1.92%	5,898	5.65%
8.	Education	800	2.84%	16,958	16.23%
9.	Health	513	1.82%	6,031	5.77%
10.	Others	2,492	8.83%	7,539	7.22%
11.	Total	28,215	100%	104,469	100%

Source: First 3-year Periodic Plan, 2022, PMC

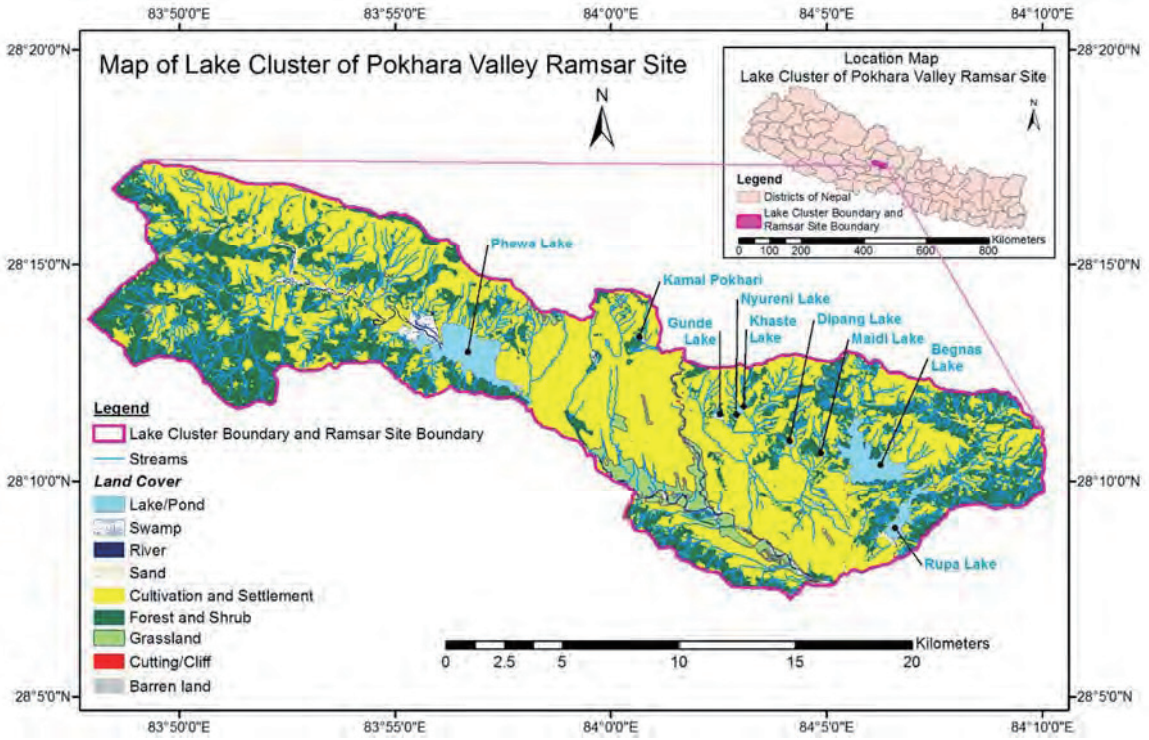
A2.4 Land Use

PMC has not formulated a defined urban plan. However, the current land use of each ward in Pokhara was organized by the Nepal Urban Resilience Project (NURP) supported by UK Aid in 2019. Therefore, the map was digitized and utilized to plan the sewerage area in the Project.

A2.5 Water Environment

A2.5.1 Wetland registered in Ramsar Convention

February 2, 2016, the area including a group of nine lakes near Pokhara, shown in Figure A2-9, was designated as a Ramsar Convention-listed wetland for the purpose of conserving the environment and biodiversity of the entire area, including Lake Phewa. which is a tourism hub. Policy developments related to the Ramsar Convention are discussed below in A4.



Source: Lake Cluster of Pokhara Valley, Department of National Parks and Wildlife Conservation, 2016

Figure A2-9 Ramsar Convention Registration Area in Pokhara

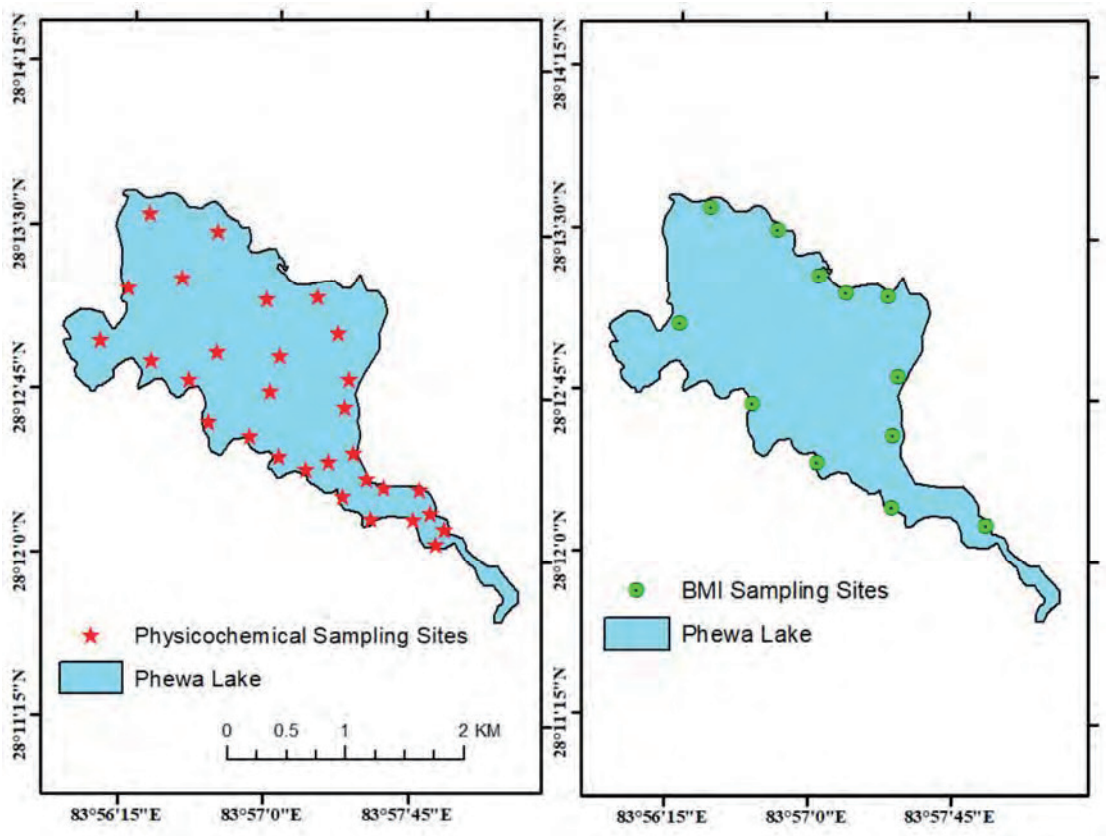
A2.5.2 Water Quality Situation of Lake Phewa and its Rivers

In order to understand the current situation of environmental water quality in Pokhara City, the results of the existing water quality surveys were organized. It is difficult to determine changes in water quality over time at a specific point because each water quality survey was conducted for different periods of time, the monitoring points and survey methods are inconsistent, and the monitoring locations are unknown in many cases. However, this project attempts to identify spatial and temporal trends in water quality to the extent possible.

(1) Lake Phewa Water Quality Survey by DoFSC[1]

The Department of Forest and Soil Conservation ("DoFSC") conducted a water quality and benthic organism (macroinvertebrate) survey of Lake Phewa by contract out to Tribhuvan University in March 2021. The survey points are shown in Figure A2-10 and the results of the water quality analysis in Table A2-10. In addition, DoFSC aims to accumulate information on an ongoing basis.

[1] Department of Forest and Soil Conservation, Water Quality and Ecological Health Assessment of the Phewa Lake, Gandaki Province, Nepal (June 2021).



Note: Sampling points (30 water quality (Physicochmemical Sampling) and 12 benthic organisms (BMI Sampling))

Source: Department of Forest and Soil Conservation, Water Quality and Ecological Health Assessment of the Lake Phewa, Gandaki Province, Nepal (June 2021)

Figure A2-10 Water Quality Sampling Points in the DoFSC Survey in 2021

Table A2-10 Results of Water Quality Analysis in the DoFSC Survey

Table 6: Average value of physicochemical parameters of different sampling sites

S.N	Parameters	Mean	Standard deviation	Maximum value	Minimum value	WHO guideline,2016
1	Tem	22.28	0.73	23.4	20.7	-
2	pH	8.06	0.31	8.6	7.1	6.5-8.5
3	EC	80.50	4.78	89	65	1500
4	TDS	43.13	12.44	108	38	1000
5	Ca^{2+}	14.77	7.61	51.2	5.6	100
6	Mg^{2+}	4.13	0.77	6.2	3	50
7	K^{+}	0.31	0.15	0.75	0.15	100
8	Na+	2.62	0.82	5.9	0.49	200
9	NO_3^{-}	2.31	0.38	2.9	1.55	50
10	Cl^{-}	10.81	7.47	35.5	4.26	250
11	SO_4^{2-}	7.64	2.67	15.4	3.8	250
12	HCO_3^{-}	59.83	7.71	75	45	600
13	PO_4^{3-}	0.12	0.01	0.136	0.111	-
14	NH_4^{+}	0.08	0.01	0.132	0.064	-
15	DO	7.46	1.04	8.75	5.45	> 4
16	BOD	70.18	69.99	276.8	9.6	< 30
17	COD	98.25	97.99	387.5	13.4	< 250
18	Tur	5.68	5.68	23	0.996	5
19	TH	41.43	7.54	62	30	500
20	CaH	27.20	7.59	46	14	-
21	MgH	14.27	6.36	28	4	-
22	Free CO_2	37.20	22.95	114.4	6.6	-

Source: Department of Forest and Soil Conservation, Water Quality and Ecological Health Assessment of the Lake Phewa, Gandaki Province, Nepal (June 2021)

The main conclusions stated in this study are summarized below.

- Cations were identified as Ca^{2}+ >Mg^{2}+>Na+>K+ and anions as HCO_3->Cl->SO_4^{2}->NO_3- at higher concentrations in that order. The predominance of Ca^{2}+ and HCO_3- is due to the geological environment of Lake Phewa (limestone).
- The results of the analysis of the main factor items of eutrophication are as follows. These items are highly dependent on fertilizer application, livestock waste, and domestic wastewater inflows.

Table A2-11 Main results of Water Quality Analysis of Lake Phewa in the DoFSC Study in 2021

Item	Mean Value	Minimum Value		Greatest Value	
Nitrate-nitrogen (NO_3 -N)	2.31 mg/L	1.55 mg/L	Near Lakeside	2.9 mg/L	Near the outlet of Lake Phewa
Phosphoric acid (H3PO4) (PO_4^{3-} P)	0.12 mg/L	0.11 mg/L	Multiple locations on the east side of the lake	0.136 mg/L	Near Barahi Temple
Ammonium (NH_4^{+})	0.08 mg/L	0.064 mg/L	Boat area near Barahi Temple	0.132 mg/L	Pame area* and near Barahi Temple

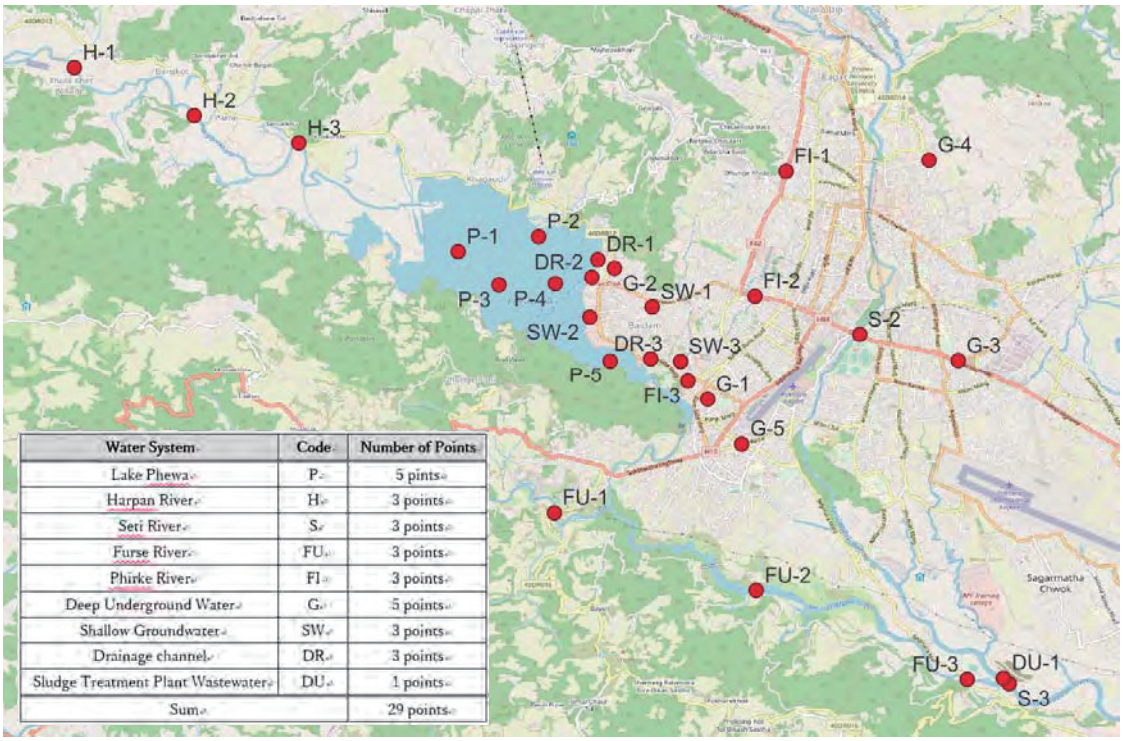
Note: *Pame area: commercial area in the northwestern part of the lake, with aquaculture in the vicinity.

Source: JET

- DO averaged 7.46 mg/L (minimum 5.45 mg/L, maximum 8.75 mg/L), which is appropriate for fish survival in freshwater (>3 mg/L).
- The results of the water quality survey and benthic organism survey indicate that within Lake Phewa, water pollution due to anthropogenic influences is ongoing in the boat area on the east side, around lakeside, near the outlet of Lake Phewa, and in the Pame area on the northwest side.
- The water quality of Lake Phewa is currently at a level that can be used for irrigation and is also usable as drinking water with treatment.
- Based on the results of the aquatic plant survey and the high concentrations of PO_4^{3-} and NO_3^- identified in the water quality survey, conditions are favorable for abnormal algal blooms.

(2) JICA Pokhara City Waste Water Management M/P Project

Water quality surveys were conducted in Lake Phewa and surrounding rivers and groundwater in December 2021 (dry season), July 2022 (rainy season), December 2022 (dry season) and July 2023 (rainy season) during the project. The survey points are shown in Figure A2-11, the water quality survey items and analysis methods in Table A2-12, and the analysis results in Appendix-2. The situation of surface water and groundwater quality, which can be confirmed from the analysis results, is shown in Table A2-13.



Water System	Code	Number of Points
Lake Phewa	P	5 pints
Harpan River	H	3 points
Seti River	S	3 points
Furse River	FU	3 points
Phirke River	FI	3 points
Deep Underground Water	G	5 points
Shallow Groundwater	SW	3 points
Drainage channel	DR	3 points
Sludge Treatment Plant Wastewater	DU	1 points
Sum		29 points

Source: JET

Figure A2-11 Water Quality Sampling Points

Table A2-12 Water Quality Survey Items and Analysis Methods

Item	Analytical Method	Test Procedure
Temperature	Thermometric method	APHA, AWWA, WEF (2017), 2550 B
pH (measure of acidity)	Electrometric method	APHA, AWWA, WEF (2017), 4500-H+ B
Suspended Solids (SS)	Total suspended solid dried at 103-105°C	APHA, AWWA, WEF (2017), 2540 D
Dissolved Oxygen (DO)	Azide modification	APHA, AWWA, WEF (2017), 4500-O C
bandwidth-on-demand$_5$	5 Day BOD Measured Test	APHA, AWWA, WEF (2017), 5210 B
COD_{Cr}	Open Reflux Method	APHA, AWWA, WEF (2017), 5220 B
T-N (as NH_4 -N)	Phenate Method	APHA, AWWA, WEF (2017), 4500-NH3 F
T-P (as PO_4 -P)	Ascorbic Acid Method	APHA, AWWA, WEF (2017), 4500-P E
E.Coli (Fecal Coliform)	Membrane Filtration Method	APHA, AWWA, WEF (2017), 9222 D

Source: JET

Table A2-13 Summary of Analysis Results and Situation of each Water Quality

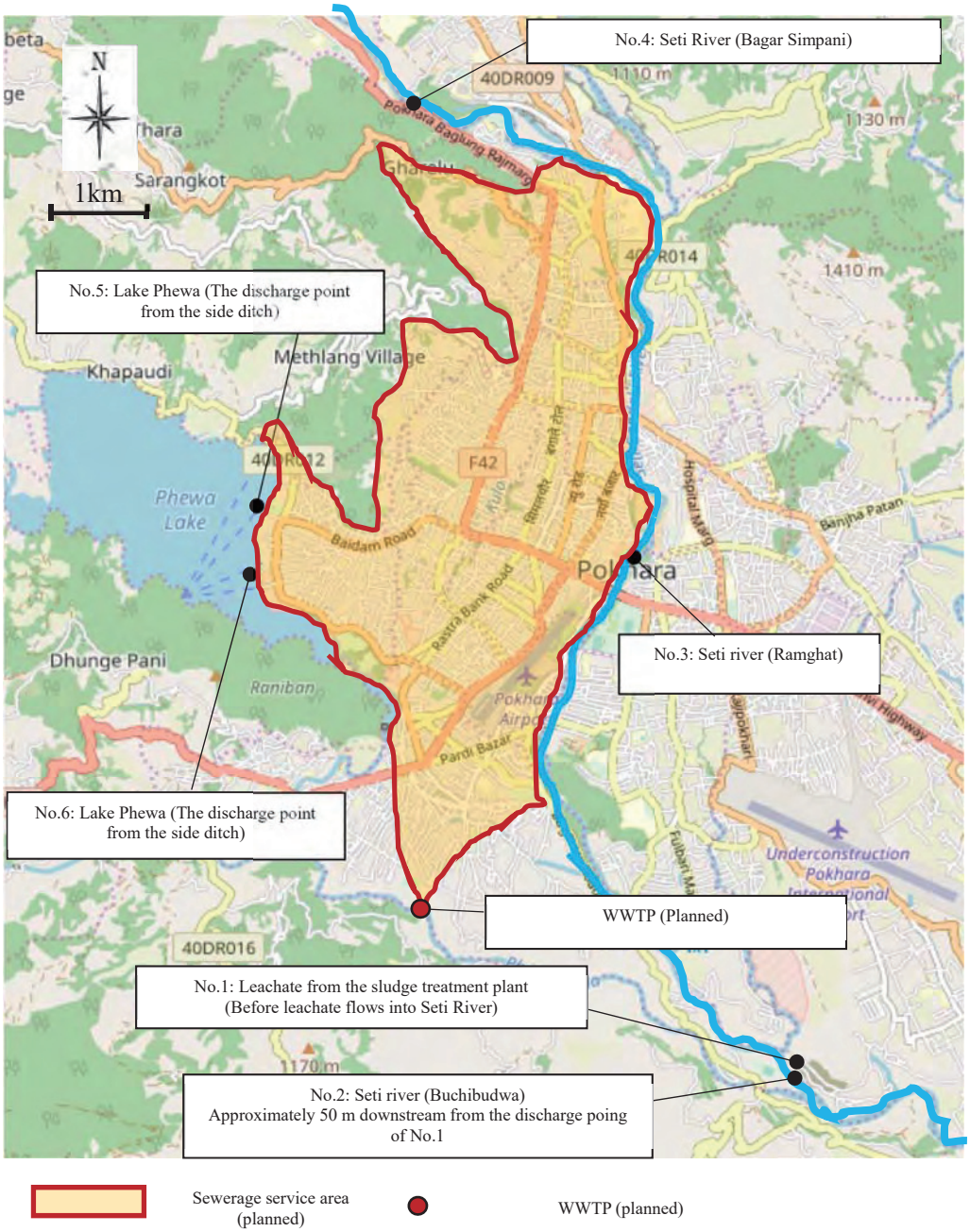
Analysis Results Summary		Water Quality Conditions
Lake Phewa Watershed		
Lake Phewa	➢ The pH averages 7.364 in the dry season and 7.219 in the wet season, with no significant differences. ➢ BOD and CODCr did not differ significantly throughout the year, ranging from 0.39 to 14.8 mg/L and 1.28 to 14.9 mg/L, respectively. ➢ NH_4 -N was detected in the western part of the lake only during the rainy season (0.136 mg/L). ➢ PO_4 -P is <0.01 mg/L most of the year, with >0.01 mg/L ranging from 0.01 to 0.018 mg/L. ➢ E. coli ranged from 0 to 405 CFU/100mL. The average (116 CFU/00mL) was within the standard of 300 CFU/100mL for Category A (water supply level 2 and 3/bathing) of the Japanese Lake Environmental Standards.	➢ It is thought to be affected by the inflow of water quality from the Harpan River, especially nitrogen content. ➢ Based on the situation in E.Coli, it is assumed that no significant impact from the inflow of manure has occurred. ➢ Large growth of water plants, bad odors from the water body and floating garbage in the water body have been observed.
Harpan River	➢ The pH averages 7.09 in the dry season and 6.77 in the wet season, with a year-round acidic trend in the wet season and a decrease in pH as you move downstream. ➢ BOD and COD did not differ significantly throughout the year, ranging from 0.42 to 6.2 mg/L and 1.5 to 20.2 mg/L, respectively. ➢ NH_4 -N was detected at 0.22 mg/L in the upstream, 0.154 mg/L in the midstream, and <0.1 mg/L in the downstream during the wet season, and <0.1 mg/L in the upstream and midstream and 0.29 mg/L in the downstream during the dry season. ➢ PO_4 -P is >0.01mg/L with a range of 0.01~0.029mg/L. ➢ E.Coli was detected at 70-460 CFU/mL throughout the year, with an average of 205 CFU/mL, which is within the standard of 300 CFU/100mL for Category A (water supply class 2/fishery class 1/water bath) of the Japanese riverine environmental standard.	➢ Nitrogen content derived from agricultural and domestic wastewater along the Harpan River is thought to be affecting water quality. However, since only NH_4 -N was targeted in this study, the content of organic nitrogen and nitrate/nitrite is unknown. ➢ Based on the situation in E.Coli, it is assumed that no significant impact from the inflow of manure has occurred.
Phirke River	➢ DO in the dry season is lower than other sites, 2.25 mg/L upstream and 3.7 mg/L downstream. ➢ BOD and COD are highest in the upper reaches during the dry season at 45.54 mg/L and 127.45 mg/L, respectively, while during the rainy season they are highest in the middle FI-2 located in the center of the urban area at 4.3 mg/L and 13.9 mg/L, respectively. ➢ NH_4 -N was detected between 0.28 and 5.29 mg/L in the dry season and <0.1-0.457 mg/L in the wet season. ➢ PO_4 -P is detected throughout the year, ranging from 0.01 to 0.47 mg/L in the dry season and 0.021 to 0.3154 mg/L in the wet season. ➢ E.Coli was detected throughout the year at levels ranging from 1 to 980 CFU/mL, with an average of 371 CFU/mL, which is within the 1,000 CFU/100mL standard for Category B (Class 3 water supply / Class 2 fisheries) of the Japanese riverine environmental standard.	➢ During the dry season, it is presumed that the low water volume causes foul odors and is not suitable for fish habitat (generally, DO levels of 2 mg/L or higher are required to prevent foul odors in rivers and other water bodies, and 3 mg/L or higher is required for fish and shellfish to survive). ➢ It is a likely source of nitrogen, phosphorus, and E.Coli to the eastern part of Lake Phewa.
Drainage channel near Lakeside	➢ BOD and COD were high during the dry season, ranging from 9.15 to 58.79 mg/L and 26.73 to 156.86 mg/L, respectively, and DR-2 was higher than the other sites even during the rainy season. ➢ NH_4 -N detected <0.1 to 1.16 mg/L throughout the year. ➢ PO_4-P is detected <0.01~0.08 mg/L throughout the year.	➢ BOD, COD, and E.Coli were also high, and NH_4^- N and PO_4^- were also detected, indicating the possibility of anthropogenic water pollution due to human waste and domestic wastewater near

	Analysis Results Summary	Water Quality Conditions
	➢ E.Coli was detected at 2-660 CFU/mL throughout the year, with an average of 303.8 CFU/mL, which is within the standard of 1,000 CFU/100mL for Category B (water supply Class 3/fishery Class 2) of the Japanese riverine environmental standard.	Lakeside.
Seti River Basin		
Seti River	➢ SS ranges from 6.1 to 75.76 mg/L in the dry season, while in the wet season it is very high, ranging from 597.51 to 2,494.88 mg/L. The values increase as you move downstream in both wet and dry seasons. ➢ DO is 7.5~8.9 mg/L in the dry season and 6.4~7.6 mg/L in the wet season, with no significant decrease in DO in the wet season. ➢ BOD and COD did not differ significantly throughout the year, ranging from 0.46 to 5.2 mg/L and 1.5 to 16.6 mg/L, respectively. ➢ NH_4 -N was detected only in the downstream area (S-3), 0.96 mg/L in the dry season and 0.96~2.86 mg/L in the wet season. ➢ E.Coli was detected at 1-660 CFU/mL throughout the year, with an average of 286 CFU/mL, which is within the standard of 300 CFU/100mL for Category A (waterworks Class 2/fishery Class 1/water bath) of the Japanese riverine environmental standard.	➢ During the rainy season, there is likely to be a large inflow of organic matter derived from phytoplankton, manure, and industrial effluent from the watershed, but it is also assumed that silt and other mineral-derived constituents from upstream areas have a significant impact on water quality.
Furse River	➢ BOD and COD during the rainy season were 1.4-9.6 mg/L and 5.5-44 mg/L, respectively, higher in the middle and lower reaches of the river than in other areas. ➢ PO_4-P has been detected <0.01~0.03 mg/L throughout the year. ➢ E.Coli was detected at 1-540 CFU/mL throughout the year, with an average of 226 CFU/mL, which is within the standard of 300 CFU/100mL for Category A (water supply class 2/fishery class 1/water bath) of the Japanese riverine environmental standard.	➢ The river merges with the inflow from Lake Phewa in the upstream to midstream areas and the urban area is located in the midstream to downstream areas.
Underground water		
Shallow Groundwater	➢ The pH averages 7.09 in the dry season and 7.00 in the wet season, with no significant changes throughout the year. ➢ NH_4 -N detected <0.1 to 1.16 mg/L in the dry season and <0.1 to 2.0 mg/L in the wet season. ➢ E.Coli is almost undetectable in the dry season with 0-80 CFU/100mL, but in the wet season, as high as 1,200 CFU/100mL is detected near Lakeside (SW-3).	➢ Based on the detection of E. Coli, it can be inferred that the lakeside shallow groundwater on the east side of Lake Phewa is greatly affected by wastwater infiltration during the rainy season.
Deep Underground Water	➢ The pH averages 7.30 in the dry season and 7.29 in the wet season, and does not change significantly throughout the year. However, the pH tends to be slightly higher than other points only in the northeast part of the urban area (G-4). ➢ NH_4 -N detected <0.1-0.51 mg/L in the dry season and <0.1-1.1 mg/L in the wet season. ➢ E.Coli has been detected at 0~30 CFU/100 mg/L in the dry season and 0~300 CFU/100 mL in the wet season.	

Source: JET

(3) Data Collection Survey on Water Supply and Wastewater Sector by JICA

Water quality surveys (simple and laboratory analysis) are being conducted in 2019 for 3 points in the Seti River and 2 points in Lake Phewa during the dry season (March-April 2019) and the rainy season (August 2019). The survey points are shown in Figure A2-12, and the analysis results are shown in Table A2-14 and Table A2-15.



Source: Final Report on Information Collection and Verification Study on Water and Sewerage Sector, Nepal, 2019, JICA.

Figure A2-12 Water Quality Sampling Points in the 2019 Survey

Table A2-14 Water Quality Survey Results for 2019

Type		Leachate from Sludge Treatment Facility		River Water (Seti River)						Lake Water (Lake Phewa)				[Reference] Water Quality Standards in Japan	
Sampling Number		No.1※1		No.2※2		No.3		No.4		No.5※3		NO.6※4		Environment Standards	Drainage Standards
Local Name		Bachibuduwa		Bachibuduwa		Ramghat		Bagar Simpani		-		-			
Sampling Date		27th March	8th August	27th March	8th August	27th March	8th August	27th March	8th August	27th March	8th August	27th March	8th August		
Item	Unit														
1 On-site Analysis															
Water Temperature	℃	23.3	28.2	20.7	23.0	20.1	23.3	19.7	24.5	23.7	31.4	22.9	31.1		
pH	-	8.2	8.1	7.9	8.2	8.3	8.2	8.2	8.3	7.8	8.0	8.2	8.0		
DO	mg/L	7.4	3.1	8.9	6.1	8.8	6.1	8.7	4.6	7.5	5.0	7.7	4.9		
EC	mS/cm	7.49	8.20	0.33	0.21	0.29	0.20	0.29	0.16	0.36	0.10	0.10	0.05		
Turbidity	NTU	73	152	36	230	37	220	48	140	40	11	5	17		
Ammonia	mg-N/L	500	1,000	0.5	0.2	0.2	Less 0.2	0.2	Less 0.2	0.2	0.2	0.2	0.5		
Nitrate nitrogen	mg-N/L	50	Less 2	0.5	Less 0.2	0.2	Less 0.2	0.2	Less 0.2	0.2	Less 0.2	0.2	Less 0.2		
Phosphoric Acid	mg-N/L	20	100	0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.05	0.05		
General Bacteria	CFU/ml	500	4	66	Numerous	70	Numerous	24	17	Numerous	Numerous	38	Numerous		
E.coil	CFU/ml	300	Numerous	21	Numerous	28	Numerous	7	6	Numerous	11	11	Numerous		
Chromaticity	TCU	2,000	2,000	10	10	10	20	10	20	20	50	10	20		
Odor	-	Nothing	Nothing	Nothing	Nothing	Nothing	Smells Slightly	Nothing	Nothing	Smells Slightly	Nothing	Nothing	Nothing		
2 Water Quality Laboratory Analysis (Official Method)															
pH	-	8.6	8.9	7.9	8.6	8.0	8.7	8.1	8.6	7.5	7.6	7.7	7.2	6.5-8.5	5.6-8.6
TSS	mg/L	76	52	27	166	40	259	75	69	22	10	32	3		200
TS	mg/L	4,076	4,822	179	277	169	358	205	151	189	54	78	75		
[Organic Matter, etc.]															
COD_{Cr}	mg/L	448	633	Less 2	Less 2	Less 2	Less 2	Less 2	3	12	7	Less 2	3		
BOD_5	mg/L	65	300	Less 3	Less 3	Less 3	Less 3	Less 3	Less 3	4	Less 3	Less 3	Less 3	1 (water supply class	160

Type		Leachate from Sludge Treatment Facility		River Water (Seti River)						Lake Water (Lake Phewa)				[Reference] Water Quality Standards in Japan	
														1), 2 (water supply class 2), 3 (water supply class 3)	
Total Nitrogen	mg-N/L	578	639	7	2	3	2	3	1	5	1	4	3	0.1 (Type I), 0.2 (Type II), 0.4 (Type III), 0.6 (Type IV), 0.1 (Type V)	120
Total Phosphorus	mg-N/L	18.6	11.2	0.10	0.03	0.02	0.07	0.03	0.04	0.20	0.01	0.04	0.01	0.05 (Type I), 0.01 (Type II), 0.03 (Type III), 0.05 (Type IV), 0.1 (Type V)	16
Fats and Oils	mg/L	6	11	3	Less 1	3	Less 1	4	Less 1	4	Less 1	2	Less 1		5 (mineral oil), 30 (animal and vegetable oil)
[Microorganisms]															
E.coil	MPN/100ml	9.2×10^3	9.2×10^3	2.4×10^3	2.3×10^3	4.6×10^3	2.4×10^3	1.5×10^3	4.6×10^3	4.6×10^3	2.0×10^3	4.6×10^3	9.3×10^3	※Coliform Group 50MP/100ml (waterworks grade 1), 1000MPN/100ml (waterworks grade 2)	※Coliform Group 3×10^5MPN/100ml

Source: Final Report on Information Collection and Verification Study on Water and Sewerage Sector, Nepal, JICA, 2019.

Note: ※1 The leachate flow rates on March 27 and August 27 were approximately 10 L/min and 25 L/min, respectively.
※2 Samples were taken approximately 50 m downstream from P1.
※3 The sample was taken at the point where the drainage water from the roadside ditch flows into Phewa Lake.
※4 The sample was taken when wastewater from roadside ditches flowed into Lake Phewa.
※5 Environmental standards for designated lakes and marshes in Japan

Table A2-15 Groundwater Quality Survey Results for 2019

Sample No./Criteria	Ammonia Nicotinamide Adenine Dinucleotide $(NN)_4$	Nitrate-nitrogen NO_3	Phosphoric Acid (H_3PO_4) PO_4	Bacteria	Fecal Coliform Bacteria
Sample 1 (Lakeside)	0.5mg/L	10mg/L	0mg/L	11 cfu / mL	2 cfu / mL
Sample 2 (Lakeside)	0.5mg/L	1mg/L	0mg/L	40 cfu / mL	2 cfu / mL
Sample 3 (Lakeside)	0.5mg/L	0.5mg/L	0mg/L	2 cfu / mL	0 cfu / mL
Groundwater Environmental Standards in Japan (Reference)		44mg/L			
Nepal Drinking Water Quality Standards (Reference)	1.5mg/L	50mg/L			0 MPN/100 mL

Note: The Japanese environmental standard for nitrate-nitrogen specifies 10 mg/L for the nitrogen content in nitrate-nitrogen and nitrite-nitrogen. The simple survey of the sample measures the concentration of NO3, which is converted to NO_3 concentration by atomic mass.
Source: Final Report on Information Collection and Verification Study on Water and Sewerage Sector, Nepal, JICA, 2019.

The main conclusions stated in this study are summarized below.

- The pH of the Seti River exceeds 8.5 at all points during the rainy season.
- In the Seti River (No. 2-4), fecal coliform (E. coli) concentrations tended to increase slightly downstream during the dry season. In the lower reaches, 2400 MPN/100 mL of E. coli were detected, while in the vicinity of Lake Phewa, the concentration was as high as 4600 MPN/100 mL in the No. 5 dry season.
- At two points (No.5 and No.6) where roadside ditches flow into Lake Phewa, total nitrogen was 5 mg/L and 4 mg/L in the dry season, respectively, and 1 mg/L and 3 mg/L in the rainy season, higher than the standard value of 1 mg/L for Category V (class 3 of fishery / industrial water / agricultural water / environmental conservation) of the Japanese Lake Environmental Standards.
- BOD at the survey points in the Lake Phewa and Seti River is <3 mg/L to 4 mg/L throughout the year and COD_{Cr} is <2 mg/L to 12 mg/L. CODCr was maximum at No. 5 in both wet and dry seasons (7 mg/L in wet season and 12 mg/L in dry season).

(4) JICA Lake Phewa Environmental Conservation Planning Study

The Lake Phewa Environmental Protection Plan Study conducted in 2002 showed that the river and drainage culvert flows and pollutant loads into Lake Phewa were Table A2-16. The water quality situation of Lake Phewa as of 2002 according to the same report is also shown in Table A2-17.

Table A2-16 River and Drainage Culvert Flows and Pollutant Loads Entering Lake Phewa

Inflow River	Flow Rate (esp. Water or Electricity)		COD_{Mn}			T-N.			T-P.		
	(m^3 /second)	(%)	(mg/L)	(g/sec)	(%)	(mg/L)	(g/sec)	(%)	(mg/L)	(g/sec)	(%)
Harpan River	6.15	73.4	1.8	10.8	61.1	0.7	4.5	52.1	0.16	0.97	43.9
Seti River	1.04	12.4	2.1	2.2	12.3	1.8	1.8	21.5	0.58	0.60	27.2
Seti Canal	0.17	2.0	10.0	1.7	9.6	5.0	0.9	10.0	1.53	0.26	11.8
Phirke River	0.22	2.6	10.0	2.2	12.4	5.0	1.1	12.9	1.50	0.33	14.9
Forested area	0.80	9.5	1.0	0.8	4.5	0.4	0.3	3.5	0.06	0.05	2.2
Total amount	8.38	100		17.68	100		8.54	100		2.21	100

Source: Lake Phewa Environmental Conservation Plan Study, JICA, 2002.

Table A2-17 Water Quality Situation of Lake Phewa

Item	Situation
Eutrophication	An abnormal algae bloom occurred from 1993 to 1995 due to the inflow of nitrogen and phosphorus in runoff from agricultural lands around Lake Phewa and domestic wastewater from the city center. The phosphorus concentration in the rivers flowing into Lake Phewa reaches around 0.2 to 2 mg/L, which is high compared to the classification criteria of 0.035 to 0.1 mg/L* for a harmonic lake.
Organic pollution	The inflow of organic matter in runoff from agricultural lands around Lake Phewa and domestic wastewater from the city center caused a massive fish die-off in 1993, along with an abnormal algae bloom.
Fecal coliform contamination	The fecal coliform concentration per 100 mL in the river flowing into Lake Phewa is about 10^2 levels, which is a level that poses a hazard to people (boats, etc.) recreating in Lake Phewa.

Note: *: Eutrophication of Waters, Monitoring, Assessment and Control, OECD, 1982

Source: Lake Phewa Environmental Conservation Plan Study, JICA, 2002

A2.5.3 Other Water Quality Studies in Lake Phewa

In addition to the above-mentioned surveys, other agencies were identified as conducting water quality testing. The confirmed water quality data are shown in Table A2-18. For reference, the water quality environmental standards for lakes and marshes in Japan (Category A-II: the level at which highly purified water can be used as a source of drinking water) are also listed. The results confirmed that T-N and T-P values have been high since 2002, and there is concern that eutrophication is progressing in Lake Phewa.

Table A2-18 Historical Water Quality Measurement Data in Lake Phewa

Item	pH (measure of acidity)	Suspended solids mg/L	Bandwidth-on-demand mg/L	COD mg/L	DO mg/L	Escherichia coli (E. coli) MPN/100mL	Fecal coliform bacteria MPN/100mL	T-N. mg/L	T-P. mg/L
2002	-	-	1.14	2.08	-	5,900* (in the U.S.)[1]	10*[1]	2.46	0.06
2014			3.57	10.79	11.9			1.79	0.05
2016	7.50	-	2.5	5.7	7.9	-	70	1.78* (1.78*)[2]	-
2017	6.72	-	1.82	-	-	-	-	-	-
Reference: Japan Criteria (A-II)	6.5-8.5	5 or less		3 or less	7.5 or higher	Less than 1,000	-	Less than 0.2	Less than 0.01

Note: *1: Units are in cfu, *2: Sum of NH_3 -N, NO_3 -N, NO_2 -N

Source: Lake Phewa Environmental Conservation Plan Study, JICA, 2002

Final Report Detailed Engineering Design of Lake Phewa Wastewater Management Project, DWSSM, 2014

Water quality study by DHM-2072, 2016 (Ministry of Population and Environment, Nepal, at that time)

Water quality assessment in the lakes of Pokhara Valley, 2017 (Tribhuvan University)

A2.5.4 Summary of Current Situation of Environmental Water Quality in the Pokhara City

Based on the above water quality survey results, it can be said that no significant water pollution is occurring in the water bodies of Pokhara City at this time, but serious water quality deterioration could occur in the future depending on urbanization and population growth. The water bodies in Pokhara City are classified into three major categories: i) Seti River Basin, ii) Lake Phewa Basin, and iii) groundwater, and the characteristics of water pollution in each area are summarized in this section.

- Seti River Basin: In addition to mineral-derived constituents such as silt from the geological environment (limestone), water quality pollution is being caused by the inflow of pollutants such as domestic wastewater and human waste in the process of flowing through the urban area.

- Lake Phewa Basin: In the eastern part of the lake, water pollution is caused by the inflow of pollutants from urban areas, such as domestic wastewater and human waste. On the other hand, in the western part of the lake, there are concerns about water pollution caused by agriculture and livestock farming along the Harpan River, which flows into the lake, such as fertilizers and livestock wastes. Pollution due to anthropogenic influences in the Pame area in the northern part of the lake is also considered to be progressing.
- Groundwater: E. coli contamination of groundwater near the urban area can be confirmed in some areas due to seepage of human waste. On the other hand, groundwater contamination by nitrate-nitrogen and nitrite-nitrogen from agricultural sources is unknown at this time, as groundwater measurements have not been conducted along the Harpan River upstream of Lake Phewa.

A2.6 Development Plan of Pokhara Metropolitan Municipality

A2.6.1 Long-term Vision

With the change to the current city area in 2018, PMC has formulated a long-term development vision (Pokhara 2100 and Strategic Plan 2077-82), as a long-term development guideline. The vision here is "Prosperous Touristic Pokhara", and the following main guidelines are listed.

(1) Sustainable, Inclusive and Planned Urban Development
(2) Three pillars (public, private & cooperative) concept of Economic Development
(3) Human Development and Quality of Life
(4) Social Justice, Inclusion and Egalitarian Development
(5) Climate change adaptation and disaster resilience
(6) Human Resource Management and Quality Service Delivery
(7) Coordination, Partnership and Collaboration Based Development
(8) Good Governance, Transparency and Virtue
(9) Outcome based Development Management

A2.6.2 First 3-year Periodic Plan (2021/22-2023/24)

PMC formulated the First 3-year Periodic Plan (2021 / 22 - 2023 / 24) in 2021. This is PMC's first three-year development plan and corresponds to a concrete development plan in the future.

(1) Objectives and Main Strategies

The following are listed as development objectives. The wastewater management and water environment management projects correspond to "Balanced Environment and Inclusive Infrastructures," and the Project is in line with this development policy.

(1) Human Resource Development and Development of Knowledge Based Economy
(2) Economic Modernization and Empowerment of the People's Private Sector
(3) Good Governance and Institutional Social Development
(4) Balanced Environment and Inclusive Infrastructures
(5) Participation with Gender and Ethnic Equality
(6) Maximum Use of Science, Technology, Information and Communication Sectors
(7) Climate Change Adaptation

In addition, the following are listed as strategies. The wastewater management and water environment management projects businesses include "Simplified and facilitated environment friendly urban development," "Building an environment sensitive and responsible society," and "Solid waste treatment and proper management and use of latest technology in pollution control." It matches in terms of "creation".

(1) Rapid economic growth through green, uplifting, inclusive and balanced development with low carbon emissions
(2) Smart and tourist city with modern and well-organized infrastructure

(3) Simplified and facilitated environment friendly urban development
(4) Systematic and Nature Friendly Integrated Housing Scheme
(5) Inclusive and Disaster Resilient Urban Infrastructure Development
(6) Building an environment sensitive and responsible society
(7) Solid waste treatment and proper management and use of latest technology in pollution control
(8) Socially and morally responsible, creative, competitive and productive education system
(9) All-accessible quality health care to prepare healthy and productive citizens
(10) Ensuring the participation of women, minorities and marginalized groups in all the institutional structures of the metropolitan city
(11) Improving the quality of public services and increasing the access of all citizens
(12) Meaningful Coordination, Partnership and Cooperation between Government, Cooperatives, Private Sectors, Communities and Citizens
(13) People-Oriented Service Delivery, Performance Capacity and Accountability Enhancement
(14) Effective COVID Infection Control and Management Creating Relief, Income and Employment Growth Opportunities for Livelihood Crisis

(2) Quantitative Goals

Based on the objectives and strategies mentioned above, the First 3-year Periodic Plan sets quantitative targets for each sector. The major development goals are associated with the SDGs, and the ones that are directly related to the Project are shown in Table A2-19.

Table A2-19 Quantitative Goals (Water and Sanitation)

No	Indicator	Present (2015)	Goal (2023)	Goal (2030)
1	Population using safe water supply (%)	15*1	65 (2025) *1	90 *1
2	Households with access to tap water (%)	50	90	100
3	Expansion of Basic Water supply (%)	91	100	100
4	Single Households using modern sanitation facilities (%)	73	90	100
5	Urban households with toilets connected to sewerage (%)	30 *2	80	100
6	Population using Toilets (%)	81	100	100

*1: Goal of Population using safe water supply is the national one and not PMC's one.
*2: It is supposed the number of wastewater direct discharge households since no sewerage is developed in PMC area.
Source: First 3-year Periodic Plan, 2021, PMC

In addition, the First 3-year Periodic Plan sets also the following three-year goals.

(1) Achieving easy access to safe water and adequate sanitation
(2) Start of comprehensive sewage treatment system development through the formulation of master plan and detailed project plan

In addition, a three-year investment plan for that purpose is planned, but the specific content has not yet been decided. The financial resources also need to be discussed with the federal and state governments.

Table A2-20 Investment Plan of PMC (Water and Sanitation Sector)

No	Program/Project	Unit	Qty	Investment (Thousand NRP)				Investment per Unit (Thousand NPR)
				2021/22	2022 /23	2023 /24	Total	
1	To ensure clean and adequate water supply in all households.	house hold	10,000	120,000	140,000	140,000	400,000	40
2	To provide permanent toilets for the households living	house hold	30	10,000	10,000	10,000	30,000	1,000

No	Program/Project	Unit	Qty	Investment (Thousand NRP)				Investment per Unit (Thousand NPR)
				2021/22	2022 /23	2023 /24	Total	
	below the poverty line and using temporary toilets.							
3	Clean water supply will be provided in public places.	place	60	2,000	2,000	2,000	6,000	100
4	Public toilets will be provided in public places.	place	30	15,000	15,000	15,000	45,000	1,500
5	Pokhara Metropolitan City Integrated Sewerage Construction	km	25	100,000	100,000	100,000	300,000	12,000
	Total			**250,000**	**270,000**	**271,000**	**791,000**	

Source: First 3-year Periodic Plan, 2021, PMC

A2.7 Condition of Water Supply

A2.7.1 Outline of Water Supply Service

In PMC area, the core area is watered by NWSC, while the suburbs are watered by Water Users and Sanitation committee ("WUSC"). Table A2-21 shows the status reported in the First 3-year Periodic Plan. Although many WUSCs are involved, the list of WUSCs is not prepared by PMC / FWSSMP because WUSCs are independent entities and not placed under PMC or FWSSMP.

In addition, the water supply coverage rate is reported to be about 93% in the First 3-year Periodic Plan, as shown in Table A2-22.

Table A2-21 Water Supply Service Providers in Pokhara

Area	Institution
Ward 1 to 17 (Main urban area)	80% from NWSC 20% from WUSCs
Ward 14, Bachchebaduwa	WUSC
Ward 16, Armala	15% from NWSC New WUSC project being prepared for 1000 households
Ward 18, Sarangkot	WUSC
Wards 21	WUSC
Wards 22 and 23	WUSCs
Ward 24	WUSC
Ward 25, Hemja	NWSC
Ward 26, 27, 28, 29, 30, 31, 32	WUSC

Source: First 3-year Periodic Plan, 2021, PMC

Table A2-22 Water Supply Coverage (Based on Households Number of 2011 Census)

Source of Water Supply	Household Number	Percentage
Pipe network	97,896	92.67 %
Tube well/ hand pump	158	0.15 %
Covered well	958	0.90 %
Open well	1,417	1.34 %
Water of natural origin	2,573	2.43 %
River	360	0.34 %
Others	1,909	1.80 %
Source not open	354	0.34 %
Total	105,631	100.00 %

Source: First 3-year Periodic Plan, 2021, PMC

A2.7.2 Volume of Water Supply and Distribution

At the Pokhara branch of NWSC, the largest water service provider, reports the follows although not accurate because of not metered value and many of non-revenue water / leakage included:

(1) Water supply population: about 180,000
(2) Average water supply: about 42MLD (million L / day)

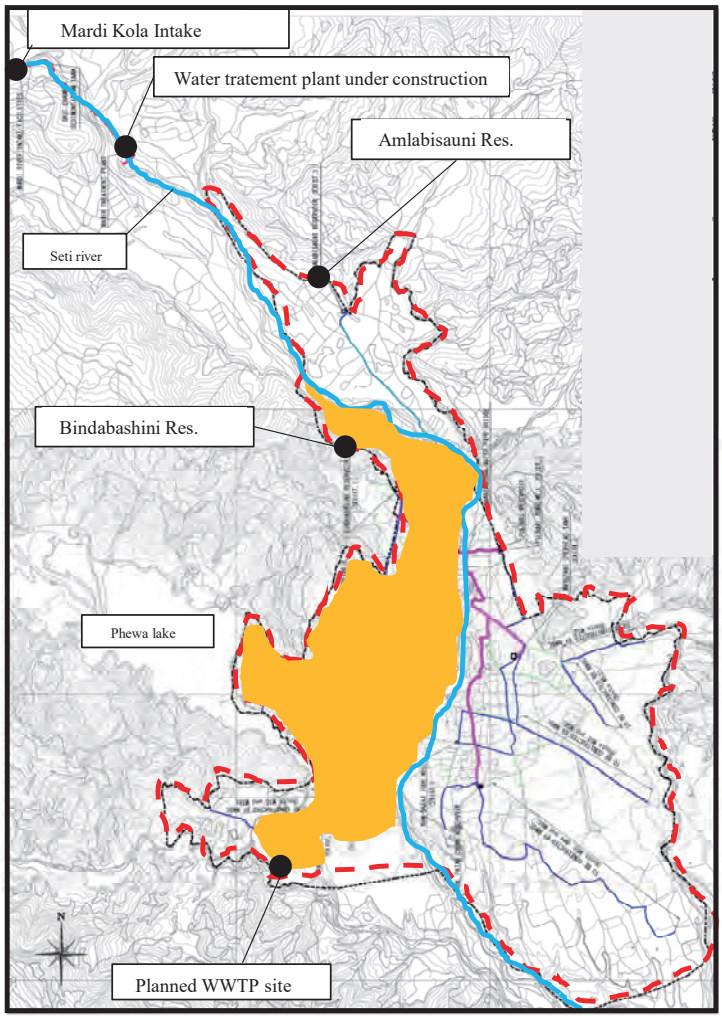
(3) Water coverage: about 70%
(4) Average daily water supply per person: about 230LCD

As mentioned in Chapter B2.1, the meter readings shown in billing data is 151 LCD on the average.

In addition, Lekhnath WUSC, the largest WUSC, reports that the water supply population is approx. 57,000 (15,850 connections x 3.62), the average water supply volume is approx. 9.5 MLD, and the average water consumption volume is approx. 6.65 MLD. The average daily water consumption is estimated at about 116 LCD. On the other hand, in Kahun WUSC in the mountainous area, it is 75LCD, and the difference between regions and operators is large.

A2.7.3 Water Distribution Zone in Core Area

As mentioned above, the core area is supplied with water by the Pokhara branch of NWSC. The main water source is the Mardi River, and a new water treatment plant (planned water supply volume of 41,000 m^3 / day) is under construction with Japan's Grant Aid. Figure A2-13 shows the water supply zone of the core area and the project target area of the existing sewerage development plan formulated by DWSSM.



Source: JET

Figure A2-13 NWSC's Water Supply Zone in Core Area and Target of Existing Plan for Sewerage

A2.7.4 Water Tariff

Table A2-23 shows the present NWSC water tariff. Table A2-24 shows Lekhnath WUSC' one, which is the largest WUSC. In Nepal, WUSCs providing small-scale water services are often higher in water tariff than NWSC, as the case of Lekhnath WUSC.

Also, since they have no sewerage service, sewerage charges are not collected. In the Kathmandu Valley, where sewerage charges are collected, 50% of the water charges are charged as sewerage charges, and it is thought that the same level of sewerage charges can be collected at Pokhara.

Table A2-23 Water Tariff of NWSC

Water Tariff					
Diameter of Service Pipe	Base Consumption (L)	Metered Base Customer		Fixed rate Customer	
		Base Charge (NPR)	Charge Exceeding Base Consumption (NPR/m^3)	Main Tap (NPR)	Branch Tap (NPR)
1/2"	10,000	110	25	560	200
2/3"	27,000	1,490	40	3360	1,600
1"	56,000	3,420	40	9,200	2,700
1 1/2"	155,000	9,600	40	20,700	6,500
2"	320,000	21,600	40	42,300	12,000
3"	881,000	49,500	40	131,400	33,000
4"	1,810,000	97,200	40	250,200	62,000
Public tap	1,600 NPR/month				
Tank Truck	5,000L: 1,950 NPR				
	6,000L: 2,200 NPR				

Source: NWSC

Table A2-24 Water Tariff of Lekhnath WUSC

Category	Base Consumption (L)	Metered Base Customer	
		Base Charge (NPR)	Charge Exceeding Base Consumption (NPR/m^3)
1	0 - 10,000	245	
2	10,000 - 20,000		27
3	21,000 - 30,000		32
4	31,000 - 40,000		36
5	41,000 -		45

Source: Lekhnath WUSC

A3 Wastewater Management System / Upper Level Plan and related Regulations in Nepal

A3.1 Overall Structure of Wastewater Management

The Local Government Operation Act established in 2017 clarified that the implementation of wastewater management is conducted by local governments. At the federal level, MoWS is in a position to supervise the activities of local governments involved in wastewater management.

Since local governments have not been in charge of wastewater management business so far, they lack the system, personnel, and skills for planning and operation / maintenance of wastewater management. Therefore, DWSSM and the provincial government are undertaking facility development and technical advice. In accordance with the request of local governments and / or communities, DWSSM and the

provincial government formulate facility development plans and develop facilities as necessary, and transfer the facilities to local governments to develop wastewater management conditions.

A3.2 Policies and Strategies for Wastewater Management

A3.2.1 National Development Plan

During the period of the 14th Three-Year Plan, in the sector of water supply and wastewater management, the basic level water supply coverage reached 89% against the target of 90% by 2019. On the other hand, the water supply coverage above the Middle level (average daily water supply per 65LCD or more) remained at 21% against the target of 30%. In terms of wastewater management, the coverage of sanitary facilities for Basic services was achieved at 99% against 89% of target. However, it does not reach the improved service.

The 15th Five-Year Plan (2019/20-2023/24) follows the concept of the previous plan, and the development plan is proceeding as shown in Table A3-1.

Table A3-1 Summary of the 15th Five-Year Plan (water supply and wastewater management sector)

Items	Contents
Vision	Improvement of the public health and livelihoods through appropriate quality, reliable and easily accessible drinking water and sanitation services.
Goals	The provision of basic level water supply and sanitation services to all people.
Output (Water supply)	The basic water supply coverage will be 99% at the end of the Plan. Over the middle water supply coverage will be 40% at the end of the Plan
Output (Wastewater management)	Allow constant access to sanitary facilities in restricted areas of open defecation. Ensure that at least 20% of industrial and domestic wastewater is properly treated and discharged into public water zones.

Source: 15th five-years plan

The basic water supply coverage ratio and the sanitation service described in this document are defined as shown in Table A3-2.

Table A3-2 Target Level of Water Supply and Sanitation Services

Section	Level	Content
Water Supply	High class	Daily average water supply per capita is 100-150LCD
	Middle class	Daily average water supply per capita is 65-100LCD
	Basic class	Daily average water supply per capita is 45-65LCD
	Substandard class	Daily average water supply per capita is 25-45LCD
Wastewater management	Improved service	Each household has one or more toilets (impermeable). Safe handling without environmental impact problems. There are also regular cleaning and O&M and management records.
	Basic service	Each household has a toilet (impermeable). Safe handling without environmental impact problems. There is a management record of cleaning and O&M.
	Limited service	There is a communal toilet (penetration) within 10m. Insufficient management records for cleaning and O&M (requires sludge removal from pits, etc.).
	No service	There is no clear separation of living space and faeces. O&M have not been implemented. (Open defecation, etc.)

Source: Nepal Water Supply, Sanitation and Hygiene Sector Development Plan

A3.2.2 Goals for "SDGs" and the Achievement

The targets and the status of Sustainable Development Goals (hereinafter called SDGs) for water supply and sanitation services in Nepal are shown in Table A3-3. The house connection ratio of the water supply service is 49.5% in the achievement status in 2015 against the 90% of target. In addition, the number of urban households connected to appropriate wastewater facilities such as sewer and impermeable septic tank is 30% of the achievement status in 2015 against the 90% of target. In both cases, the gap between

the achievement and the target is large. In view of goals and achievements of SDGs, development of the following points is considered necessary.

- Dissemination of house connection water supply
- Improvement of distributed water quality
- Implementation of wastewater management service such as sewerage and / or impermeable septic tanks
- Improvement of appropriate management rate of domestic wastewater

Table A3-3 Achievement of SDGs, Cotegory-6

SDG No.	Indicator (2030)	Goals (2030)	Achievement (2015)
6.1.1	Household with access to piped water supply	90%	49.5%
6.1.2	Basic water supply coverage	99%	87%
6.1.3	Household with E. Coli risk in house hold water	0%	82.2%
6.1.4	Household with E. Coli risk in water source	0%	71.1%
6.1.5	Population using safe drinking water	90%	15%
6.1.6	Turbidity	5NTU	30NTU
6.2.1	Household using improved sanitation facilities which are not shared	95%	60%
6.2.2	Proportion of population using latrine	98%	67.6%
6.2.3	Local authority areas that have declared Open Defecation Free (hereinafter called ODF)	99%	41%
6.2.4	Sanitation coverage	99%	70%
6.2.5	Urban households with toilets connected to sewer systems/ proper on-site sanitation	90%	30%
6.3.1	Proportion of untreated domestic wastewater	65%	99%
6.3.2	Untreated industrial wastewater ratio	10%	99%
6.4.5	NRW	5%	20%
6.5.1	Degree of integrated water resources management implementation	60%	0%

Source: Sustainable Development Goals Baseline Report, National Planning Commission, 2017

A3.2.3 Development Plan for Water Supply and Sanitation Sector

While the water service and sanitation population ratios have been improved in recent years, MoWS established Nepal Water Supply, Sanitation and Hygiene Sector Development Plan to overcome following issues:

- Access gap to water supply and sanitation
- Inequality of service provision
- Quality of water, and sustainability and function of supply system
- Quality of the service, etc.

The plan is to indicate a course of action for achieving the SDGs mentioned above, and the development policy for 15 years from 2016 to 2030 is clearly stated. The outline is shown in Table A3-4. It is aimed at providing basic level water and wastewater management services. In addition, medium and large-scale cities are shown to have sewerage facilities. In the same document, the clarification of the division of the responsibility of relevant organizations in consideration of the federal system is shown and summarized as follows.

- DWSSM formulates policies and plans.
- Water supply and sewerage department of each province and DWSSM branch office of each province carry out the infrastructure development.
- Each municipality and regional water supply management board (WSMB) will operate and maintain facilities and businesses as an operator.
- For NWSC that operates and maintains the water supply business for urban cities in Nepal, its branch offices will be categorized as local operator.

Table A3-4 Summary of Nepal Water Supply, Sanitation and Hygiene Sector Development Plan

Items	Content
Vision	- Improve public health and livelihood through the spread of safe and sufficient water supply and wastewater management facilities.
Goals	- Improve service levels through improved governance of the water supply and wastewater sector and make Basic water supply and wastewater management available to all citizens. - Implement all issues and development plans of water supply and wastewater sector. - Define priorities, strategies and activities. - Lead national priorities, strategies, standards and procedures to all relevant agencies. - Develop policy and legal frameworks, clear organizational frameworks, funding, capacity development, etc. in order to guarantee functional and sustainable water supply and wastewater management services for all people.
Output	- Decrease the water borne diseases - Reduce the dropout rate of female students due to inappropriate access to water and sanitation. - Decrease infant mortality ratio - Improvement of human resource development index
Clarification of service levels of water supply and wastewater management	- The service levels of water supply and wastewater management are as shown in Table A3-2.
Water Supply	- Identify unsupplied households and areas. - Improve the water supply / non-water supply area database using GPS. - Set development priorities and make development investments in accordance with the priorities. - In order to guarantee equal access to water, secure the necessary technology, management system, budget support, etc. for water supply to geographically and socially isolated areas, even if the cost per capita is high. - Install water supply facilities in all schools and public facilities.
Wastewater management	- Develop general sanitation guidelines to support effective and sustainable wastewater management step-up. - Properly evaluate obstacles to hygiene improvement and improve hygiene. - Promote public awareness and behavior reform, taking into account diversity and geographical location. - To strengthen the capacity of the municipality to understand policy and improve business methods. - Improve monitoring mechanisms to ensure the sustainability of public wastewater management services. - Encourage actions to guarantee sustainability of the open defecation area. - Introduce a sewerage plan to large and medium sized cities. (With modern WWTP) - Recommend the power generation by sludge digestion and gasification. - In low income areas, decentralized sewerage is recommended. - Explore the possibility of multi-city cooperation for urban sewage treatment. - Providing sample design and O&M manuals for septic tanks to small-scale municipalities to improve them. - Explore the possibility of reuse and recycling, such as composting of septic tank sludge.
Function and sustainability	- Authorize community-based management for rural water supply and water supply projects in small cities. - The beneficiary's burden is 10-30% of capital investment costs and 100% of O&M costs. - Establish a maintenance fund for the timely maintenance of the water supply system. - Provide support after construction of the facility.
Innovation and new technology application	- Application of rainwater storage technology. - Development of the dam lake. - Introduction of solar pump. - Ecosystem management of rivers. - Bulk water supply system for remote areas. - Metering of flow rates. - Reuse of treated sewage water.
Institutional improvement and capacity development	- Transparency, accountability, stakeholder planning. - Respect the rights of the people. - Enactment of water supply and wastewater management policies, laws and regulations. - Restructure the business management structure of related organizations - Secure budget for capacity development activities. - Establishment of the National Water Supply and Sanitation Training Center.

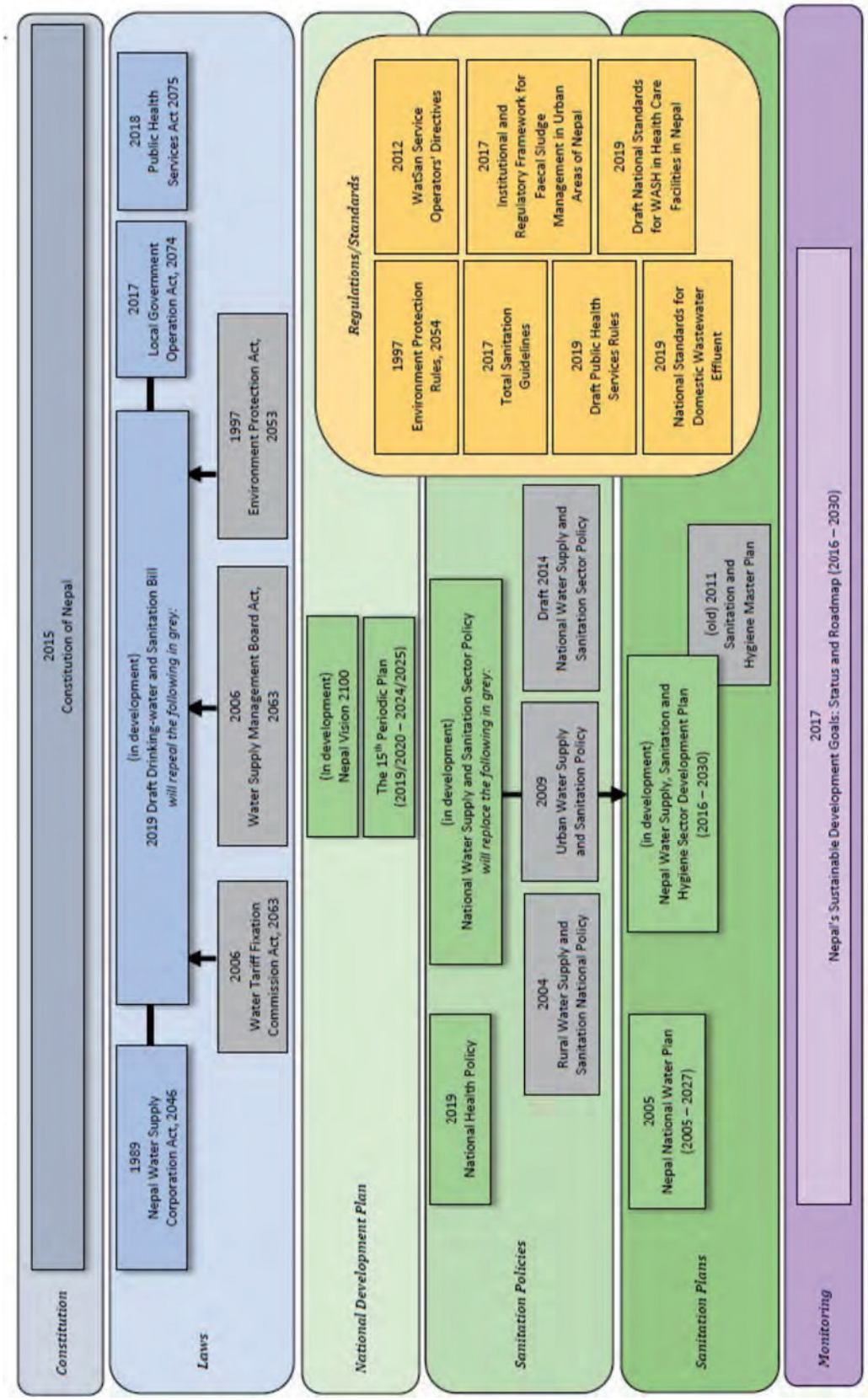
Source: Extracted from Nepal Water Supply, Sanitation and Hygiene Sector Development Plan

A3.3 Related Laws for Wastewater Management

A3.3.1 Policy and Planning Framework for Sanitary Environment in Nepal

The framework and related laws and policies regarding the sanitary environment in Nepal are shown in Figure A3-1. Policies and frameworks consist of;

- Constitution
- Law
- National Development Plan
- Sanitary Environmental policy
- Sanitary Environmental plan
- Monitoring
- Rules and standard



Sanitation Policy and Planning Framework Case Study for Discussion(World Health Organization, WHO)

Figure A3-1 Policy and Planning Framework for Sanitary Environment in Nepal

A3.3.2 Local Government Operation Act

In 2017, the responsibility and administrative scope of the local government in the federal system was defined. The local governments are divided into three, according to the scale as shown in Table A3-5. There are some differences in the urban infrastructure to be provided by this division. There is no special mention of water supply and wastewater management in large-scale cities, but facilities and services equivalent to medium-scale cities are required.

Table A3-5 Administrative Scope of Local Government

Division	Municipality	Sub-Metropolitan City	Metropolitan City
Target cities	-	Janakpur, Butwal and Hetauda	Kathmandu Valley (Kathmandu, Lalitpur), Pokhara and Birgunj
Population scale	Himalaya region: over 10,000 Mountain region: over 40,000 Madhesh region: over 50,000 Terai region: over 75,000 Kathmandu Valley:100,000	Over 200,000	Over 500,000
Main infrastructure	Providing minimal roads, electricity, communication, water supply facilities as a city	Secure access to paved streets, citizens' water, electricity and communications, national level stadium	Secure access to urban transportation with consideration for people with disabilities, international stadiums, international airports
Waste	Managed waste collection and landfill site	Systemized waste management	-
Medical institution	Minimum of 25 beds in hospitals	Total of at least 200 beds in hospitals (one hospital has at least 100 beds)	Total of at least 500 beds in city (one hospital has at least 100 beds)
Education	-	Higher education institutions (including technical education)	Higher education institutions capable of master's level education

Source: Extracted from Local Government Operation Act, 2017

The following administrative tasks are mainly stipulated as necessary at the local government level. Implementation of water supply and wastewater management including construction of facilities is mentioned in the administrative tasks of local governments.

(1) Urban Planning

- Preparation of urban development plan and project, implementation monitoring, evaluation and related regulations development.
- Identification and documentation for developable natural resources.
- Permission for construction based on national regulations.
- Construction and maintenance of public facilities such as schools.
- Cooperation and coordination with projects implemented by the federal and provincial Governments.

(2) Environment and Sanitation Hygiene

- Formulation and implementation of policies and regulations on basic health and hygiene improvement.
- Control of food, air pollution and noise pollution.
- Public awareness promotion concerning the management of waste generated in health facilities.
- Waste management including collection, recycling and final disposal.
- Formulation of regional management plans and regulations for environmental protection and biodiversity.
- Formulate and implement policies and regulations on basic health and hygiene improvement.

(3) Road and Irrigation

- Road planning, construction and maintenance in regional level.
- Planning, construction and maintenance of regional irrigation facilities.

(4) Water Supply and Electricity

- Regional water supply planning, construction and maintenance, and set the water tariff.
- Planning, construction and maintenance of regional hydropower up to 1 MW.
- Alternative energy planning, construction and maintenance at the regional level.

- Electricity distribution plan, construction and maintenance at the regional level, and set the tariff

(5) Disaster Management

- Implementation of disaster management plans and projects.
- Formulate regional action plans at the time of the disaster (information systems, relief, stockpile, etc.)
- River management and landslide management.
- Disaster hazard map creation and evacuation plan development.

(6) Water Environment Protection and Environmental Conservation

- Develop regional plans for water and natural environment conservation.
- Protection of water resource
- Community response to regional level plans for water and natural environment conservation
- Permission and approval of quarry for soil and stone

A3.3.3 Nepal Water Supply Corporation Act, and its Amendment

In 1989, the Nepal Water Supply Corporation Act was enacted in order to provide water and sewage services regularly throughout Nepal. NWSC was established according to the law. The law has been revised several times. In addition, it is stipulated that the Government of Nepal can instruct the NWSC at any time, and that the NWSC should follow it. It is more likely to be a department within the Government than an independent public corporation. The role and authority of the NWSC are indicated in the current law as follows;

- Preparation of a plan for water supply and sewerage and implement the project.
- Conducting the survey for water supply and sewerage management
- Identification of the routes from water sources to water distribution areas.
- Construction of water supply and sewerage facilities.
- Taking administrative procedures related to necessary international cooperation under agreements between Government of Nepal and foreign Governments / international organizations.
- Operation of water and sewerage project designated by Government of Nepal.
- Collection of necessary fees for water and sewerage and provide necessary services.
- Preparation of conditions for the water supply and sewerage services.
- Prevention of incorrect water use.
- Prevention of pollution of drinking water.
- O&M of water and sewerage facilities.

In addition, in parallel with the enactment of the WSMB Act in 2006, a sentence was added that "if the Government of Nepal instructs the NWSC, the ownership of the facilities and services will be handed over to the WSMB."

It is also stipulated for the NWSC to be run by the following board members.

- Board chairperson is appointed by the Government of Nepal from experienced persons of water supply management
- Representative from Ministry of Housing and Physical Planning
- Representative from Ministry of Health and Population
- Mayor of the Municipality of NWSC service area, appointed by the Government of Nepal
- Two women appointed by the Government of Nepal from a group for beneficiary protection
- A water quality expert appointed by the Government of Nepal
- A Person from an environmental NGO appointed by the Government of Nepal
- General Manager of NWSC appointed by the Government of Nepal

A3.3.4 Water Supply Management Board (WSMB) Act

It was enacted in 2006 for the purpose of providing reliable water and sewerage services to the residents and for enabling Local Government to take initiative activities. The Kathmandu Valley Water Supply Management Board (hereinafter called KVWSMB) and HWSMB are established according to the law.

This enables to transfer the existing facilities owned by the Government and related municipalities to WSMB so that the WSMB can operate the service. For establishment, it is required to be approved by the Government of Nepal based on the application submitted by related municipalities. The roles and privileges of the WSMB are summarized as follows:

- Implementation of construction, expansion and rehabilitation for the services.
- Establishment of the principle for medium-long term business implementation plan and actions.
- Prevention of wrong use and water pollution of drinking water.
- Research for business on drinking water and sewerage management.
- Securing the budget as well as budget planning.
- Securing the financial resources for service development and expansion.
- Introduce of service fees within provisions of the related laws.
- Enforcement of all the activities which are necessary for high quality services.
- Subcontracting with a service provider.
- Cost recovery from the tariff collection
- Management of complaint from the users

Provision of WSMB board member as follows;

- Mayors of municipalities in water supply service area
- Representative of Ministry of Physical Planning and Works
- Representative of village development committee in water supply service area
- Chairperson of a local chamber of the commerce
- Chairperson of a local user's committee
- Representative of NGO for water supply and sanitation
- Expert of water supply and wastewater management

A3.3.5 Water Supply Tariff Fixation Commission Act

It was enacted in 2006 to protect the interests of the beneficiaries and to realize high quality and reliable water and sewerage management by appropriate price.

The members of the committee are defined as follows.

- Appointed by the Government of Nepal, required with at least a bachelor's degree in the fields of technology / management / economics / finance and managerial experience in public institutions for more than 12 years.
- Appointed by the Government of Nepal, required with at least a bachelor's degree in economic / finance / accounting / commerce and at least 10 years of economics / financial evaluation work experience.
- Appointed by the Government of Nepal, required woman with a bachelor's degree or more in the field of technology / sociology / law, and seven years or more work experience, a position lower than caste, or a minority.
- Tenure period is 4 years

The following persons are not elected as the members;

- Member of the Government of Nepal
- Core person of political party
- Staff, officials and interested persons of service providers of water and sewerage management
- A person who is over the age of 65 years old

Also the role of the committee as defined as follows;

- Setting the Water and Sewerage tariff to be collected by a water service provider
- Approval of the policy and procedure that the service provider has to comply for proposing a water tariff.
- Monitoring of the service provider business
- Arbitration of disputes among service provider and users

- Information collection for publication by a service provider
- Setting of evaluation criteria for the tariff
- Advisory of the Government of Nepal for water supply and sewerage management

Following are stipulated for the service provider to submit the information when planning the rate revision.

- Basis of calculation for proposed water tariff.
- Price comparison table before and after the price revision.
- The fair profit for the service provider.
- Analysis of the increased O&M cost
- Support measures for the people who are unable to pay
- Copy of the service provider's business permit.

A3.3.6 Water and Sanitation Bill (WASH Bill)

The Water and Sanitation Bill, commonly referred to as the WASH Bill, was enacted in September 2022. This defines the responsibility system for water supply and wastewater projects implemented under the federal system. While the principle of implementing water supply and wastewater management projects is specified in the local governments, the involvement of the federal government and provincial governments in construction of large-scale facilities and facilities through international organizations and foreign support is stipulated.

WASH Bill is intended to have a basic legal concept that bundles all water-related laws. However, Nepal Water Supply Corporation Act, Water Supply Management Board (WSMB) Act and Water Supply Tariff Fixation Commission Act will be remained independently outside the WASH Bill.

WASH Bill makes it clear that facilities construction projects funded by foreign organizations such as JICA will be managed by the federal government, and the operation of the facilities will be implemented by the local government.

(1) Water Resource

- Water resources development is under the control of the Federal Government.
- Individuals and communities who traditionally take water for domestic use have the right to use the same water resources.
- Public facilities using water are allowed to continue the present systems until completion of alternative systems.
- The federal government, provincial governments and local governments work together to conserve and protect water resources.

(2) Responsibility of Federal Government

- Implementation of a sanitation project for national level environmental protection.
- Implementation of projects with international organizations and projects jointly invested with communities at the regional level.
- Implementation of projects across multiple States.
- Implementation of multipurpose wastewater treatment projects requiring large funds.
- Implementation of water usage projects across basin boundaries.
- Implementation status monitoring of water supply and wastewater management projects.

(3) Responsibility of Provincial Government

- Implementation of water supply and sanitation project at moderately sized level.
- Implementation of wastewater management project.
- Implementation of projects across multiple locality areas within the province.

(4) Responsibility of Local Government

- Implementation of water supply and sanitation project at basic level.

- Promotion of residence awareness in hygiene
- Operation, maintenance and monitoring of wastewater management projects in the local government area.
- Operation of water supply and wastewater management projects in the suburbs.

(5) Authorization for Water Supply and Wastewater Management Project

Persons who want to conduct facility construction, operation, maintenance and management business for water supply and wastewater management needs to obtain permission. However, the following cases are excluded. In other words, large-scale projects such as KUKL, NWSC, and WSMB require a business permit, but small-scale WUSC projects, private wells and on-site treatment facilities for each house exempt from the permit.

- Small businesses such as WUSC.
- Wastewater infiltration treatment of each house within a level not affecting the environment
- Use of water resources on own land.

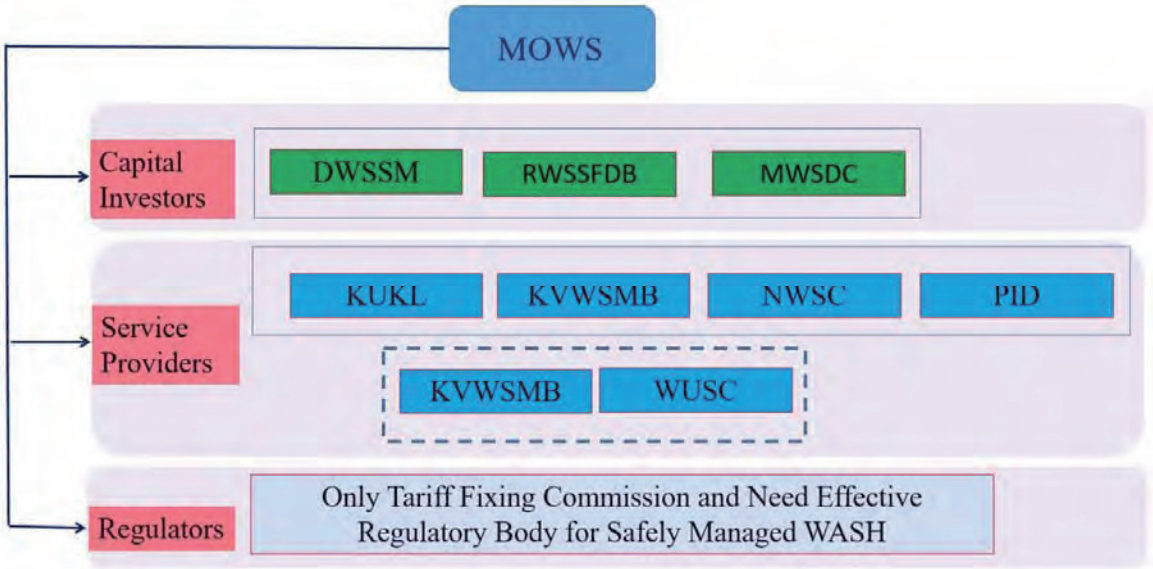
A3.3.7 Water Quality Standards

There are no environmental standards for water in Nepal. However, wastewater effluent standards are set based on Article 15 of the Environmental Protection Rules (hereinafter referred to as "EPR"). The criteria will be described in Chapter A4.

A3.4 Wastewater Management Related Organization

A3.4.1 Related Organization

As shown in the Figure A3-2, line ministry related to wastewater management in Nepal is Ministry of Water Supply (MoWS). Under MoWS there are three category of organization with different functions such as (1) DWSSM in charge of initial investment and RWSSFDB in charge of local water supply and sanitation fund development, Melamchi Water Supply Development Committee (hereinafter, "MWSDC"), and (2) KUKL, KVWSMB, NWSC in charge of service operation and maintenance, Project Implementation Directorate (hereinafter referred to as "PID") and WUSC and (3) Regulatory Authority.



Source：DWSSM

Figure A3-2 Organization and Role of MoWS

On the other hand, since the responsibility for implementation is stated to the local governments in the Local Government Management Law, it is necessary to discuss each case with related agencies for plan, funding and implementation.

Table A3-6 shows the actual role of each related organization in wastewater management in Nepal.

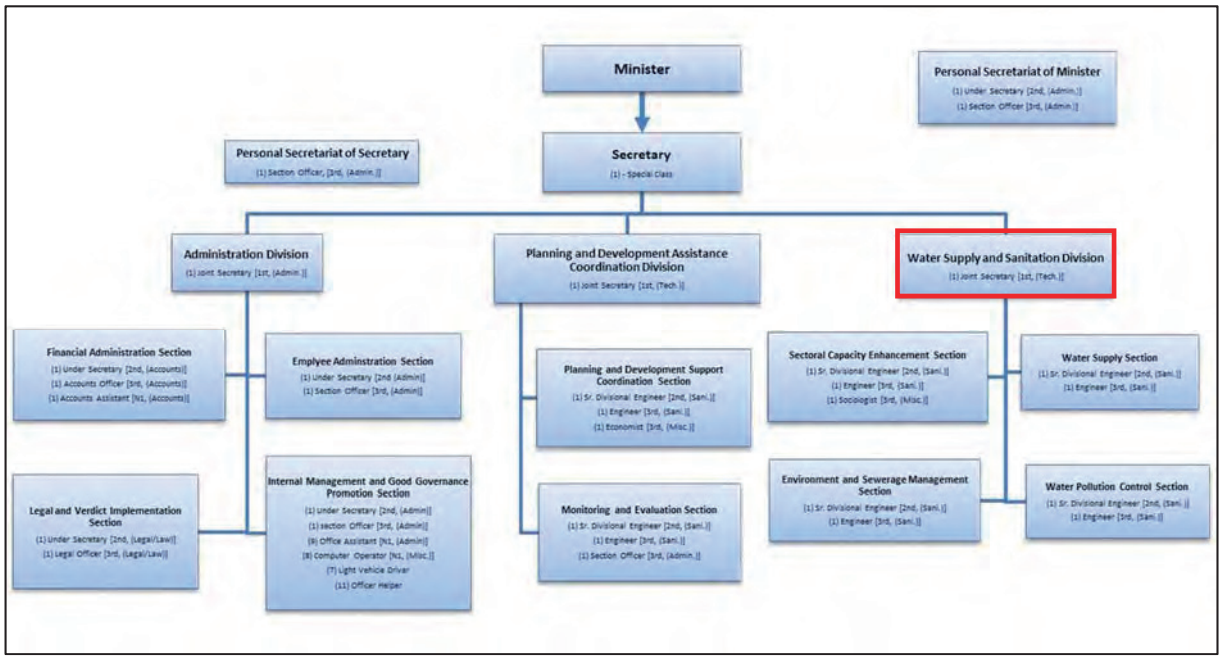
Table A3-6 Role and Responsibility of Organization

No.	Organization	Summary
1.	MoWS	The role is to establish national-level policies related to the water and sewerage sector. Facility construction through large, medium and small-scale projects, international cooperation, and joint investment projects with the community will be carried out through DWSSM under MoWS, and after the facility is completed, it will be handed over to local governments and community-based WUSC, KUKL, and NWSC.
2.	DWSSM	DWSSM is responsible for the practical design of water supply and sewerage facilities in MoWS. In addition, FWSSMP is installed in 20 locations nationwide, and FWSSMP will construct facilities for large-scale projects in each region. Even for small-scale WUSC projects, international cooperation and joint investment projects with the community will be handled by DWSSM. Therefore, Japan's Grant-in-Aid for Grants, etc. will be handled by DWSSM.
3.	MoUD	In some cases, the Urban Development and Construction Bureau (DUDBC) * 1 under the umbrella of MoUD plans and designs facilities for sewerage projects in urban areas. The ADB-sponsored sewerage projects in Hetauda and Birgunj are implemented by DUDBC. It is also a superordinate organization of HPCIDBC (Bagmaty General Development Committee), which is involved in sewerage development in the Kathmandu Valley.
4.	Local Government、WUSC	Although it is legally possible for local governments to develop facilities, it is difficult in terms of financial and technical capabilities, and water and sewage treatment projects will be operated using facilities constructed by MoWS, MoUD, and the state government. Most of the facilities outside the urban area will be handed over to the community-based WUSC, and no local government will be involved. WUSC is separated from the administration of local governments, and WUSC is not under the control of local governments.
5.	KUKL	KUKL is a service provider of water and sewage business in the Kathmandu valley, which was established independently from NWSC in 2016, and basically operates and maintains the water and sewage business with the income of water and sewage charges. It is the implementing body of the Kathmandu Valley Wastewater Management Project, a sewerage improvement project currently underway in the Kathmandu Valley.
6.	HPCIDBC	High Powered Committee for Integrated Development of the Bagmati Civilization was established in 1995 under the Nepalese government to comprehensively prevent and improve water pollution in the Bagmati River basin, which is the main river in the Kathmandu Valley. Currently, it belongs to the MoUD. The committee has carried out the planning, design, construction, operation and maintenance of the existing sewage treatment facility (16,000 m^3 / d) currently in operation in Kathmandu, and the planning and construction of the main sewerage trunk line.
7.	NWSC	NWSC works as a water supply service provider in 22 cities nationwide. Basically, there is no system to carry out large-scale facility construction, and water supply operation and maintenance will be carried out with water supply fee income. In January 2020, a basic agreement was reached on the operation and maintenance of sewerage in Birgunj City.

※1: Former belong to Ministry of Physical Planning and Works
Source: JET

A3.4.2 Ministry of Water Supply (MoWS)

Figure A3-3 shows the organization chart of MoWS. DWSSM is an implementation body of projects under the umbrella of MoWS.

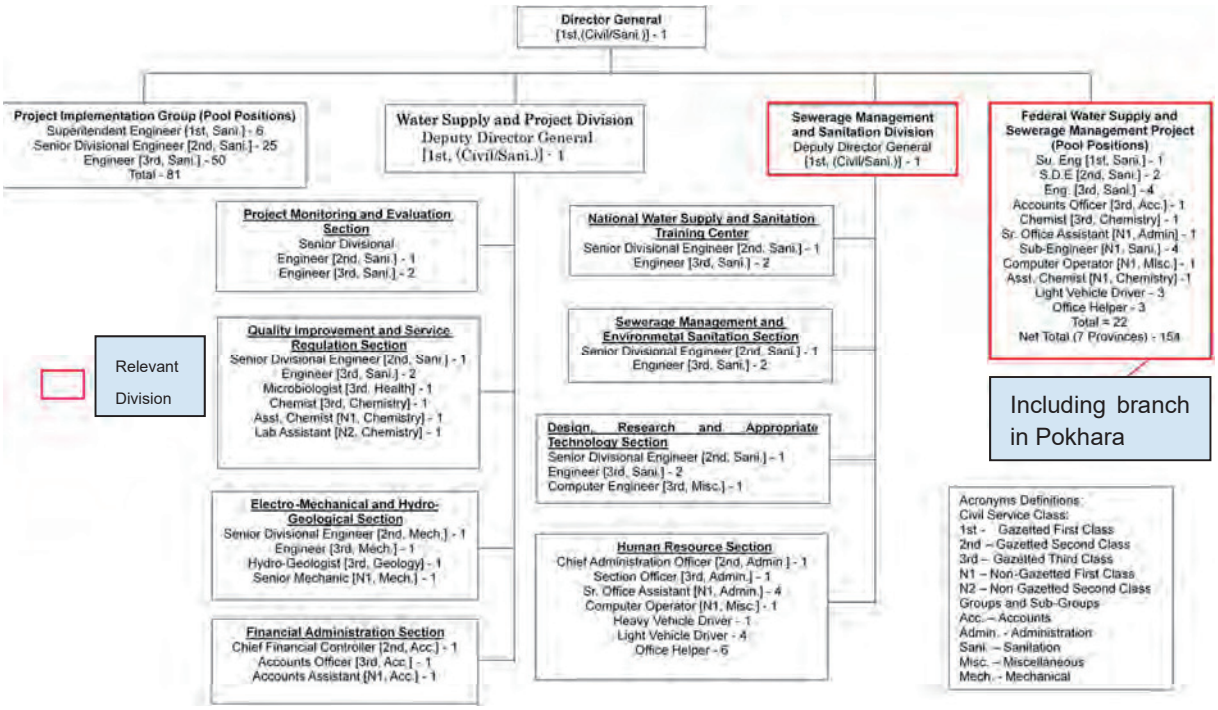


Remark: Red box shows the responsible section of this project
Source: MoWS

Figure A3-3 MoWS Organization Chart

A3.4.3 Department of Water Supply and Sewerage Management (DWSSM) and Federal Water Supply and Sewerage Management Project (FWSSMP)

Figure A3-4 shows the organization chart of DWSSM. DWSSM is under the umbrella of MoWS and implementation body for this Project, and Director General is the project manager for this Project. In addition, DWSSM has 20 branches, called as FWSSMP, in seven provinces. Pokhara branch is positioned as a key counterpart of this Project.



Source: DWSSM

Figure A3-4 DWSSM Organization Chart

As mentioned above, there are 20 FWSSMPs in 7 states and the Pokhara branch is one of them. Each branch has 22 staff and 154 in seven provinces. FWSSMP took the initiative in planning the existing sewerage plan for PMC, which will be described later.

(1) Organizational overview

FWSSMP belongs to DWSSM. There are 20 offices nationwide. In Pokhara branch, 5 senior employees are allocated, and they are in charge of 5 districts including Kaski district where Pokhara city is located.

(2) Budget and activities

The annual budget is about NPR1 billion, and the main task is to construct local water supply facilities for WUSCs.

(3) Relationship between national and local governments

FWSSMP is a federal organization and cannot provide direct financial support to the local government, such as PMC. However, providing technical support is possible, through participation to project management unit (PMU) which is established by a local government initiative.

(4) Capacity

The five senior staff of FWSSMP Pokhara are all in charge of sanitation, not water supply, but they have little experience in constructing or maintaining sewerage facilities.

(5) Existence of sewerage-related business

Sewerage-related work is not currently carried out at the Pokhara office.

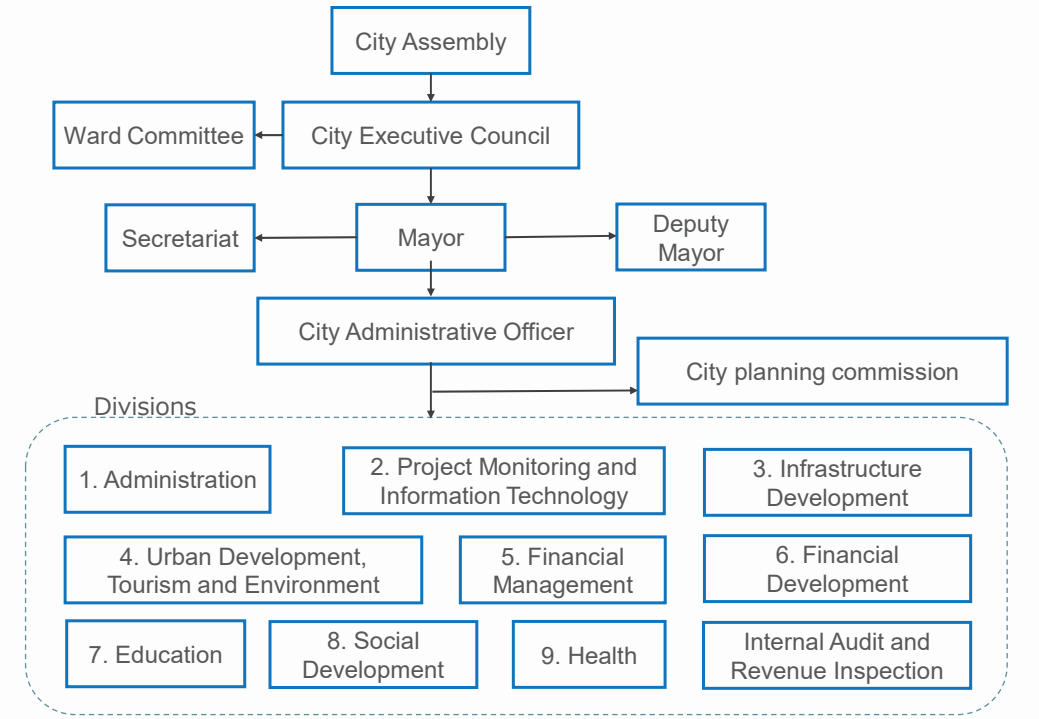
(6) Basis law

FWSSMP has no legal basis for its installation presently.

A3.4.4 PMC

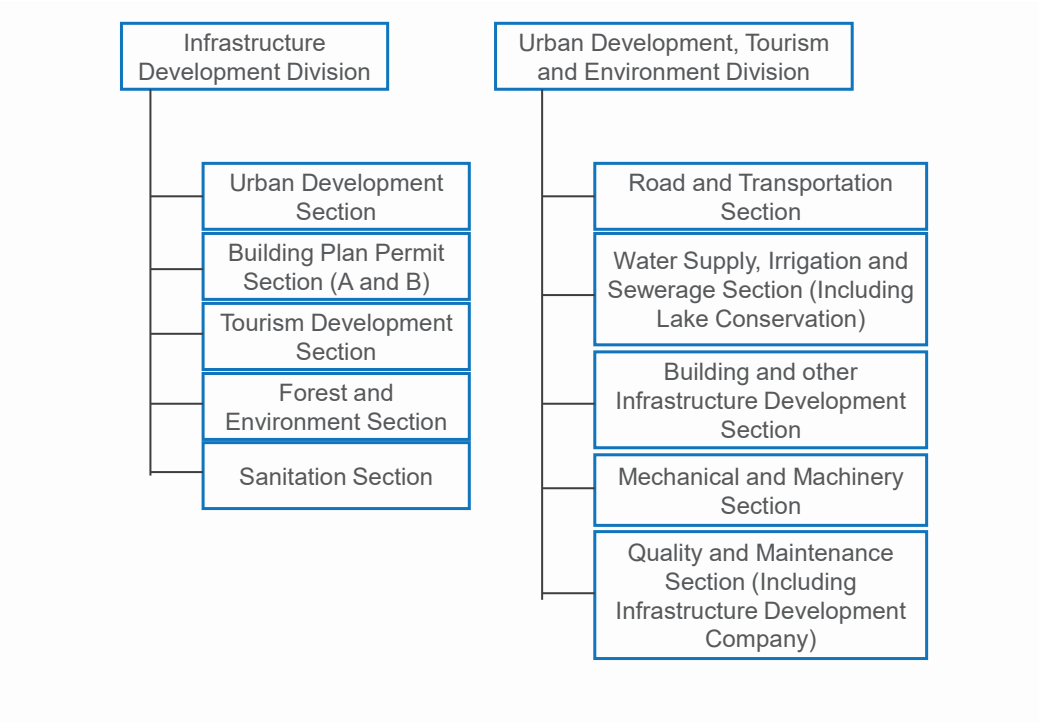
The organization of PMC is shown in Figure A3-5 and Figure A3-6. The Infrastructure Development Division and the Urban Development, Tourism and Environment Division are in charge of wastewater / water environment management. The Water supply, Irrigation and Sewerage Section of the Infrastructure Development Division and the Sanitation Section of the Urban Development, Tourism and Environment Division are especially deal with wastewater management.

The organization and system for future wastewater management are as shown in Chapter B6.1.4 (5) “Proposal of management and O&M framework”. Organizations related to water quality management of water areas such as rivers and lakes are shown in Chapter B7.3 “Plan Implementation System and Roles”.



Source: JET

Figure A3-5 PMC Organization Chart (As of Dec2021)



Source: JET

Figure A3-6 PMC Organization Chart Related to Wastewater Management

PMC recognizes that it is necessary to enact ordinances when starting the wastewater management. Since it has an experience of formulating solid waste management ordinances in January 2020, it is optimistic to formulate a wastewater management ordinance regarding tariff and tax collection for

wastewater management.
The outline of the present activities of the wastewater management is as follows:

(1) Road and Transportation Section, Infrastructure Development Division

- Main activities are road construction and improvement, bridge construction.
- Annual budget is about NPR1.5 billion.
- No municipal rules and guidelines for road construction. The federal guidelines / specifications issued by Department of Road (DoR), Ministry of Physical Infrastructure and Transportation are applied in PMC's works.
- The division is in charge of road drainage facilities and drainage channels. There are both facilities in the core city, but only gutters in the suburbs. There is no design standard and the size is determined according to the information on local rainfall. No permit is required for draining gray-water into road gutters.
- Flood damage has rarely occurred because the rainwater basically penetrates even during heavy storm. There is a case that wood etc. get caught in the bridge over the river and flooding occurs.
- The sewer laying work can be done by the open-cut method. When laying sewers under the federal road, permission is required from the DoR. For the other roads, the permission is granted by the Road and Transport Division.

(2) Sanitation Section, Urban Development, Tourism and Environment Division

- The section is in charge of on-site sanitation as well as solid waste management.
- Annual budget is about NPR10 million.
- Septic tank management is conducted through private sector business, which is contracted yearly. As a monitoring system, PMC is accepting the public complaints, but it is rarely delivered.
- PMC is planning to relocate the landfill site for solid waste by PPP scheme. Since the fecal sludge of septic tank is landfilled in the exiting site, the present operation will be continued for the time being.
- PMC has no regulations or standards for fecal sludge management.

A3.5 International Cooperation on Wastewater Management Sector

As of May 2024, there are no projects currently being implemented or planned to be implemented by other development partners in the fields related to wastewater management in Pokhara.

A4 Systems, Plans and Laws on Water Environmental Management in Nepal

A4.1 Management and Supervision on Water Environmental Management

Environment and Biodiversity Division in MoFE is responsible for environmental management, formulation of environmental standard, and EIA procedures etc. In 2016, 9 lakes, including Lake Phewa, were registered as Ramsar Convention Wetlands. After then, the Division is an international gateway to the Ramsar Convention. As for the management and conservation of the Lakes, Gandaki Province and / or PMC should be responsible.

Before the introduction of the federal system, the local branch of the Soil and Watershed Management Department under MoFE, was collecting and managing information such as environmental data. However, the Department was integrated to Forest Department in MoFE, due to organizational restructuring. As a result, the data collection system for the water environment in each region has not been functional. At present, the collection and management of information related to the water environment, including the tracking of past information, has not been carried out.

A4.2 Policies on Water Environmental Management

Table A4-1 shows policies on water environmental management.

The policies mention that all people have a right to access to water and sanitation services, which are essential for socio-economic development and reduction of water-borne diseases.

Table A4-1 Policies on Water Environmental Management

Documents	Year
Rural Water Supply and Sanitation National Policy 2004	2004
Rural Water Supply and Sanitation Strategy 2004	2004
Rural Water Supply and Sanitation Sectoral Strategic Action Plan 2004	2004

Source: JET

A4.3 Laws on Water Environmental Management

There are no laws on water environmental management, but effluent standards of Table A4-2 are set by MoFE.

There are 3 types of standards, depending on discharge points and the wastewater from WWTP.

Table A4-2 Effluent Standards

Item		Unit	Discharge Point		Inland Water from WWTP
			Surface Water	Sewer	
Total Suspended Solids (TSS)		mg/L	30-200	600	60
Particle size of TSS		-	Not more than 850μm	-	Not more than 850μm
pH		-	5.5 – 9.0	5.5 - 9.0	60 - 9.0
Temperature		-	Shall not exceed 40 degree in any of the stream within 15 meters downstream from the effluent outlet	45	Shall not exceed 40 degree in any of the stream within 15 meters downstream from the effluent outlet
Total chromium		mg/L	-	2	-
Sulfates (SO_4)		mg/L	-	500	-
TDS		mg/L	-	2100	-
BOD at 20°C		mg/L	50	400	50
Oils and grease		mg/L	10	50	10
Phenolic compounds		mg/L	1	10	1
Cyanides (as CN)		mg/L	0.2	2	0.2
Sulphides (as S)		mg/L	2	2	2
Radioactive materials	α emitters	c/mL	10^{-7}	-	10^{-7}
	β emitters	c/mL	10^{-8}	-	10^{-8}

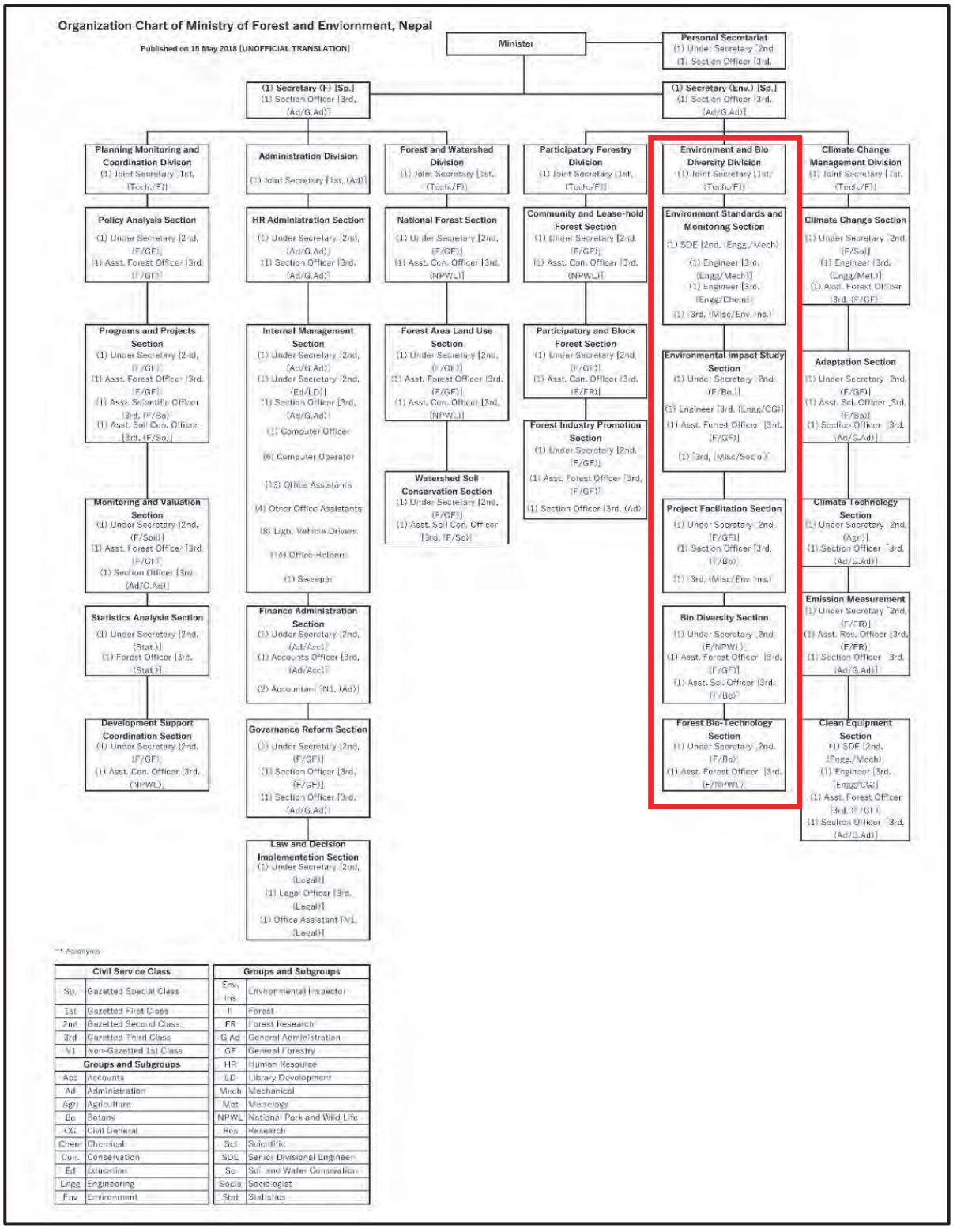
Item	Unit	Discharge Point		Inland Water from WWTP
		Surface Water	Sewer	
Insecticides	-	Not detected	Not detected	Not detected
Total residual chlorine	mg/L	1	-	1
Fluorides (as F)	mg/L	2	10	2
Arsenic (as As)	mg/L	0.2	1	0.2
Cadmium (as Cd)	mg/L	2	2	2
Hexavalent chromium(as Cr)	mg/L	0.1	-	0.1
Copper (as Cu)	mg/L	3	3	3
Lead (as Pb)	mg/L	0.1	0.1	0.1
Nickel (as Ni)	mg/L	3	3	3
Selenium(as Se)	mg/L	0.05	0.05	0.05
Zinc (as Zn)	mg/L	5	5	5
Mercury (as Hg)	mg/L	0.01	0.01	0.01
Mineral Oils	mg/L	-	10	-
Inhibition of nitrification test at 200ml/L	-	-	<50%	-
Ammonical nitrogen	mg/L	50	50	50
COD	mg/L	250	1000	Monitor and record only
Silver	mg/L	0.1	0.1	0.1

Source: Nepal Gazette, 30 April 2001 and 23 June 2003

A4.4 Organizations on Water Environmental Management

A4.4.1 Ministry of Forest and Environment (MoFE)

Figure A4-1 shows the organogram of MoFE. MoFE is the federal government organization, which is responsible for conservation of forests and environment, and consists of 6 Divisions. However, some affairs are transferred to municipalities under the federal system, and the division of duties with municipalities needs to be clarified.



Source: JET

Figure A4-1 Organogram of MoFE

A4.4.2 Lake Conservation and Development Authority (LCDA)

LCDA is a new organization established in Gandaki Province in 2020 to conserve and develop lakes. Since there are only 3 non-regular staff members, the expected effects have not been achieved due to shortages of human resources and budget.

A4.4.3 PMC

In PMC, Urban Development, Tourism and Environment Division, which is described in Chapter A3.4.4 is in charge of the environmental management.

The enactment of the Local Government Management Act in 2017 clarified that the responsibility for environmental conservation in the area belongs to PMC. Therefore, PMC needs to establish a system for water environment management and wastewater management in Pokhara, including Lake Phewa. PMC needs to establish an appropriate organization at an early stage and start implementing environmental improvement projects. At present there are 4 Staffs in Water Supply and Irrigation and sewerage section, 6 Staffs in Forest and Environment Section and 9 Staffs in Sanitation Section.

A4.5 Policies on Ramsar Registration Wetlands

Table A4-3 shows Policies on Ramsar registration wetlands

"National Ramsar Strategy and Action Plan", formulated by MoFE in 2018, is the highest policy.

The plan refers to not only conservation and recovery of natural environment, but also adequate use and value increase of wetlands, and shows the following 5 targets and 15 activities.

- Target 1: To effectively conserve and manage the Ramsar site network
- Target 2: To manage wetlands including the Ramsar site at the footprint of wisely use principle
- Target 3: To engage federal, provincial and local stakeholder and capacitate them for the wetlands and Ramsar sites conservation
- Target 4: To enhance the Ramsar site conservation through the national and international cooperation
- Target 5: To monitor and evaluate the implementation of the National Ramsar Strategy and Action Plan

The plan mentions the formulation of Wetland Act, as the activity of Target 1. However, as for January 2022, the formulation has not been implemented.

Table A4-3 Policies and Plans on Ramsar Convention Registration Wetlands and Conservation of the Lake Ecosystem

Documents	Year
Policies and Plans	
National Ramsar Strategy and Action Plan (2018-2024)	2018
Integrated Lake Basin Management Plan of Lake Cluster of Pokhara Valley, Nepal (2018-2023)	2018
Nature Conservation National Strategic Framework for Sustainable Development (2015-2030)	2015
National Biodiversity Strategy and Action Plan 2014-2020	2014
National Wetland Policy	2012

Source: JET

A4.6 Cooperation on Ramsar Registration Wetlands by other Development Partners

In Target 4 of "National Ramsar Strategy and Action Plan", cooperation with international development partners such as World Bank, Asian Development Bank, and Green Climate Fund etc. is shown, but the agreement with these donors has not been concluded presently.

A4.7 Systems and Laws on Environmental and Social Considerations

A4.7.1 Policies and Laws

The main policies and laws related to environmental and social considerations in Nepal are as follows. Due to the constitutional amendment and administrative system reforms in 2015, a number of policy, legal, and other amendments have been amended in recent years. In 2019, the National Environmental Policy, the basis for environmental protection in Nepal, was formulated. The policy specifies various countermeasures aimed at preventing environmental pollution, properly managing waste, expanding parks and green spaces, and ensuring environmental justice (simultaneous pursuit of environmental

conservation and social justice), including the introduction of a system for pollution control measures, application of environmentally friendly technologies, and prohibition of the production and use of harmful agricultural chemicals. With regard to water pollution, the policy promotes the application of appropriate wastewater treatment technology to industrial wastewater and other wastewater discharges. This policy is under the jurisdiction of MoFE and will be reviewed every five years.

Table A4-4 Policies and Laws on Environmental and Social Considerations

Document Name	Year
The Constitution of Nepal	2015
Policies and Plans	
National Environmental Policy	2019
National Forest Policy	2018
National Ramsar Strategy and Action Plan (2018-2024)	2018
Integrated Lake Basin Management Plan of Lake Cluster of Pokhara Valley, Nepal (2018-2023)	2018
National Ramsar Strategy and Action Plan (2018-2024)	2018
Nature Conservation National Strategic Framework for Sustainable Development (2015-2030)	2015
National Biodiversity Strategy and Action Plan 2014-2020	2014
National Wetland Policy	2012
Water Resources Strategy	2002
Laws	
Environment Protection Rules	2020
Environment Protection Act	2019
Labour Act	2017
Control of International Trade of Endangered Wild Fauna and Flora Act	2017
Solid Waste Management Rules	2013
Solid Waste Management Act	2011
Child Labour (Prohibition and Regulation) Rules	2006
Child Labour (Prohibition and Regulation) Act	2000
Forest Rules	1995 (amended 2005)
Forest Act	1993 (amended 2019)
Water Resources Rules	1993
Water Resources Act	1992
Soil and Watershed Conservation Act	1982
Tourism Act	1978 (amended 1997)
National Parks and Wildlife Conservation Act	1973 (amended 1992)
Aquatic Animals Protection Act	1960 (amended 1997)

Source: JET

A4.7.2 Relevant Administrative Organizations

The administrative organization for environmental and social considerations is as follows. Kaski District, where Pokhara City is located, does not have functions related to environmental management, as it is only responsible for coordination between the five municipalities in the district and the provincial government after Nepal's administrative reforms.

(1) Ministry of Forest and Environment (MoFE)

The MoFE is the central government agency responsible for forest and environmental conservation in the country, and is primarily responsible for formulating environment-related policies and institutions, coordinating with related agencies, and serving as a contact point for environment-related international conventions. In 2018, the Ministry of Forests and Soil Conservation and the Ministry of Population and Environment merged to form the current MoFE. The main departments and specialized divisions within the MoFE are listed below.

- Environment and Biodiversity Division: Matters related to environmental standards and monitoring, EIA, project facilitation, biodiversity, and forest ecosystem technology
- Climate Change Management Division: Matters related to climate change

- Participatory Forestry Division: Matters related to participatory Forestry
- Forest and Watershed Division: Matters related to forest and watershed conservation
- Planning Monitoring and Coordination Division: Matters pertaining to policy, statistics, monitoring and evaluation, and coordination with relevant agencies

(2) Ministry of Industry, Tourism, Forest and Environment

The Ministry of Industry, Tourism, Forestry and Environment (MoITFE) of Gandaki State is responsible for developing environmental management measures in the province and supporting and supervising their implementation in municipalities in the province, as well as coordinating with the MoFE. Decentralization under the new 2015 Constitution has also strengthened the provinces functions related to environmental management. The main departments for environmental protection are as follows.

- Forest Management and Biodiversity Division: Matters related to forest conservation, wildlife conservation, soil and watershed management, and biodiversity
- Science, Environment and Climate Change Division: Matters related to science and technology, climate change, and environmental protection

(3) PMC

The Water Environment Monitoring Section, under the Urban Development, Tourism & Environment Division of the PMC, is the implementing agency for environmental management based on federal and state policies, and is responsible for the approval process of IEE projects and overall environmental conservation in Pokhara. Currently, the Water Environment Monitoring Section is staffed by four employees.

A4.7.3 Environmental Standards

(1) Air Quality

Environmental standards for air quality are shown in Table A4-5.

Table A4-5 Environmental Standards for Air Quality

Item		Environmental Standard Value	WHO Standard	Unit	Test Methods
TSP	24 hour value*	230	-	µg/m^3	High Volume Sampler and Mass Spectrometry
PM10	24 hour value	120	45	µg/m^3	High volume samplers and mass spectrometry, TOEM, beta-ray absorption
SO2	Annual Average value **	50	-	µg/m^3	Ultraviolet fluorescence method, West-Gaeck method
	24 hour value *	70	40	µg/m^3	
NO2	Annual Average value **	40	10	µg/m^3	Chemiluminescence method
	24 hour value *	80	25	µg/m^3	
CO	8 hour value *	10,000	10,000	µg/m^3	NDIR method
Lead	Annual Average value**	0.5	-	µg/m^3	High volume sampler and atomic absorption spectrophotometry
Benzene	Annual Average value **	5	-	µg/m^3	Gas chromatography
PM2.5	24 hour value *	40	15	µg/m^3	Mass spectrometry
Ozone	8 hour value *	157	100	µg/m^3	Ultraviolet spectroscopy

Note* The 24-hour and 8-hour values shall be the 95th % of the annual values; the 5% values shall not be for two consecutive days.

Note** Based on 104 data per year obtained by averaging data obtained twice during a 24-hour period at an arbitrary point for one week.

Source: National Ambient Air Quality Standards for Nepal, 2012, WHO global air quality guidelines

1) Regulatory Standards

No international regulatory standards (emission standards) for air quality have been established.

(2) Water Quality

1) Environmental Standards

No environmental standards for water quality have been established. (a) shows the environmental standards related to water pollution based on the WHO and the Basic Environment Law in Japan. (b) and thereafter, the environmental standards related to water pollution that also follow the Basic Environment Law in Japan are shown. These environmental standards will be used as reference in this survey.

(a) Environmental Standards for the Protection of Human Health and Environmental Standards for Dioxins, etc.

Table A4-6 Environmental Standards for the Protection of Human Health

Item	Standards Value of Japan (mg/L)	WHO Standard Value (mg/L)
Cadmium	0.003	0.03
Total Cyanide	Not detected	Not detected
Lead	0.01	0.01
Hexavalent Chromium	0.05	-
Arsenic	0.01	0.01
Total Mercury	0.0005	
Alkyl Mercury	Not detected	-
PCB	Not detected	-
Dichloromethane	0.02	0.02
Carbon tetrachloride	0.002	0.004
1,2-Dichloromethane	0.004	0.03
1,1-Dichloroethylene	0.1	-
Cis-1,2-dichloroethylene	0.04	-
1,1,1-Trichloroethane	1	2
1,1,2-Trichloroethane	0.006	-
Trichloroethylene	0.01	-
Tetrachloroethylene	0.01	-
1,3-Dichloropropene	0.002	0.02
Thiuram	0.006	-
Simazine	0.003	0.002
Thiobencarb	0.02	-
Benzene	0.01	0.01
Selenium	0.01	0.04
Nitrate-nitrogen and nitrite-nitrogen	10	-
Fluorine	0.8	-
Boron	1	2.4
1,4-Dioxane	0.05	0.05

Note* The standard value shall be the annual average value. However, the standard value for total cyanide shall be the highest value.
Note** Not detected" means lower than the limit of quantification of the assay method.
Source: Environment Agency Notification No. 59, 1971 (Final amendment 2023), Guidelines for drinking-water quality

(b) Environmental Standards, etc. Concerning Preservation of the Living Environment (Rivers)

Table A4-7 (1) Environmental Standards Regarding Preservation of the Living Environmental for River (Japan)

Type	Adaptability of Purpose of Use	Standard Value				
		pH	Biochemical Oxygen Demand	Suspended Solid	Dissolved Oxygen	Coliforms
AA	Water supply 1st class Conservation of the natural environment and those listed in class A below.	6.5 or over 8.5 or above	1 mg/L or above	25 mg/L or above	7.5 mg/L or over	20 CFU/ 100mL or above
A	Water supply 2nd class	6.5 or over	2 mg/L	25 mg/L	7.5 mg/L	300 CFU/

Type	Adaptability of Purpose of Use	Standard Value				
		pH	Biochemical Oxygen Demand	Suspended Solid	Dissolved Oxygen	Coliforms
	Fishery 1st class Water baths and those listed in class B and below	8.5 or above	or above	or above	or over	100mL or above
B	Water supply 3rd class Fishery 2nd Class and those listed in class C and below.	6.5 or over 8.5 or above	3 mg/L or above	25 mg/L or above	5 mg/L or over	1,000 CFU/ 100mL or above
C	Fishery 3rd class Industrial water 1st class and those listed in class D and below	6.5 or over 8.5 or above	5 mg/L or above	50 mg/L or above	5 mg/L or over	—
D	Industrial water 2nd class Water for agricultural use and those listed in class E	6.0 or over 8.5 or above	8 mg/L or above	100 mg/L or above	2 mg/L or over	—
E	Industrial water 3rd class Environmental Conservation	6.0 or over 8.5 or above	10 mg/L or above	No floating garbage, etc. shall be allowed.	2 mg/L or over	—

Note* the standard value shall be the average daily value.
Note* for agricultural use water points, the hydrogen ion concentration shall be between 6.0 and 7.5 and the dissolved oxygen content shall be at over 5 mg/L.
Note*
1 Natural Environment Conservation: Environmental conservation such as nature exploration
2 Water supply 1st Class: Simple water purification operation by filtration, etc.
Water supply 2nd Class: Normal water purification operation by sedimentation filtration, etc.
Water supply 3rd Class: Advanced water purification operations involving pretreatment, etc.
3 Fishery 1st Class: For fisheries organisms in poor rotting water such as landlocked salmon, char, etc., and for fisheries organisms in Fishery 2nd Class and Fishery 3rd Class.
Fishery 2nd Class: For salmonids, ayu (sweetfish), and other fisheries organisms in poor rotting water, and for fisheries organisms in Fishery 3rd Class.
Fishery 3rd Class: Carp, crucian carp, etc., for aquatic organisms in beta-medium humic waters
4 Industrial water 1st Class: Normal water purification operation by sedimentation, etc.
Industrial water 2nd class: High level of water purification by chemical injection, etc.
Industrial water 3rd class: Special purification operations
5 Environmental preservation: To the extent that it does not cause discomfort in the daily lives of citizens (including coastal recreation, etc.).
Source: Environment Agency Notification No. 59, 1971 (Final amendment 2023)

Table A4-8 (2) Environmental Standards Regarding Preservation of the Living Environmental for River (Japan)

Type	Adaptability of Purpose of Use	Standard Value		
		Total Zinc	Nonylphenol	Linear alkyl Benzene sulfonic acid and its salts
Biology A	Aquatic organisms that prefer relatively low temperatures, such as char and salmon trout, and the waters inhabited by their prey	0.03 mg/L or above	0.001 mg/L or above	0.03 mg/L or above
Biology Special A	Water bodies of organism A that require special conservation as spawning grounds (breeding grounds) or nursery grounds for juveniles of aquatic organisms listed in the column of organism A.	0.03 mg/L or above	0.0006mg/L or above	0.02 mg/L or above
Biology B	Aquatic organisms that prefer relatively low temperatures, such as carp and crucian carp, and the waters inhabited by their prey	0.03 mg/L or above	0.002 mg/L or above	0.05 mg/L or above
Biology Special B	Water areas of Organism A or Organism B that need to be especially conserved as spawning (breeding) grounds or nursery grounds for juveniles of aquatic organisms listed in the column of Organism B.	0.03 mg/L or above	0.002 mg/L or above	0.04 mg/L or above

Note* the standard value shall be the average daily value.
Source: Environment Agency Notification No. 59, 1971 (Final amendment 2023)

(c) Environmental Standards, etc. Concerning Preservation of the Living Environment (Lakes)

Table A4-9 (1) Environmental Standards Regarding Preservation of the Living Environmental for Lakes (Japan)

Type	Adaptability of Purpose of Use	Standard Value				
		pH	Biochemical Oxygen Demand	Suspended Solid	Dissolved Oxygen	Coliforms
AA	Water supply 1st class Fishery 1st class Conservation of the natural environment and those listed in class A below.	6.5 or over 8.5 or above	1 mg/L or above	1 mg/L or above	7.5 mg/L or over	20 CFU/ 100mL or above
A	Water supply 2nd and 3rd class Fishery 2nd class Water baths and those listed in class B and below	6.5 or over 8.5 or above	3 mg/L or above	5 mg/L or above	7.5 mg/L or over	300 CFU/ 100mL or above
B	Fishery 3rd class Industrial water 1st class and those listed in class C and below	6.5 or over 8.5 or above	5 mg/L or above	15 mg/L or above	5 mg/L or over	—
C	Industrial water 2nd class Environmental Conservation	6.0 or over 8.5 or above	8 mg/L or above	No floating garbage, etc. shall be allowed.	2 mg/L or over	—

Note*
1 Natural Environment Conservation: Environmental conservation such as nature exploration
2 Water supply 1st Class: Simple water purification operation by filtration, etc.
Water supply 2nd Class: Normal water purification operation by sedimentation filtration, etc.
Water supply 3rd Class: Advanced water purification operations involving pretreatment, etc.
3 Fishery 1st Class: For fisheries organisms in poor rotting water such as landlocked salmon, char, etc., and for fisheries organisms in Fishery 2nd Class and Fishery 3rd Class.
Fishery 2nd Class: For salmonids, ayu (sweetfish), and other fisheries organisms in poor rotting water, and for fisheries organisms in Fishery 3rd Class.
Fishery 3rd Class: Carp, crucian carp, etc., for aquatic organisms in beta-medium humic waters
4 Industrial water 1st Class: Normal water purification operation by sedimentation, etc.
Industrial water 2nd class: High level of water purification by chemical injection, etc.
5 Environmental preservation: To the extent that it does not cause discomfort in the daily lives of citizens (including coastal recreation, etc.).
Source: Environment Agency Notification No. 59, 1971 (Final amendment 2023)

Table A4-10 (2) Environmental Standards Regarding Preservation of the Living Environmental for Lakes (Japan)

Type	Adaptability of Purpose of Use	Standard Value	
		Total Nitrogen	Total Phosphorus
I	Conservation of the natural environment and those listed in class II below.	0.1 mg/L or above	0.005 mg/L or above
II	Water supply Class 1, 2 and 3 (except special) fishery class 1 bathing and III Listed in the following classes	0.2 mg/L or above	0.01 mg/L or above
III	Water supply 3rd class (special) and those listed in classes IV and below	0.4 mg/L or above	0.03 mg/L or above
IV	Fishery 2 types and those listed in class V.	0.6 mg/L or above	0.05 mg/L or above
V	Fishery 3, Industrial water, Agricultural water, Environmental conservation	1 mg/L or above	0.1 mg/L or above

Note
1 Natural Environment Conservation: Environmental conservation such as nature exploration
2 Water supply 1st Class: Simple water purification operation by filtration, etc.
Water supply 2nd Class: Normal water purification operation by sedimentation filtration, etc.
Water supply 3rd Class: Those that perform advanced water purification operations involving pretreatment, etc. ("special" means special water purification operations capable of removing odorous substances).
3 Fishery 1st Type: For salmonids, ayu, and other aquatic organisms, and Fishery 2nd type and Fishery 3rd type
Fishery 2nd Type: for fisheries organisms such as wakasagi, etc. and Fishery 3rd type for fisheries organisms
Fishery 3rd Type: For carp, crucian carp, and other aquatic organisms
4 Environmental preservation: To the extent that it does not cause discomfort in the daily lives of citizens (including coastal recreation, etc.).
Source: Environment Agency Notification No. 59, 1971 (Final amendment 2023)

Table A4-11 (3) Environmental Standards Regarding Preservation of the Living Environmental for Lakes (Japan)

Type	Adaptability of Purpose of Use	Standard Value		
		Total Zinc	Nonylphenol	Linear alkyl Benzene sulfonic acid and its salts
Biology A	Aquatic organisms that prefer relatively low temperatures, such as char and salmon trout, and the waters inhabited by their prey	0.03 mg/L or above	0.001 mg/L or above	0.03 mg/L or above
Biology Special A	Water bodies of organism A that require special conservation as spawning grounds (breeding grounds) or nursery grounds for juveniles of aquatic organisms listed in the column of organism A.	0.03 mg/L or above	0.0006 mg/L or above	0.02 mg/L or above
Biology B	Aquatic organisms that prefer relatively low temperatures, such as carp and crucian carp, and the waters inhabited by their prey	0.03 mg/L or above	0.002 mg/L or above	0.05 mg/L or above
Biology Special B	Water areas of Organism A or Organism B that need to be especially conserved as spawning (breeding) grounds or nursery grounds for juveniles of aquatic organisms listed in the column of Organism B.	0.03 mg/L or above	0.002 mg/L or above	0.04 mg/L or above

Note* the standard value shall be the average daily value.
Source: Environment Agency Notification No. 59, 1971 (Final amendment 2023)

Table A4-12 (4) Environmental Standards Regarding Preservation of the Living Environmental for Lakes (Japan)

Type	Adaptability of Purpose of Use	Standard Value
		Dissolved Oxygen
Biology 1	Water bodies where aquatic organisms with low anoxia tolerance in the habitat stage are conserved or rehabilitated, or where aquatic organisms with low anoxia tolerance in the reproduction stage are conserved or rehabilitated.	4.0 mg/L or above
Biology 2	Water bodies where aquatic organisms can inhabit and reproduce, excluding aquatic organisms with low tolerance to anoxia during the habitat stage, or where aquatic organisms can reproduce and reproduce, excluding aquatic organisms with low tolerance to anoxia during the reproduction stage.	3.0 mg/L or above
Biology 3	Water areas where aquatic organisms with high anoxia tolerance can inhabit during the habitat stage are conserved or restored, water areas where aquatic organisms with high anoxia tolerance can reproduce during the reproduction stage are conserved or restored, or water areas where inanimate areas are eliminated.	2.0 mg/L or above

Note* the standard value shall be the average daily value.
Source: Environment Agency Notification No. 59, 1971 (Final amendment 2023)

2) Regulatory Standards

Effluent standards are set by the MoFE. (See A4.3 Laws and Regulations Concerning Water Environment Management)

(3) Noise

1) Environment Standard

Environment standard for noise is shown Table A4-13.

Table A4-13 Environment Standard for Noise

Region	Noise Level（dB）	
	Daytime	Nighttime
Industrial Area	75	70
Commercial Area	65	55
Rural Residential Area	45	40
Urban Residential Area	55	50
Mixed Residential Area	63	55
Peace Area	50	40

Source: National Ambient Sound Quality Standard 2012

2) Regulatory Standards

No regulatory standards have been established for noise. No regulatory standards for noise have been established. For reference, the regulatory values under the Japanese Noise Regulation Law are shown below.

(a) Factories and Establishments with Specified Facilities

Eleven specific facilities are defined, including blowers and crushers. Regulation values vary from municipality to municipality and are shown in ranges.

Table A4-14 Noise Regulatory Standards for Factories and Establishments with Specified Facilities (Japan)

Area	Daytime 8:00-19:00	Morning/Evening 6:00-8:00/19:00-22:00	Nighttime 22:00-6:00
Type 1 Area	45-50 dB	40-45 dB	40-45 dB
Type 2 Area	50-60 dB	45-50 dB	40-50 dB
Type 3 Area	60-65 dB	55-65 dB	50-55 dB
Type 4 Area	65-70 dB	60-70 dB	55-65 dB

Type 1 Area: Areas that need to be kept particularly quiet in order to preserve a good residential environment.
Type 2 Area: Areas that are used for residential purposes and require the preservation of tranquility
Type 3 Area: Areas that are used for commercial or industrial purposes in addition to residential purposes, and where noise emissions must be prevented in order to preserve the living environment of the residents in the area.
Type 4 Area: Areas that are mainly used for industrial purposes and where significant noise emissions must be prevented in order to prevent the deterioration of the living environment of the residents within the area.
Source: Ordinance for Enforcement of the Noise Regulation Law, 1971 (Final amendment in 2021)

(b) Specific Construction Operations

Eight operations are designated as specific construction work, including work using backhoes and tractor shovels.

Table A4-15 Noise Regulatory Standards for Specific Construction Operations

Zone	Zone 1	Zone 2
Noise level	Not exceeding 85 dB at the site boundary	
working hours	Do not work from 19:00-7:00	Do not work from22:00-6:00
working period	Less than 10 hours per day	Less than 14 hours per day
	Within 6 consecutive days	
Working Day	Not on Sundays or other holidays.	

Zone 1: Zones that need to be kept particularly quiet in order to preserve a good residential environment.
Zone 2: Designated zones other than the zone 1
Source: Ordinance for Enforcement of the Noise Regulation Law, 1971 (Final amendment in 2021)

(c) Automobile Noise

The required limits for automotive noise are as follows.

Table A4-16 Requested Limit of Automobile Noise (Japan)

District	Number of Lanes	Daytime 6:00-22:00	Nighttime 22:00-6:00
a and b district	1lane	40-45 dB	40-45 dB
a district	More than 2 lanes	45-50 dB	40-50 dB
b district	More than 2 lanes	55-65 dB	50-55 dB
c district	More than 1 lanes		

a district: District used exclusively for residential purposes
b district: District used primarily for residential purposes
c district: Districts used for commercial, industrial, etc., in conjunction with a significant number of dwellings.
Note*: 75 dB during the daytime and 70 dB during the nighttime for districts adjacent to roads carrying arterial traffic (up to 15 m from the road property boundary for roads with two or fewer lanes and up to 20 m from the road property boundary for roads with more than two lanes)
Source: Ordinance for Enforcement of the Noise Regulation Law, 1971 (Final amendment in 2021)

(4) Vibration

No standards have been established for vibration. The regulatory standards in Japan are shown for reference.

(a) Factories and Establishments with Specified Facilities

Eleven specific facilities are defined, including blowers and crushers. Regulation values vary from municipality to municipality and are shown in ranges.

Table A4-17 Vibration Regulatory Standards for Factories and Establishments with Specified Facilities (Japan)

Area	Daytime 5:00-8:00 ~ 19:00-22:00	Nighttime 19:00-22:00 ~ 5:00~8:00
Type 1 Area	60-65 dB	55-60 dB
Type 2 Area	65-70 dB	60-65 dB

Type 1 Area: Areas that require the preservation of peace and quiet in order to preserve a good residential environment, and areas that require the preservation of peace and quiet because they are used by residents.
Type 2 Area: Areas used for commercial or industrial purposes in addition to residential purposes, where vibration must be prevented in order to preserve the living environment of the residents, and areas used mainly for industrial purposes, where significant vibration must be prevented in order to prevent the deterioration of the living environment of the residents in the area. Areas where significant vibration must be prevented in order to protect the living environment of the residents within the area.
Source: Regulations for Enforcement of the Vibration Regulation Law, 1976 (Final amendment in 2021)

(b) Specific Construction Operations

Four operations have been designated as specific construction operations, including work using pie hitters and pavement slab crushers.

Table A4-18 Vibration Regulatory Standards for Specific Construction Operations

Zone	Zone 1	Zone 2
Noise level	Not exceeding 85 dB at the site boundary	
working hours	Do not work from 19:00-7:00	Do not work from22:00-6:00
working period	Less than 10 hours per day	Less than 14 hours per day
	Within 6 consecutive days	
Working Day	Not on Sundays or other holidays.	

Zone 1: Zones that need to be kept particularly quiet in order to preserve a good residential environment.
Zone 2: Designated zones other than the zone 1
Source: Ordinance for Enforcement of the Noise Regulation Law, 1971 (Final amendment in 2021)

(c) Automobile Noise

The required limits for automotive noise are as follows.

Table A4-19 Requested Limit of Automobile Vibration (Japan)

District	Day Time	Night Time
1st district	65 dB	60 dB
2nd district	70 dB	65 dB

1st district: Districts that require the preservation of tranquility in order to preserve a good residential environment, and districts that require the preservation of tranquility because they are used by residents.
2nd district: Districts used for commercial or industrial purposes in addition to residential purposes, where vibration must be prevented in order to preserve the living environment of the residents, and districts used mainly for industrial purposes, where significant vibration must be prevented in order to prevent the deterioration of the living environment of the residents in the district. District where significant vibration must be prevented in order to preserve the living environment of the residents within the district.
Note*: However, upon consultation among the prefectural governor (or the mayor in the case of a city stipulated in Article 5 of the Order), the road administrator, and the Prefectural Public Safety Commission, the limit for roads around schools, hospitals, and other facilities that particularly require quietness shall be the value specified in the table or lower, and the limit shall be 5 decibels less than or equal to said value, and the limit for all or part of the section of certain already established trunk roads The limit for nighttime Class 1 districts in part may be the value for nighttime Class 2 districts.
Source: Ordinance for Enforcement of the Noise Regulation Law, 1971 (Final amendment in 2021)

(5) Odor

No standards have been established for odors. For reference, the regulatory standards for offensive odors in Japan are shown below. The Law for the Prevention of Malodorous Odors establishes standards for site boundaries, emission outlets, and emission water. Since the standards for outlets and water emissions are based on a formula, the regulatory standards at the site boundary where 22 specific malodorous substances are specified are shown as a reference.

Table A4-20 Regulatory Standards for Specific Malodorous Substances and Site Boundaries

Item	Regulatory Standards at Site Boundaries (ppm)
Ammonia	1.0
Methyl mercaptan	0.002
Hydrogen sulfide	0.02
Methyl sulfide	0.01
Methyl dioxide	0.009
Trimethylamine	0.005
Acetaldehyde	0.05
Propionaldehyde	0.05
Normal butyraldehyde	0.009
Isobutyraldehyde	0.02
Normal Valeraldehyde	0.009
Isobarrelaldehyde	0.003
Isobutanol	0.9
Ethyl acetate	3.0
Methyl isobutyl ketone	1.0
Toluene	10.0
Styrene	0.4
Xylene	1.0
Propionic acid	0.03
Normal butyric acid	0.001
Normal valeric acid	0.0009
Isovaleric acid	0.001

Note*: Regulation standards for gases containing specified odorous substances emitted from workplaces on the ground surface at the boundary line of the site of the workplaces concerned.
Source: Enforcement Regulations of the Offensive Odor Control Law, 1972 (Final amended in 2021)

A4.7.4 Resettlement and Land Acquisition

Policies and laws pertaining to land acquisition and resettlement are listed below. Land acquisition in Nepal is conducted under the Land Acquisition Act, and the procedure differs depending on whether the land is privately or publicly owned. In recent years, with the support of UNHABITAT and other organizations, the National Land Policy has been formulated and the land administration system has been reformed. In 2015, the ADB-supported Land Acquisition, Resettlement and Rehabilitation Policy was formulated for infrastructure projects, which stipulates the implementation of economic and social impact assessments, which had not been provided for in the previous legal system, and the inclusion of all costs related to land acquisition, compensation, and resettlement as project costs.

Table A4-21 Policies and Laws for Resettlement and Land Acquisition

Document Name	Year
The Constitution of Nepal	2015
Polisies and Plans, etc.	
National Land Policy	2019
Land Acquisition, Resettlement and Rehabilitation Policy	2015
Land Leasing Policy	2014
Laws, etc.	
Land Use Act	2019
Land Revenue Act	1978
Land Acquisition Act	1977 (Amended 1993)
Land Reform Act	1964

Document Name	Year
Land (survey and measurement) Act	1963

Source: JET

A4.7.5 Gap Analysis between JICA Environmental and Social Considerations Guidelines and laws and Regulations of Nepal

(1) Gap Analysis of EIA System

Table A4-22 shows Gap Analysis between JICA Guidelines for Environmental and Social Considerations 2010 (hereinafter referred to as "JICA Guidelines") and Laws and Regulations in Nepal.

Table A4-22 Gap Analysis between JICA Guidelines and Nepal Regulations

Item	JICA Guidelines	Laws and Regulations in Nepal	Gaps / Countermeasures
Underlying Principles	Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan. (JICA Guidelines p. 28)	EIAs and IEEs, including screening, scoping and environmental impact assessment processes, etc., applicable to individual projects are specified in the EPA and EPR.	There is not a big gap.
Information disclosure and stakeholder consultation	EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them. •EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted. (JICA Guidelines, p.32) •For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans. (JICA Guidelines, p. 29) •In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared; •Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared; (JICA Guidelines, p. 32)	During the preparation of the EIA/IEE report, the operator conducts a public hearing (EPA Chapter 2). There are also provisions for information disclosure, such as a public inspection period for the EIA report.	Although there are no major differences, the policy shall be to meet the requirements of the JICA guidelines according to the characteristics of individual projects, such as preparing documents in a language and format understood by local residents and obtaining copies of reports by residents and others.
Impact to be assessed	The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air,	In the EPR, items to be included in the EIA/IEE report include rainfall, temperature, wind	Although the evaluation items are described specifically, there is no description

Item	JICA Guidelines	Laws and Regulations in Nepal	Gaps / Countermeasures
	water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. (JICA Guidelines, p. 28) In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project. (JICA Guidelines, p. 29)	direction, air quality, water quality, topography, landslides and soil erosion, surface and groundwater, vegetation, protected areas, gender status, caste status, and health and hygiene status (EPR Schedule 5 & 6).	of derivative or secondary impacts, cumulative impacts, or impacts of indivisible projects, etc. Therefore, the policy is to meet the requirements of the JICA guidelines.
Monitoring and Grievance Redness Mechanism	Project proponents should make efforts to make the monitoring results available to local stakeholders involved in the project. (JICA Guidelines, p.30) When third parties point out specifically that environmental and social considerations are not being fully undertaken, project proponents should make efforts to reach an agreement on the procedures to resolve the problems, through forums for discussions and examinations of the countermeasures with participation of stakeholders involved in the projects, based on sufficient information disclosure. (JICA Guidelines, p.30)	Monitoring: Items determined to have environmental and social impacts are to be monitored through the development of an environmental management plan. The results of the monitoring also are included in the annual report.	There are no major differences in monitoring, but as there is no clear statement on complaint handling, efforts will be made to meet the JICA guideline requirements.
Ecosystem	Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests. (JICA Guidelines, p. 30)	The EPA states that the balance between environment and development is to be managed appropriately to reduce impacts on the environment and biodiversity.	There is not a big gap.
Indigenous people	Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses. (JICA Guidelines, p. 30)	Nepal is an interethnic country, and although 126 defined indigenous peoples (Jaati) and other undefined Jaati have been reported, no environmental and social considerations framework for the protection of indigenous peoples has been developed.	If there is a possibility of impact on indigenous peoples, efforts will be made to avoid or minimize the impact in accordance with JICA guidelines.

Source: JET

(2) Gap Analysis on Land Acquisition and Resettlement

Table A4-23 shows Gap Analysis between JICA Guidelines and Laws and Regulations in Nepal regarding Land Acquisition and Resettlement.

Table A4-23 Gap Analysis between JICA Guidelines and Nepalese Laws and Regulations on Land Acquisition and Resettlement

No.	JICA Guidelines WB Safeguard	Laws and Regulations in Nepal	Gaps / Countermeasures (Draft)
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	The EPA states that priority mitigation measures will be given to communities affected by the project. In addition, the Land Acquisition, Resettlement and Rehabilitation Policy (LARRP) has been established to avoid negative impacts associated with land acquisition and resettlement due to the project.	There is not a big gap.
2.	When avoidance of resettlement is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected. (JICA GL)	When resettlement is required for public works projects, compensation is provided under the Land Acquisition Act (LAA).	There is not a big gap.
3.	Those affected by involuntary resettlement and loss of means of livelihood shall be provided with adequate compensation and assistance to enable the relocated population to improve or at least regain their former standard of living, income opportunities and production. (JICA GL)	There is no corresponding statement in the LAA. On the other hand, the LARRP states that it will assist affected residents to achieve a standard of living that is at or above that before project implementation.	There are no significant differences when the LARRP is applied. Therefore, the policy is to apply the LARRP according to the characteristics of individual projects.
4.	Compensation, at full replacement cost, must be provided as much as possible (JICA GL)	While the LAA clearly states that compensation is based on market value, the LARRP states that compensation is calculated based on reacquisition price.	There are no significant differences when the LARRP is applied. Therefore, the policy is to apply the LARR according to the characteristics of individual projects.
5.	Compensation and assistance must be provided prior to relocation. (JICA GL)	Compensation will be provided in the early stages of project implementation. (LARRP)	Since the specific timing of implementation is not specified, the policy will be to meet JICA guideline requirements according to the characteristics of individual projects.
6.	For projects where large scale involuntary resettlement will occur, a resettlement plan must be prepared and made available to the public. (JICA GL)	The LARRP states that a Resettlement and rehabilitation plan will be developed for medium- to high-risk projects, but there is no mention of public disclosure.	When the LARRP is applied, there is no significant difference. Therefore, the policy is to apply the LARRP according to the characteristics of individual projects and satisfy the JICA Guideline requirements.
7.	In preparing a resettlement plan, sufficient information must be made available to the public in advance, and consultation with affected people and communities must be conducted based on this information. (JICA GL)	The LAA will provide information to local residents when acquiring land, and the LARRP will consult with and provide information to affected residents throughout the project implementation period.	When the LARRP is applied, there is no significant difference. Therefore, the LARRP should be applied according to the characteristics of individual projects.
8.	Consultations must include explanations in a language and format that is understandable to those	Dialogue in the language of impacted residents, etc. (LARRP)	When the LARRP is applied, there is no significant difference. Therefore, the LARRP should be applied

No.	JICA Guidelines WB Safeguard	Laws and Regulations in Nepal	Gaps / Countermeasures (Draft)
	affected. (JICA GL)		according to the characteristics of individual projects.
9.	Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. (JICA GL)	Ensure that any affected residents and others participate in the consultation process. (LARRP)	When the LARRP is applied, there are no significant differences. Therefore, the LARRP should be applied according to the characteristics of individual projects.
10.	An adequate and accessible grievance system must be established for the affected people and communities. (JICA GL)	The LAA describes how to file a petition against the compensation amount, and the LARRP also mentions the establishment of a grievance system.	There are no major differences, but the LARRP will be applied according to the characteristics of individual projects.
11.	Affected people must be identified and certified as soon as possible through baseline surveys. Baseline surveys include identification of affected people, cut-off dates, asset surveys, and socioeconomic surveys. Where possible, they shall be conducted at specific stages of the project to prevent the creation of new inflows of people seeking to enjoy the benefits. (WB OP 4.12 Para. 6)	The preceding is covered as a description of the Resettlement and rehabilitation plan. However, there is no description regarding the identification of affected people, cut-off dates, or the occurrence of inflows. (LARRP)	The policy will be to apply the LARRP according to the characteristics of individual projects and to meet JICA guideline requirements.
12.	The requirements for receiving compensation are those who have legal formal possession of land rights, those who do not possess legal rights to land at the time of the census but claim ownership, and those who have no ownership rights to the land they occupy. (WB OP 4.12 Para. 15)	Under the LAA, landowners and tenants are entitled to compensation; under the LARRP, there is also a requirement to interact with non-legal occupants, but the requirements for receiving compensation are unclear.	The policy will be to apply the LARRP according to the characteristics of individual projects and to meet JICA guideline requirements.
13.	For residents whose livelihoods depend on the land, a land-based relocation strategy will be used. (WB OP 4.12 Para. 11)	In addition to compensation in money, compensation can also be made through land donation. (LAA)	There is not a big gap.
14.	Provide support during the transition period. Support is also provided during the period of livelihood recovery after relocation. (WB OP 4.12, para.6)	The LARRP states that it will also provide for post-relocation monitoring and evaluation, but is unclear about support during the livelihood restoration period.	The policy will be to apply the LARRP according to the characteristics of individual projects and to meet JICA guideline requirements.
15.	Among the resettled residents, special attention will be paid to the socially vulnerable groups such as the poor, the landless, the elderly, women, children, and ethnic minorities, among others, and compensation will be provided. (WB OP 4.12 Para. 8)	Special attention will be paid to the socially vulnerable groups such as the poor, non-landowners, elderly, women, children, and ethnic minorities, among others, for consultation. (LARRP)	The policy will be to apply the LARRP according to the characteristics of individual projects and to meet JICA guideline requirements.
16.	For projects involving land acquisition or involuntary resettlement of less than 200 persons, abbreviated resettlement action plan will be prepared. (WB OP4.12	Resettlement and rehabilitation plans are developed for medium to high risk projects. Resettlement and rehabilitation plans are not necessary for low-risk*	If site acquisition or involuntary resettlement occurs, a resettlement and rehabilitation plan will be developed, and the policy to meet JICA guideline requirements.

No.	JICA Guidelines WB Safeguard	Laws and Regulations in Nepal	Gaps / Countermeasures (Draft)
	Para.25)	projects. (LARRP)	

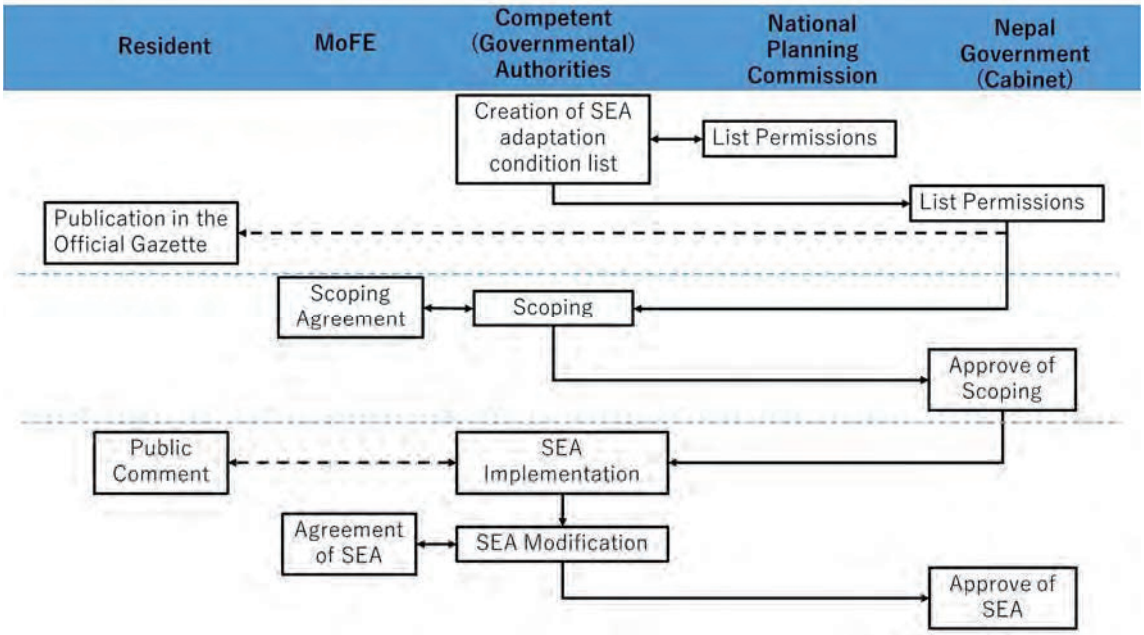
Note: *: High Risk Project: Project that caused both physical and economic displacement i. 50 or more families in the mountain region, ii. iii. 75 or more families in the hills, 100 or more families in the Tarai plains
Medium Risk Project: Project that caused both physical and economic displacement i. ii. iii. less than 50 families in the mountain region, less than 75 families in the hills, less than 100 families in the Tarai plains.
Low Risk Project: i. projects with no physical displacement ii. iii. project with only economic displacement, and none of affected person lose more than 10% of their productive assets
Source: JET

A4.7.6 Strategic Environmental Assessment (SEA)

In the amendment of Environmental Protection Act (EPA) in 2019, SEA has been described, as follows:

Environmental Protection Act 2019
9. Strategic environmental analysis: (1) Prior to the implementation of such policy, program or project as may be specified by the Government of Nepal by a notification in the Nepal Gazette, the strategic environmental analysis shall be carried out in relation to such a policy, program or project.
(2) Other provisions relating to the strategic environmental analysis shall be as prescribed.

The Environmental Protection Rules of 2020, hereafter referred to as the "EPR," stipulate the approval process for SEAs as shown in Figure A4-2. SEAs under the act will be applied to cases deemed necessary by the competent authorities on a cross-sectoral and nationwide basis, which, due to their procedural characteristics, will require coordination among the National Planning Commission (NPC) and various ministries and agencies.



Source: Prepared by JET based on EPR 2020

Figure A4-2 SEA Approval Process

According to the MoWS, since this MP is limited to Pokhara City and is within the authority of the MoWS, SEA under the law does not apply to it. The SEA has not yet been applied in accordance with the law. The implementation of SEA has so far been confirmed in the projects listed in Table A4-24. These projects were implemented with donor support prior to the 2019 EPA revision.

Table A4-24 SEA Implementation Status in Nepal

Project Name	Year	Implementing Agency
Nationwide Storage Hydroelectric Power Plant MP Survey	2014	JICA
A Strategic Environmental and Social Assessment of Nepal's REDD+ Strategy	2014	Ministry of Forest and Soil Conservation（現 MoFE）
Integrated Strategic Environmental Assessment in post-earthquake Nepal 2015-2017	2017	UNEP

Source: JET

A4.7.7 EIA and Initial Environment Examination (IEE)

(1) EIA

The EIA applicable to individual projects is stipulated in the EPA and EPR. While the screening, scoping and EIA processes are basically the same as those in the JICA Guidelines for Environmental and Social Considerations, land acquisition and resettlement procedures are not mentioned. The following outlines the EIA procedures based on the above-mentioned laws and regulations.

(2) Applicability Requirements for EIA and IEE

Under Nepal's EIA system, a Brief Environmental Study ("BES"), Initial Environmental Examination ("IEE"), or EIA review is required in the EPR, depending on the nature and scale of the project. The approval agency for IEE is the competent authority or the province or local government, and the approval agency for EIA is the MoFE or the province, depending on the project characteristics. Projects subject to province and local government approval are defined in province laws and ordinances based on federal law. The documents required for IEE and EIA screening are listed in the EPR, and the screening of projects is usually determined in consultation with the project operator and the approving agency. Table A4-25 shows the classification of projects subject to EIA and IEE related to the sewerage sector; there is no classification of the sewerage sector in the EPR, and sludge disposal is included in the waste sector.

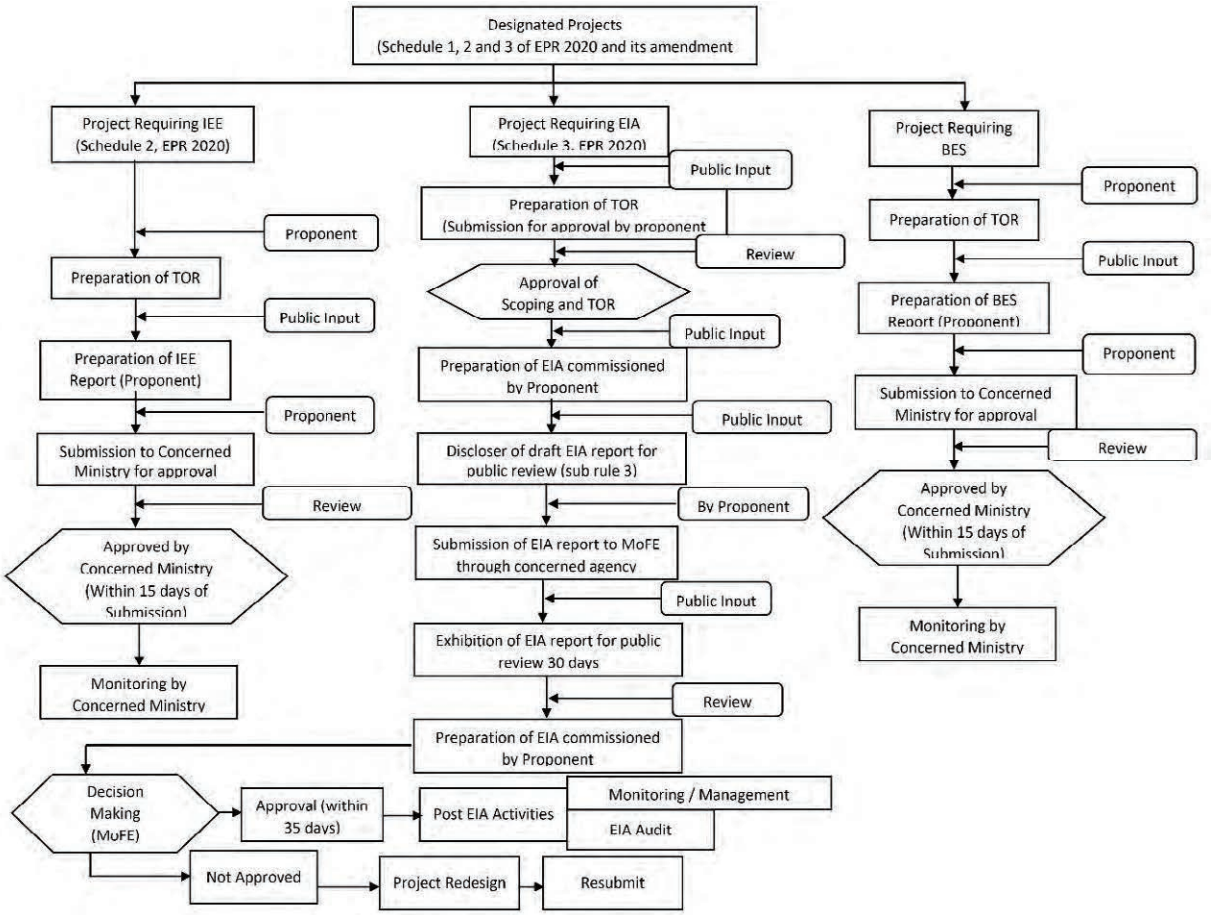
Table A4-25 Projects Covered by EIA and IEE Related to the Sewerage Sector

	BES (Schedule 1)	IEE (Schedule 2)	EIA (Schedule 3)
Waste Sector			
Waste Landfill	－	1,000～5,000 t/year	5,000 t/year～
Relay Stations and Resource Recovery Facilities	－	5～10 ha	10 ha～
Sorting, recovery, treatment, and recycling of waste (including mechanical, chemical, and biological techniques)	－	5～10 ha	10 ha～
Compost Facility	－	5～10 ha	10 ha～
Sludge Treatment	－	～ 5 MLD	5 MLD ～
Solid Waste or Sludge Management	－	～ 50,000 people	50,000 people～

Source: Prepared by JET based on EPR

1) EIA/IEE Process

Figure A4-3 shows the EIA/IEE process in Nepal.



Source: Prepared by JET based on EPR

Figure A4-3 EIA/IEE Process

2) Monitoring

After approval of the IEE/EIA project, monitoring will be conducted by the competent authority or the province or local government. If the PMC is the approving authority, a monitoring committee chaired by the deputy mayor will be established to conduct monitoring after IEE approval. MoFE does not directly conduct monitoring even if it is an EIA project, but is in charge of environmental audits.

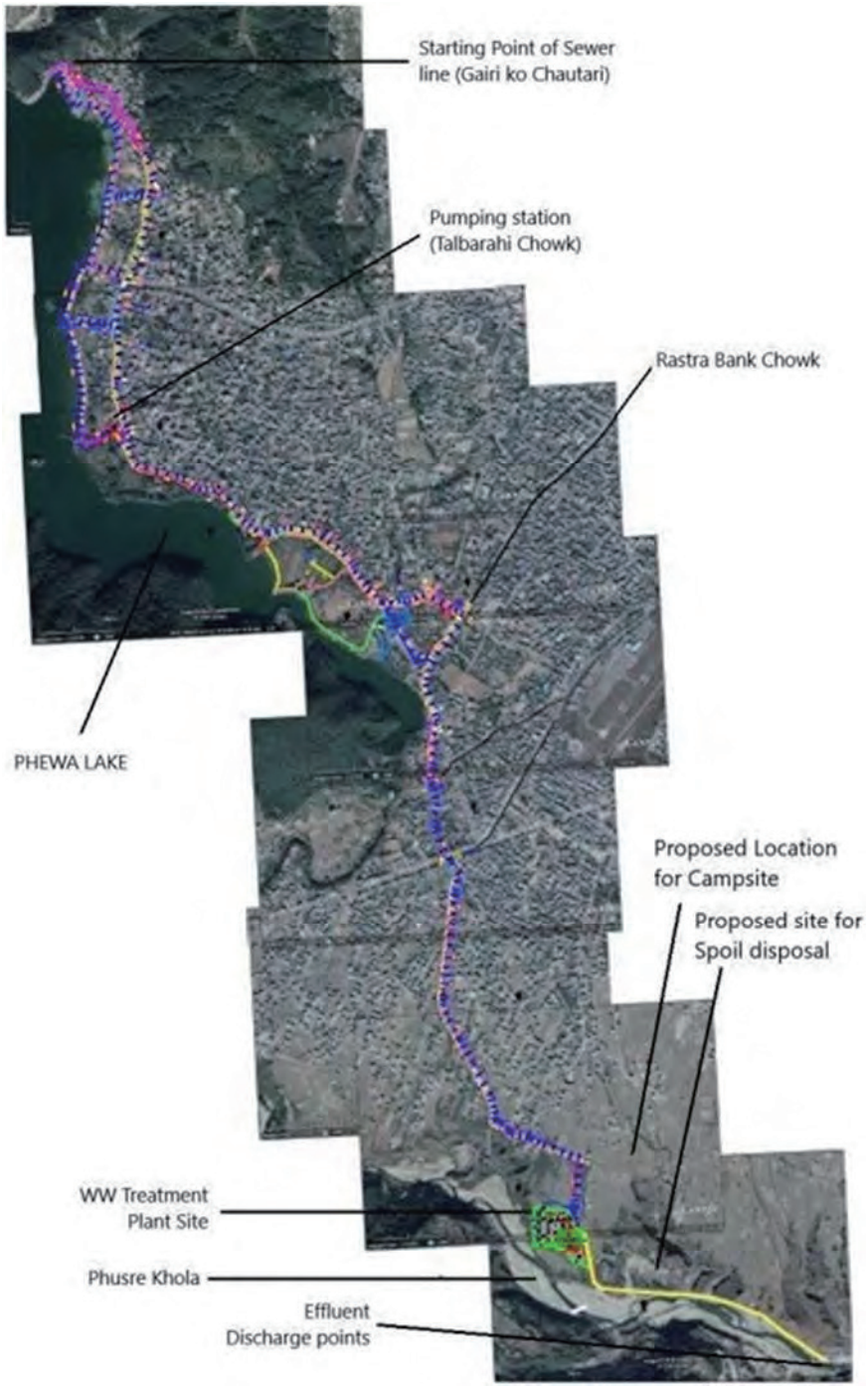
3) EIA for Phewa Lake Drainage Management Project

DWSSM has planned sewerage improvements (sewers and WWTP) for the area west of the Seti River since 2014, and an EIA report was prepared. A summary of the project is shown in Table A4-26 and the subject project site is shown in Figure A4-4. The approval letter includes the minimization of environmental impacts and the implementation and reporting of monitoring as conditions. The English translation of the approval letter is shown in Figure A4-5.

Table A4-26 Summary of Phewa Lake Drainage Management Project

Item	Contents
Project Name	Phewa Lake Waste Water Management Project
Business Components	Total length of sewage pipeline: approx. 9 km (Main pipe: approx. 5.6 km (Ward 6, 7, 17)) Sewage treatment facility (Ward 17)
Total Project Cost	1,522 Million Rupee
Schedule for EIA Survey	30/03/2018: Approval of scoping documents and TOR 30/12/2019: Submission of EIA Final Report

Source: Prepared by JET based on EIA of Phewa Lake Waste Water Management Project (December 2019)



Source: EIA of Phewa Lake Waste Water Management Project (December 2019)

Figure A4-4 Planned Sewerage Improvement Area for Phewa Lake Drainage Management Project

Unofficial Translation

Government of Nepal

Ministry of Forest and Environment

Environment and Bio-Diversity Division

Letter No. : Va.Pra.A.Sha 0- 220-2077/078 Date : 25 March 2021 ***(2077-12-12 BS)***
Dispatch No. : 699
Received Letter No. and Date : -

Subject : Regarding Approval of Environmental Impact Assessment (EIA) report of Phewa Lake Sewerage Construction and Treatment Project.

To,
Ministry of Water Supply,
Singha Durbar, Kathmandu.

With reference to the letter dispatch no. 46 received from your ministry dated 12 January 2020 ***(2076/09/27 BS)*** along with the Secretary Level Decision of your ministry dated 12 January 2020 for the approval of Environmental Impact Assessment (EIA) Report on Phewa Lake Sewerage and Treatment Project to be implemented by Federal Water Supply and Sewerage Management Project (as proponent of Project) at Ward No. 6,7 and 17 of Pokhara Metropolitan City of Gandaki Province, I would like to inform you that the EIA report for Phewa Lake Sewerage and Treatment Project is approved according to Sub-Clause 5 of Clause 7 of Environment Protection Act 2076 (2019 AD) and Environment Protection Rules 2077 (2020 AD) on 3 March 2021 ***(2077/11/19 BS)***. This approval is granted on belief that project will not violate the prevalent laws and regulations and the project will follow all recommendations highlighted in the report during the implementation of the project along with the terms mentioned below:

Terms:

1. Proponent shall minimize/rectify at his own cost additional/new environmental impacts during implementation of the proposal.
2. During the implementation of the proposal, proponent shall regularly monitor and submit monitoring report to this ministry and other concerned agencies regularly as per Sub-Rule 1 of Rule 45 of Environment Protection Rules 2077 (2020 AD).
3. Proponent shall implement the proposal following prevalent environmental acts, rules, regulations and various bye-laws issued by ministry and other acts, rules and regulations relevant to other concerned agencies.
4. While disposing the waste generated during the implementation of the project, appropriate methods shall be followed to reduce to negative impacts in future.
5. Proponent shall implement the issues raised by people during the public hearing at his own cost.
6. Proponent shall coordinate with concerned agencies during the implementation of the project.

Signed

Subhash Kumar Sharma
Assistant Forest Officer

CC:
Federal Water Supply and Sewerage Management Project, Pokhara, Kaski (1 Copy report Attached)
Department of Environment, Babarmahal, Kathmandu (1 Copy report attached)

Source: JET English translation of letter issued by MoFE

Figure A4-5 EIA Approval Letter

In addition, the main mitigation measures presented in the EIA report are listed below.

Table A4-27 Main Mitigation Measures Presented in the EIA Report for the Lake Phewa Wastewater Management Project

Phase	Item	Mitigation Measure
Before Construction	Ecosystem	Consideration of placement with relatively little loss of vegetation
	Odor	Installation of lids on inlets Planting aromatic shrubs and trees in buffer zones
Under Construction	Land Use	Secure buffer zones and promote revegetation
	Soil Erosion	Installation of waterways and ditches Prevent sediment transport outside the site by using sedimentation basins Use of settling tanks before draining into waterways, etc.
	Water Pollution	Avoidance of construction of workers' dormitories in the drainage area Collection or removal of used oil from the site Prohibition of open defecation by installing toilets Prohibit car washing near rivers Keep distance between irrigation ditches and rivers and sediment dumping sites or fuel storage sites, etc.
	Air Pollution, Noise/Vibration	Control of dust by sprinkling water Regular vehicle maintenance and prohibition of construction vehicle operation at night Compliance with emission standards
	Waste	Composting of organic waste Delivery of valuable materials to collection companies Installation and collection of temporary storage of construction waste Management of wastewater from workers' quarters, etc.
	Ecosystem	If cutting down of trees cannot be avoided, compensatory afforestation of 10 trees for each one cut down Provision of seedlings to local communities or forestry personnel after seedling cultivation
	Safe	Provision of drinking water and hygienic toilets for men and women in the workers' dormitories Conduct awareness programs and regular health checkups on human trafficking and sexually transmitted diseases Prohibiting the use of firewood for cooking and providing LPG gas stoves Provision of personal protective equipment (PPE), including safety helmets, safety belts, boots, and gloves Provision of first aid kits, fire extinguishers, and emergency vehicles
	Social Service	Arranging for contractors to supply food and daily necessities for workers Restoration of road equipment and public property damage to its current condition Developing detour routes and traffic plans and assigning traffic control personnel
	Health/Sanitation	Installation of toilets for workers at least 50 meters away from water sources Prohibit littering of waste materials
	Social Conflict	Apply wages and codes of conduct based on local norms, limit alcoholic beverage consumption
	Gender	Ensure that 10-15% of the workforce is female Provide a separate wing for women in workers' quarters
	Land Acquisition	Crop compensation for affected land
In Operation	Air Pollution, Noise/Vibration	Use of generators that meet emission standards Implementation of air quality monitoring every 3 months (PM2.5 , SOx, NOx, CO)
	Odor	Removal of sludge deposits within 24 hours Planting of aromatic trees and plants
	Water Pollution	Compliance with effluent standards and monitoring of effluent water quality
	Soil Pollution	Ensure that areas where sludge is placed are impervious Establishing environmental zones around the facility and implementing drainage practices to avoid flooding
	Safe	Providing training on occupational safety

Phase	Item	Mitigation Measure
		Providing vaccinations for workers Wearing protective clothing Prepare written emergency procedures Installation of no-entry signs

Source: Prepared by JET based on EIA of Phewa Lake Waste Water Management Project (December 2019)

A4.7.8 Legal Framework for Land Acquisition and Resettlement

(1) For Privately Owned Land

When land owned by an individual (private land) is to be acquired for public purposes, the implementing agency can make a request to the federal government (cabinet) for land acquisition under the Land Acquisition Act and pay compensation before acquiring the land. The procedure for acquiring private land is complicated, and it often takes nearly six months to reach an agreement with the landowner.
For example, if a PMC wishes to acquire a land for sewage-related facilities, it applies to the Cabinet via the MoLMCPA with a letter of recommendation from the MoWS, the competent authority for the project, and after a cabinet decision, the land evaluation and other compensation procedures are initiated. In practice, coordination with the landowner and related agencies will be made at the earliest stage of identifying the land to be acquired. The amount of compensation is determined by the Compensation Decision Committee, which consists of the Chief District Officer, the Land Revenue Office, the project owner, and the District Coordination Committee. In addition to land, compensation includes trees, crops, dwellings, walls/fences, sheds, etc. If the subject land is used for lease, the lease user is entitled to 15% of the compensation amount. However, if there are buildings and other structures built with the agreement of the landowner, the landowner may receive the full amount of compensation for those buildings and other structures. If the landowner is dissatisfied with the amount of compensation offered, or with the land acquisition in general, he/she may file a complaint with the grievance mechanism.

(2) For Government-Owned Land

If the land in question is government-owned land, the procedure is to obtain a use permit from the land-owning organization in accordance with the Land Leasing Policy, which is much easier than when purchasing privately-owned land. For example, when a PMC wants to obtain a use permit for government-owned land for construction of sewage-related facilities, it must apply to the cabinet via the MoLMCPA with a letter of recommendation from the MoWS, the authority with jurisdiction over the project, and obtain final approval from the cabinet before being able to use the land for the project. If a public agency such as a municipality obtains permission to use public land, it may use the land free of charge.

A4.8 Institutions and Policies for Climate Change

Although hydropower is the main source of greenhouse gas emissions in Nepal, the International Centre for Integrated Mountain Development (ICIMOD) estimates that between 1970 and 2010, 5.88% of the Himalayan glaciers in Nepal disappeared (an average of about 0.2% per year), which means Nepal faced the risk of climate change.
Nepal's climate change related policies and strategies are shown in Table A4-28. National Climate Change Policy, 2076 (2019) defines climate change strategies and policies for each sector (agriculture, forests, water resources, etc.). It also mentions the responsibilities for policy formulation and monitoring on climate change at the province and local levels.

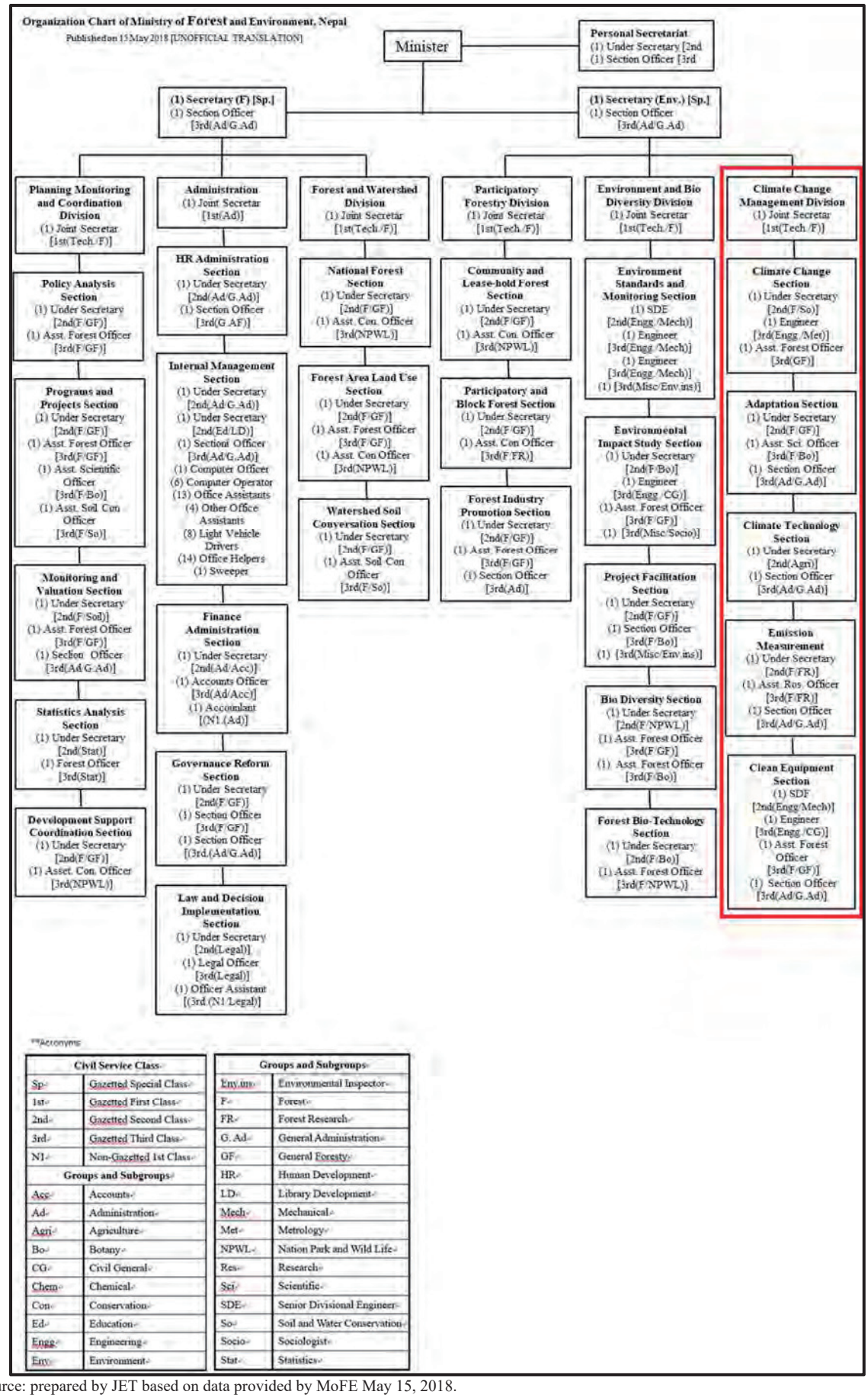
Table A4-28 Policies and Strategies Related to Climate Change in Nepal

Item	Institution/Policy
Master Plan	National Climate Change Policy, 2076 (2019)
	Forestry Sector Strategy (2016-2025)
	NRREP Programme 2012-2017
	National Sustainable Transport Strategy
	National REDD plus Strategy
	Low Carbon Economic Development Strategy

Item	Institution/Policy
	National Adaptation Programme of Action
	Local Adaptation Plans for Action
	National Adaptation Plans
	Environment ecofriendly Local Governance framework
	Agriculture Development Strategy
	Nationally Determined Contributions, October 2016
	Observed Climate Trend Analysis of Nepal

Source: Prepared by JET based on MoFE May 15, 2018

The Climate Change Management Division of the MoFE is in charge of climate change countermeasures, including the formulation of national policies on climate change, publication of reports, and calculation of greenhouse gas emissions. The Climate Change Management Division consists of five Sections, including the Climate Change Section, Adaptation Section, Climate Technology Section, Emission Measurement Section, and Clean Equipment Section. The Climate Change Management Division has 16 members, including 4 secretaries, 8 officers, and 4 support staff.



Source: prepared by JET based on data provided by MoFE May 15, 2018.

Figure A4-6 MoFE Organization

"8.7 Health, Drinking Water and Sanitation" in the National Climate Change Policy, 2076 (2019), has the following strategic objectives.

- Preparedness, forecasting, and prevention systems will be developed to prevent epidemics of vector-borne and communicable diseases caused by climate change.
- Efficient technologies will be developed to protect water resources and increase easy access to potable water in addition to developing and expanding rainwater collection and storage.
- Hazardous and toxic waste will be properly managed and biodegradable waste from homes, hotels, hospitals, etc. will be sorted and used as effective energy.

A4.8.1 Mitigation Measures

Nepal has the following policies as mitigation measures against climate change (Source: Nationally Determined Contributions, December 2020).

[Forest Sector]

- By 2030, maintain 45% of the country's total area under forest cover.
- By 2030, 50% of the forests in the Tarai area and 25% of the forests within the Tarai area will be sustainably managed, including through the use of Reducing Emissions from Deforestation and Forest Degradation ("REDD+") funds.

[Waste Sector]

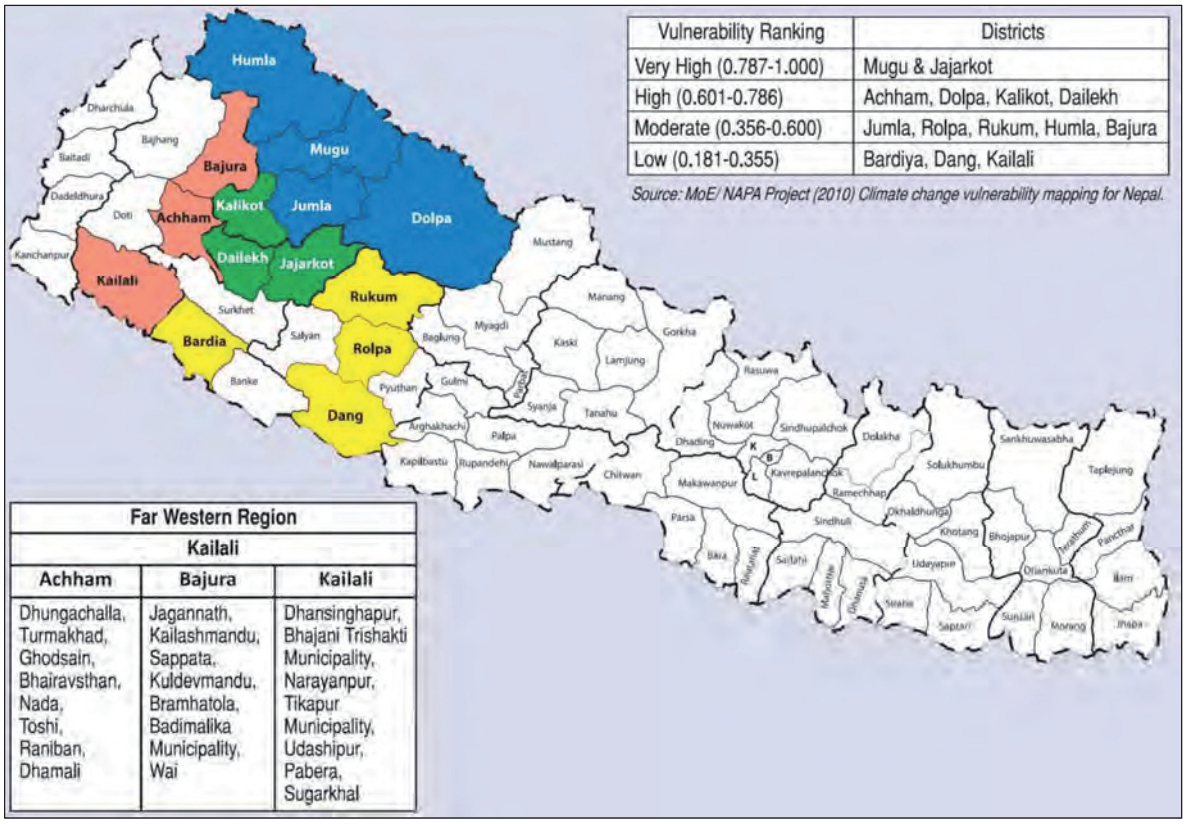
- By 2025, 380 million L/day of wastewater will be properly treated and discharged and 60,000 m^3/year of sewage sludge will be managed.

In addition, mitigation measures are planned in the Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030) developed by the MoWS, including the use of solar power to power water intake pumps.

A4.8.2 Adaptation Measures

Nepal is implementing the Nepal Climate Change Support Program ("NCCSP") with the support of the United Nations Development Plan ("UNDP") as an adaptation measure to climate change. Local Adaptation Plans for Action (LAPA) were developed by the NCCSP from 2013 to 2017 in 14 districts identified as particularly vulnerable. LAPAs are sector-specific adaptation measures to climate change (e.g., improvement of irrigation technology in agriculture, afforestation in forestry, etc.), but none have been developed in Kaski District, to which Pokhara City belongs. However, the Integrated Lake Basin Management Plan of Lake Cluster of Pokhara Valley, Nepal (2018-2023) Government of Nepal has the following measures as part of the adaptation measures.

- Include climate change adaptation in lake basin management plans
- Promote awareness and education programs on climate change and disaster risk
- Develop infrastructure that is resilient to climate change-induced disasters



Source: Nepal Climate Change Support Program

Figure A4-7 Counties with Local Adaptation Plans for Action (LAPA)

In 2012, a landslide near the Machhapuchre Mountains caused the Seti River to overflow due to a large inflow of sediment. This was reportedly caused by three days of heavy rainfall. In addition, the city of Pokhara could be affected by the recent increase in precipitation and flooding in neighboring countries as described in Section A2.2.2, as well as by melting snow from the glaciers in the Himalayas. Therefore, it is necessary to consider plans related to adaptation measures, such as securing backup power sources for facilities and installing or moving equipment to locations above the flooding level.

A4.8.3 NDC

Nationally Determined Contributions ("NDC") set the objectives shown in Table A4-29. The Paris Agreement, which entered into force in 2016, requires NDCs to be resubmitted every five years, and the second NDC was submitted to the UNFCCC on December 8, 2020.

Table A4-29 NDC in Nepal

No.	Objective
1	By 2030, all 753 local governments will prepare and implement climate resilient and gender-responsive adaptation plans.
2	A National Adaptation Plan ("NAP") is updated every 10 years. A national Vulnerability and Risk Assessment ("VRA") is implemented every 5 years.
3	By 2025, institutional mechanisms including the Inter-Ministerial Climate Change Coordination Committee "IMCCCC", Thematic and Thematic working groups "TWG", Cross-cutting working groups "CWG" and Climate Change Research Center will be established and operational.
4	By 2021, Gender Equality and Social Inclusion ("GESI"), Climate Change Strategy and Action Plan and Climate Resilience Plan and Budget Guidelines will be developed.
5	By 2025, strategies and action plans for climate change sensitive technologies and practices will be developed and implemented.
6	By 2025, climate change-related education will be provided in all secondary schools and 2,000 climate change adaptation officers will be constituted in municipalities.
7	By 2025, climate change-related disease surveillance systems will be enhanced as weather

No.	Objective
	information is integrated into existing surveillance systems.
8	By 2030, the population with access to basic water supplies will increase from 88% to 99% and the population with access to improved water supplies will increase from 20% to 40%.
9	By 2025, climate risk assessment mechanisms will be integrated into the planning and implementation cycle of the WASH program.
10	Public Weather Services "PWS" including agricultural weather information systems will be enhanced and established.
11	By 2030, a multi-hazard monitoring and early warning system covering all provinces will be established.
12	By 2025, a national strategy and action plan on losses and damages related to climate change impacts will be planned.
13	By 2022, a climate finance strategy and national capacity for climate finance management will be developed.
14	Adaptation measures based on circular economy and sustainable resource use will be developed and implemented.

Source: Prepared by JET based on Nationally Determined Contributions, December 8, 2020

A5 Current Status of Wastewater Management in PMC

A5.1 Current Status of Wastewater Management

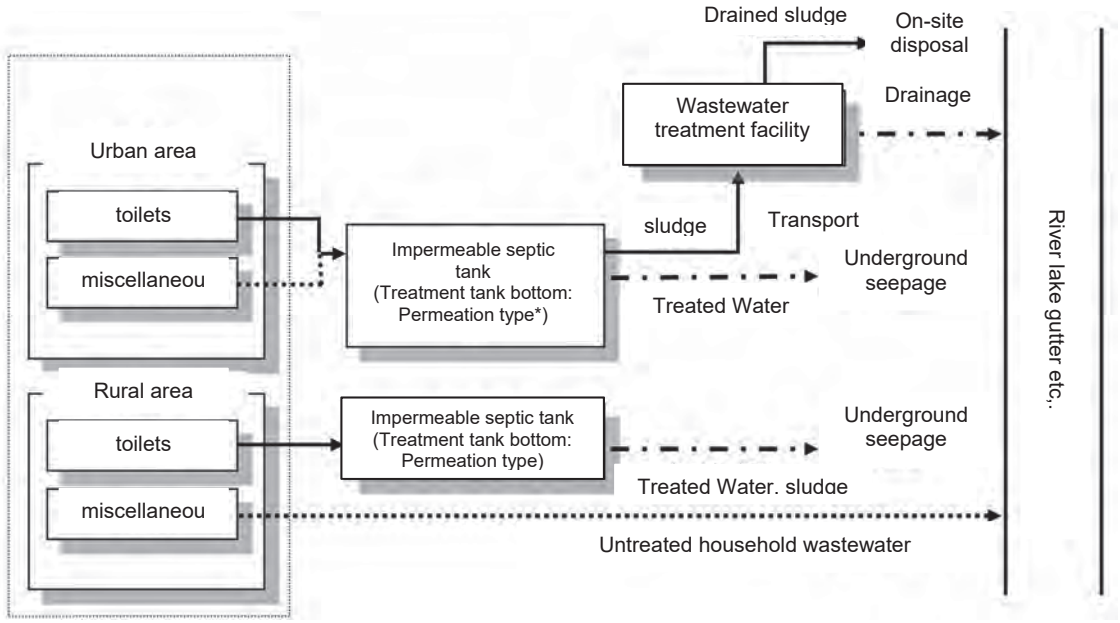
A5.1.1 Wastewater Treatment System

There is no centralized sewerage system in PMC. The majority of households rely on on-site wastewater management facilities.

The sewage system has not been developed till now so that toilet wastewater has been treated in septic tanks. However, permeable septic tanks are basically utilized in PMC and there is still a few cases that Impermeable septic tanks are installed.

In urban areas, miscellaneous wastewater is usually treated in permeable septic tank along with toilet wastewater. However, it is discharged into some rivers without treatment. In rural areas, it is basically discharged into gutters, rivers, lakes, etc. without treatment.

Faecal sludge should to be removed and collected on-call by the septic tank owner, but actually, the sludge removal is rarely conducted and only requested when some problems such as odor from septic tanks are occurred in some houses which are located in densely populated areas. The extracted faecal sludge is transported to a sludge disposal site in the city. In the low-density area, the sludge have never been desludged since they were installed.



Note: *A very small portion is "Treatment tank bottom: impermeable type)
Source: JET

Figure A5-1 Wastewater Treatment System

A5.1.2 Wastewater Treatment Body

The current status of wastewater treatment body in Pokhara city is shown in Table A5-1.

Table A5-1 Wastewater Treatment Body

Wastewater treatment facility	Target wastewater	Wastewater management body
Impermeable septic tank (Treatment tank bottom: Permeation type*)	Toilet wastewater, miscellaneous wastewater	Installation by Costumers, etc. O&M by Costumers, etc.

Note: *A very small portion is "Treatment tank bottom: impermeable type)
Source: JET

A5.1.3 Issues of Wastewater Management

The pollution of the water environment in Pokhara City is described in Chapter A2.5. It is necessary to countermeasure promptly. The basic policies for wastewater management including measures for on-site treatment issues are shown below.

- Development of sewerage
- Development of laws, regulations, standards, etc. related to wastewater management
- Establishment of a system for permitting installation of septic tanks, inspection, sludge removal and transportation
- Improvement of structure from permeable to impermeable septic tank
- Treatment of miscellaneous wastewater

A5.2 Existing Sewerage Plan (Lake Phewa Waste Water management Project)

Sewerage development was firstly proposed in 2002 by “Development Study on The Environmental Conservation of Lake Phewa in Pokhara, Nepal, JICA” (JICA Study). Based on the above JICA Study, “Detailed Engineering Design of Lake Phewa Waste Water management Project” (Detailed Design) was prepared by the Department of Water Supply and Sewerage, Ministry of Urban Development in 2014 (Ministry of Water Supply at the present).

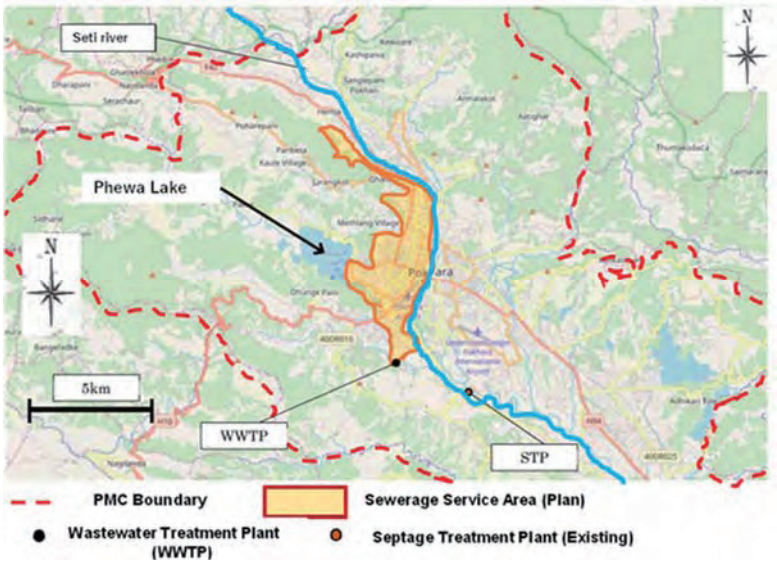
A5.2.1 Outline

(1) Objectives

The project aims to improve the health of Lake Phewa and preserve the tourism economy of Pokhara. Increased sedimentation and organic loads are the major problems for the accelerated deterioration of the Lake.

(2) Sewerage Service Area

The sewerage service area would cover the urbanized catchment areas of the drains flowing into Lake Phewa as shown in Figure A5-2.



Source: JET

Figure A5-2 Sewerage Service Area

(3) Sewage Collection Method

A separate system would be introduced along the promenade on the shores of Lake Phewa and Lakeside Road. Sewage from other areas would be intercepted from waterways that flow into Lake Phewa. This is the most economical way to manage the inflow from urban areas, and it will be developed into a full-scale separate system in the future. Figure A5-3 shows the sewage collection plan.



Source: JET

Figure A5-3 Existing Sewerage Plan

(4) Planning Framework and Parameters

These are shown in Table A5-2.

Table A5-2 Framework and Parameters

Item	Detailed Design	Remarks
Service Area (ha)	1,344.27	
Target Year	2040	
Served Population (cap)	2011: 139,175 2040: 318,272	
Tourists (cap)		2012: 176,680 cap (4 days stay)

Item		Detailed Design	Remarks
Other Sewage Source		Institutional, tourists, floating pop.	
Water Consumption		130 lcd	
Water Comversion Rate		0.8	Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, December 1993
Sewage Generation Unit			
	Domestic wastewater	104 lcd	
	Tourist wastewater		
	Non-domestic wastewater	0.1 l/ha/s	Including tourists
	Groundwater infiltration	0.06 l/ha/s	
Sewage Generation Amount			
	Domestic wastewater	0.383 m^3/s (33,100 m^3/day)	
	Tourist wastewater	0.135 m^3/s (11,660 m^3/day)	(35% of domestic wastewater)
	Non-domestic wastewater	0.081 m^3/s (7,000 m^3/day)	(15.6% of wastewater)
	Groundwater infiltration	0.599 m^3/s (51,753 m^3/day)	
	Diversion	Seti canal: 0.1 m^3/s Phirke Khola:0.15 m^3/s	
	Peak factor	$5/P^{1/6}$ (P: population in thousand)	Babbit formula: $5/P^{1/5}$ (P: population in thousand)
D Max./D Ave.		(0.383+0.135) x 1.2+0.081 = 0.7026 m^3/s (67,000 m^3/day)	
Design Capacity of WWTP		0.68 m^3/s (58,800 m^3/d)	Wastewater + infiltration+1/3 of diversion
Strength of Sewage		BOD5: 220 mg/L SS: 865 mg/L	
Household Connections		3,000 for 1st phase	

Source: JET

(5) Sewage Collection Design

The basic design for the sewage collection system is based on the criteria shown in Table A5-3.

Table A5-3 Sewage Collection System Design Criteria

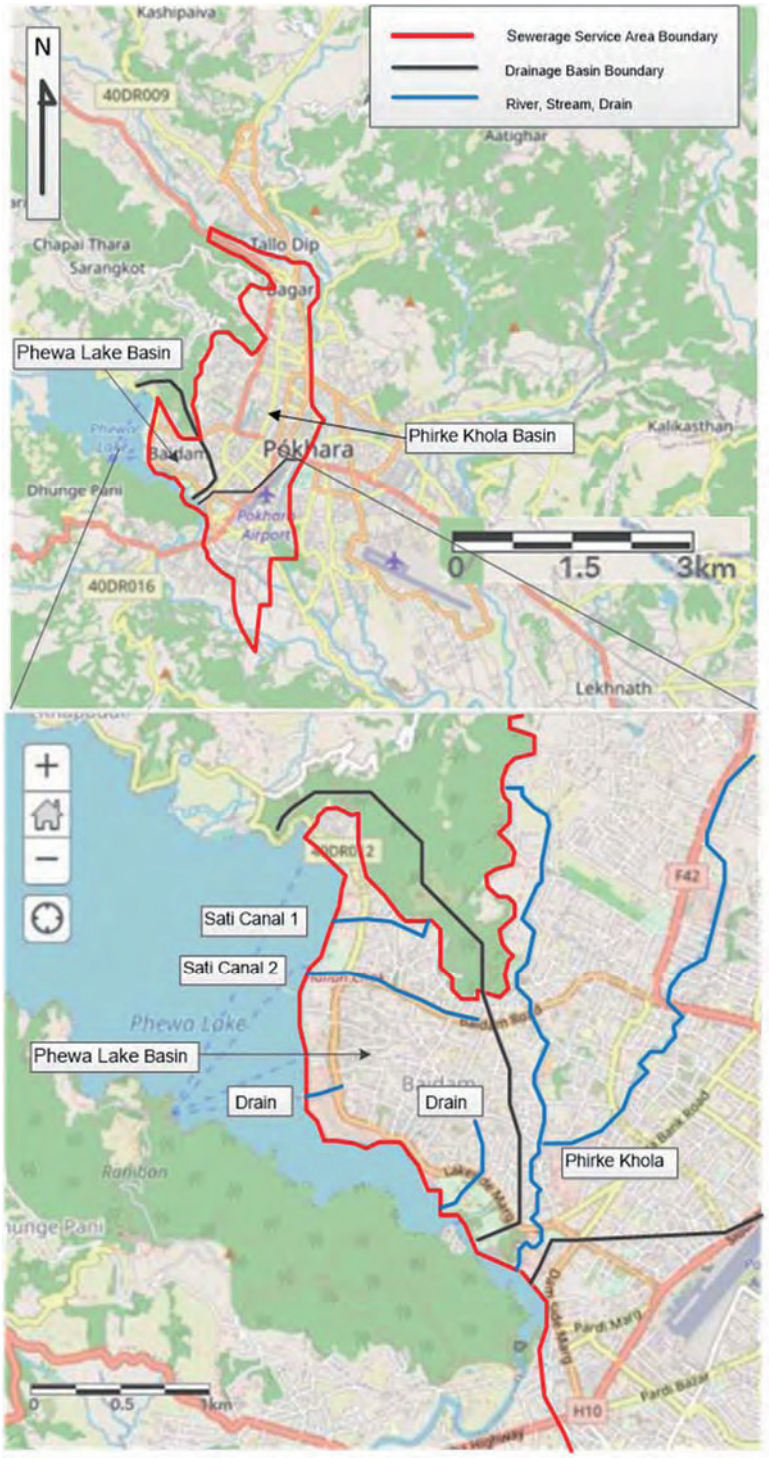
Item	Detailed Design	Remarks
Flow Formula	Manning	
Water Depth	80% (Peak flow)	
Velocity	Maximum: 3.0 m/s Early stage: 0.6 m/s Design: 0.8 m/s	
Minimum Diameter	150 mm	
Manhole Distance	30 m	

Source: JET

A5.2.2 Review of Existing Sewerage Plan

(1) Service Area and Sewage Collection System

The sewerage service area and drainage basins are shown in Figure A5-4.



Source: JET

Figure A5-4 Sewerage Service Area and Drainage Basins

The sewerage service area covers the Lake Phewa basin, Phirke River basin and the southern basin. The Lake Phewa basin has drains and gutters, including Seti canal 1 and 2. The existing plan includes 3,000 house connections at the east bank of Lake Phewa around the sewer route and interception of dry weather flow (DWF) from Seti canal 1 and Phirke River.

If each house discharges sewage directly to road gutters and drains in the city, it is a reasonable collection method for water quality conservation of Lake Phewa.

Table A5-4 shows the results of the survey for the water quality and flow rate of the drains that flowed into Lake Phewa during the dry season of November and December 2021.

No flow was observed in the drains or gutters other than the three canals shown in Table A5-4. In addition, a field survey during the dry season in November 2021 revealed water inflow from the mountains to Seti canal 1 and the tributaries of Phirke River.

Table A5-4 Water Quality and Flow Rate of Drains

Location	E.Coli (CFU/100 mL)	TN (mg/L)	TP (mg/L)	BOD (mg/L)	Q (L/S)
Seti canal 1	10	<0.1	<0.1	9.15	2.83
Seti canal 2	$2x10^3$	0.6	<0.1	11.51	0.65
Phirke River	300	0.28	<0.1	4.33	162

Source: JET

E. coli, nitrogen, phosphorus and BOD measurements indicate that the water quality of drains from the urban areas is not much affected by household wastewater or overflow of septic tanks. Most of the flow in Seti canal 1 comes from the mountains, and Seti canal 2 has an extremely low flow rate.

It is assumed that the spread of on-site treatment with a set of septic and infiltration tanks has decreased the inflow to surface drains and gutters, and the pollutant load from households is entering Lake Phewa through groundwater instead. Since the water quality of Phirke River is not so bad in the dry season and the inflow point to Lake Phewa is close to the outlet river of the lake, it is considered that the impact on the water quality of Lake Phewa is limited.

Under these circumstances, it would be preferable to replace on-site facilities with a separate sewerage system with individual household connections to reduce the inflow from the urban areas to Lake Phewa. The existing sewerage plan is effective where it provides individual connections along the lakeside promenade where sewage is discharged directly to Lake Phewa or infiltrated at the nearby locations and on the Lakeside Road on the inland side.

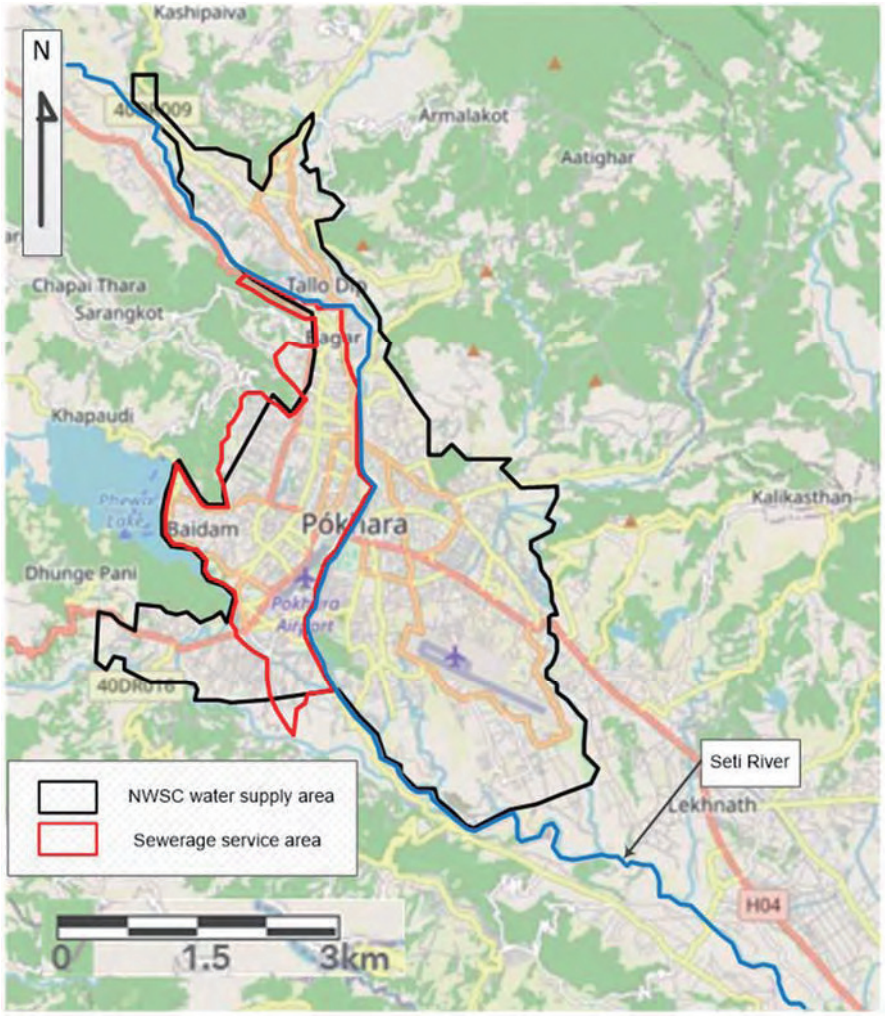
It is considered that interception of flow from the Seti canal will not be effective, and interception from Phirke River may be controversial. If not intercepting surface drains, the load from the non-point sources cannot be captured, However, the treatment plant capacity and the impact of increased wet weather flows can be reduced.

(2) Overall Sewerage Service Area

The existing sewerage plan to preserve the water quality of Lake Phewa is highly prioritized for development, and it will be necessary to conserve the quality of urban rivers, Seti River and groundwater to ensure a sanitary living environment.

It is also necessary to consider the overall service area where a sewerage system should be developed by PMC. This includes taking into consideration population density and efficiency of sewage collection. One option is to consider the current NWSC water supply area for overall sewerage development.

Figure A5-5 shows the existing sewerage service area and NWSC water supply area.



Source: JET

Figure A5-5 Existing Sewerage Service Area and NWSC Water Supply Area

If the NWSC water supply area is included in the overall sewerage service area, another treatment plant should be planned for the service area on the east side of the Seti River. The facilities of the existing plan should be re-designed taking into account the amount of sewage generated in the eastern area that is not included in the existing service area.

(3) Design Parameters

The items in the existing plan that require some clarifications are listed below.

1) Population Projection

A uniform growth rate is used for the entire PMC. It is preferable to use the growth rate for each ward based on the results of the 2021 census.

2) Non-Domestic Wastewater (0.1 l /ha/s, 35% of Domestic Wastewater)

Sewage from tourism is included, but the amount of water used in restaurants and accommodation facilities is included in the unit of domestic wastewater (130LCD) in the water services data[2]. Although it is uniform throughout the PMC, it is necessary to consider the distribution of restaurants and accommodation facilities for sizing the collection network.

3) Groundwater Infiltration

Groundwater infiltration at 15.6% of the sewage amount (domestic + non-domestic) may be high since the new system uses a lot of plastic pipe materials.

[2] Preparatory Survey Report for improvement of Pokhara Water Supply, September 2016

4) Peak Factor

Although it is set at 5 / $P^{1/6}$ (P: population of 1,000), the multiplier of the commonly used Babbit coefficient is 1/5.

5) Diversion Amount

Seti canal: 0.1 m^3/s, Phirke River: 0.15 m^3/s, but it is necessary to consider whether diversion is required.

6) Design Capacity of WWTP

The reasons are unclear for adding 1/3 of diversion amount and using a daily average.

7) Strength of Sewage

SS value of 865 mg/L is quite high for domestic sewage.

(4) WWTP

1) Sewerage Development

MoWS considers the implementation of the existing plan with a high priority. The EIA was approved by MoFE in March 2021. However, there are no concrete steps taken in FWSSMP to implement the project because of staff changes. The fact that PMC is not actively deciding the site for the WWTP is also a matter of concern.

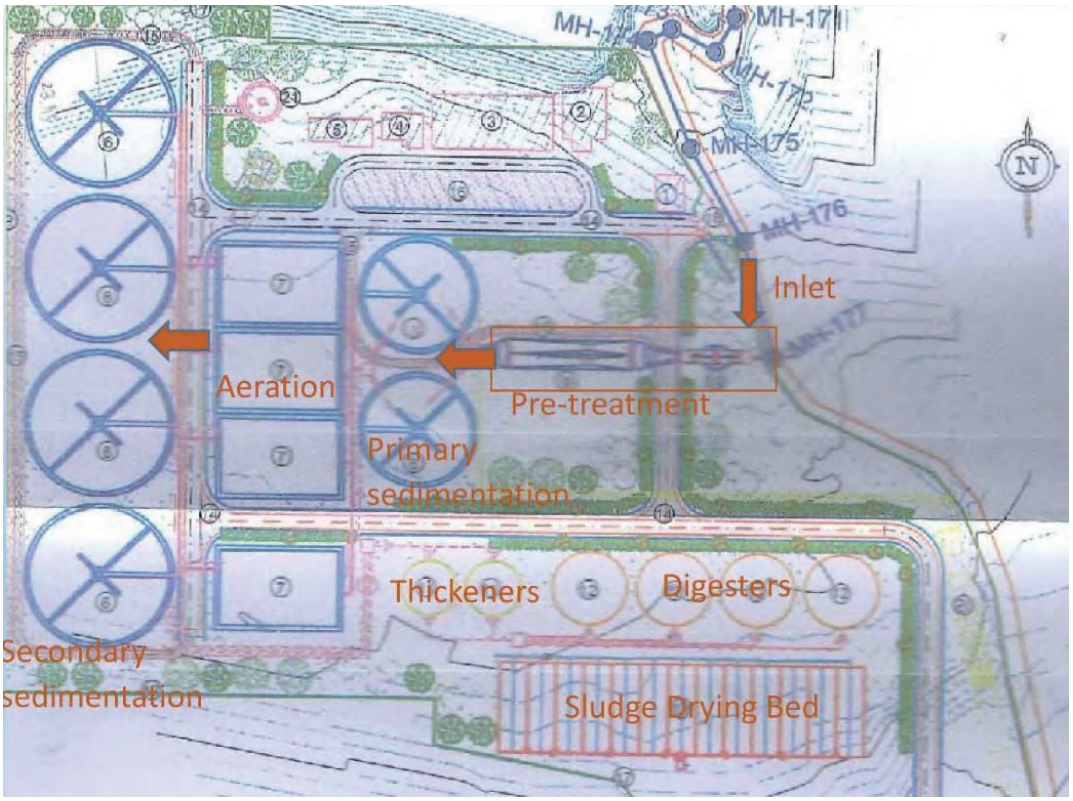
2) WWTP Site

FWSSMP indicated different possible locations for the WWTP along the Furse River, which is more than 100 m below the cliff. The location of the WWTP requires detailed examination taking into consideration on construction, operation and maintenance requirements and feasibility of site acquisition.

3) Wastewater Treatment Process

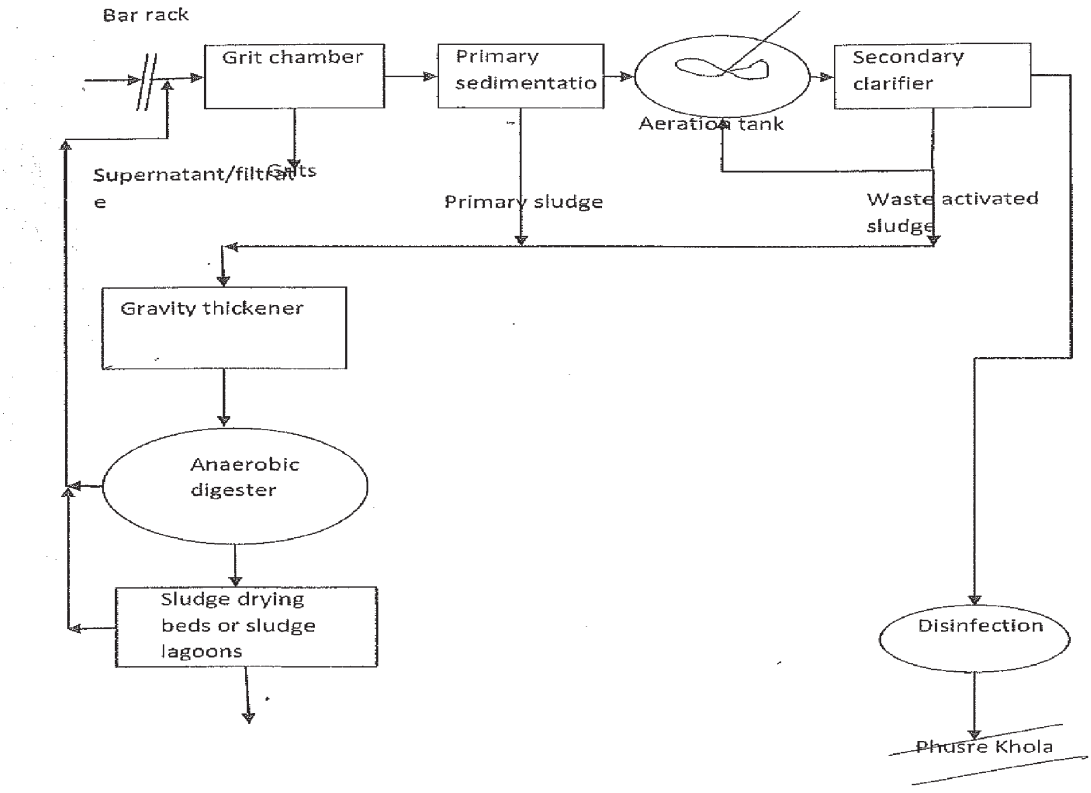
Interviews were conducted to local consultants regarding the detailed designs of WWTP eight years ago. Further, the persons in charge of PMC were changed. Therefore, the background of the consensus at that time is unclear. As shown in the WWTP layout shown in Figure A5-6 and the treatment flow chart diagram shown in Figure A5-7, the standard conventional activated sludge process was adopted, and waste sludge is thickened, digested, and dried on the sludge drying bed.

The design sewage flow is 59,400m^3 per day, and the designed water temperature of the biological reactor is 20°C. The target water quality of inflow and effluent are shown in Table A5-5.



Source: Final report detailed engineering design of Phewa Lake wastewater management project

Figure A5-6 Planned Layout in Wastewater Management Project



Source: Final report detailed engineering design of Phewa Lake wastewater management project

Figure A5-7 Planned Flowchart Diagram in the Wastewater Management Project

Table A5-5 Planned Wastewater and Treated Water Quality in Wastewater Management Project

	Design Influent	Design Effluent	Nepal Guideline
BOD (mg/L)	220	30	< 50
COD (mg/L)		-	< 250
TSS(mg/L)	490	30	< 50
TKN(mg/L)		-	N/A
pH		-	5.5-9
Oil & grease		-	< 10
Ammonia Nitrogen		-	< 50

Source: Final report detailed engineering design of Phewa Lake wastewater management project

The following issues are raised by reviews of the detailed design of WWTP,

- The hydraulic retention time of the reactor is 3.55 hours, which is far shorter than that of the standard activated sludge process.
- The extremely low construction cost of NPR 840 million, including value-added tax.
- The site area is considered too narrow compared to the size of the project.

In addition, the topography of Pokhara City has many undulations, such as deep valleys and hills, and there are already houses in flatlands suitable for the candidate site, and it seems difficult to secure a lump site for the proposed WWTP. Based on these, it is necessary to again obtain agreement with the relevant organizations on the treatment process, construction site, construction cost, etc.

Although conventional activated sludge process was adopted in the detailed design, the review including the sludge treatment process is necessary by preparing the entire plan and the phased construction plan.

A5.3 Status of On-site Sanitation

A5.3.1 Existing System of On-site Sanitation

(1) Laws and Regulations for Septic Tank

Laws and standards of the Septic tank (structure, type, scale, design, installation, inspection, operation management, frequency and method of de-sludge) have not been established for each stage from the design to utilization, and the examination by PMC is also insufficient.

In the process of the building permission for the new construction or renovation of residences, offices, etc., it is required to install a septic tank. But there is no regulation of the specification for the structure and scale of a septic tank and it shall be applied without any penalties even though the construction is not conducted according to the application document.

(2) Installation and Use of Septic Tanks

Table A5-6 shows the result of interviews for Septic tanks users.

The following trends can be found.

- In rural and mountainous areas, kitchen and shower wastewater is being discharged without treatment.
- In urban areas, kitchen and shower wastewater is also treated with Septic tank, but if there is a river etc. near houses, the wastewater is being discharged without treatment in some cases.
- The permeable septic tanks are basically utilized in both households and business office.
- The frequency of de-sludge from the permeable septic tank for household is quite few. The desludge has never been done except the permeable septic tank in the urban area. (There are some cases that septic tanks in the urban area is de-sludge once a year because the tank capacity is insufficient for 30 persons.)
- The actual damage caused by the permeation type septic tank is not a fundamental solution, as the

above-mentioned "insufficient capacity of the septic tank for the number of people using it" in an urban area causes foul odors from the septic tank. However, annual sludge withdrawal was implemented. There was no actual damage caused by permeation-type septic tanks in the areas interviewed in the suburban and mountainous areas.

Table A5-6 Results of Interviews Septic Tanks Users (Urban Area)

Local Characteristics	Urban Area	
Ward name	No.6	No. 6
Number of users	30	10
Number of households used	7	1
House type	Multi-family house	Detached house
Discharge destination of treated water	Penetration	Penetration
Septic tank structure	1 Chamber (Toilet :1)	1 Chamber (Toilet :1)
Years of use	30 years	(Under construction)
Desludge frequency	1 time/ year	(Under construction)
Wastewater to be treated : Toilet	○	○
same as above : Kitchen, shower	○	X Discharged without treatment

Source: JET

Table A5-7 Results of Interviews with Septic Tanks Users (Rural Area)

Local Characteristics	Rural Area				
Ward name	No.,24	No.28	No.28	No.30	No.30
Number of users	4	3	(Not for residential use)	2	5
Number of households used	1	1	(Not for residential use)	1	1
House type	Detached house	Detached house	Public establishment	Detached house	Detached house
Discharge destination of treated water	Penetration	Penetration	Penetration	Penetration	Penetration
Septic tank structure	1 Chamber (Toilet :1)	1 Chamber (Toilet :1)	1 Chamber (Toilet :1)	2 Chamber (Toilet :1) (Kitchen,,Shower:1)	2 Chamber (Toilet :1) (Kitchen,,Shower:1)
Years of use	15 years	21 years	6 years	(Under construction)	(Under construction)
Desludge frequency	No desludge	No desludge	No desludge	(Under construction)	(Under construction)
Wastewater to be treated : Toilet	○	○	○	○	○
same as above : Kitchen, shower	X Discharged without treatment	X Discharged without treatment	(Not for residential use)	○	○

Source: JET

Table A5-8 Results of Interviews with Septic Tanks Users (Mountainous Area)

Local Characteristics	Mountainous Area		
Ward name	No.18	No.18	No.18
Number of users	6	5	(Not for residential use)
Number of households used	1	1	(Not for residential use)
House type	Detached house	Detached house	Public establishment
Discharge destination of treated water	Penetration	Penetration	Penetration
Septic tank structure	1 Chamber (Toilet :1)	1 Chamber (Toilet :1)	1 Chamber (Toilet :1)
Years of use	20 years	5 year	15 ye
Desludge frequency	No desludge	No desludge	No desludge
Wastewater to be treated : Toilet	○	○	○
same as above : Kitchen, shower	X Discharged without treatment	X Discharged without treatment	(Not for residential use)

Source: JET

(3) Structure of the Septic Tank

Underground and the site-casted type is adopted instead of the FRP molded product type.

The standard of the structure of the septic tank for household is consisted by a reinforced concrete for slab, masonry + cement lining for wall, stone and sandbed open type for floor. The bottom slab is not installed, so the treated water and sludge is soaked out underground.

In addition, the septic tank technically has one-chamber, and wastewaters from a kitchen and a shower are mixed in the septic tank in urban areas. In rural and mountainous areas, only toilet's wastewater is treated with septic tank,

In recent years, the two-chamber structure (one chamber for toilet wastewater, one chamber for kitchen and shower wastewater, separation inflow / separation treatment) has also been adopted in urban areas.

(4) Collection and Transportation System of Septic Tank Sludge

The frequency of de-sludge of septic tank from household is about once in 10 to 30 years. However, some new Septic tanks' frequency is once in six months to one year. Because the check of the Septic tank by PMC is insufficient, a small septic tank could be installed for the construction cost reduction and the house-rooms layout.

One private company is carrying out solid waste and de-sludge works from septic tank of the whole city area.

Since there are no laws and standards for the frequency of de-sludge from septic tank, de-sludge work is not conducted constantly. In most cases, the desludge is required when the odor or overflow of the sludge is occurred.

The private company is yearly selected and permitted to undertake the de-sludge work by PMC bidding.

In the de-sludge work, the septic tank is emptied. At the end, the inside of septic tank is washed with water, and the tank is again emptied. Returning the water into septic tank after de-sludge is not performed.

(5) Organization and Operation Status of Collection and Transportation of Sludge in Septic Tanks

There are 17 personnel (2 supervisors, 5 drivers, and 5 assistant workers) who are involved in the collection and transportation of septic tank sludge in the private company. And the private company owns five tractor-towed vacuum tanks ($5m^3$) as the collection and transportation equipment (hereinafter referred to as "collection vehicles").

Five trucks collect and transport for 10 locations per day in average, and considering the one day off per week, there are 3,000 locations per year, of which about 750 are collected from households annually.

Since the Covid-19 pandemic, requests for collection from business establishments have been decreased.

(6) Disposal Status of Septic Tank Sludge

The septic tank sludge is transported to the landfill site, as of 2022, (a corner of the solid waste landfill site in Pokhara), and is thrown into the sun-drying yard where was used as a composting yard before. De-watered sludge in the yard is dumped in the landfill site. Leachate is discharged by gravity through piping into a river.

Photo (1): De-sludge work



Photo (2): De-sludge work
*1 chamber structure

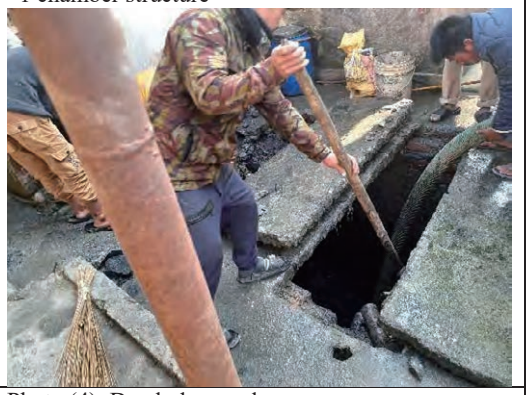


Photo (3): De-sludge work
*2-chamber structure. The partition wall is visible in the center of the opening



Photo (4): De-sludge work
※same as left



Photo (5): Sludge disposal site



Photo (6): Status of dumping into sludge disposal site



Source: JET

(7) Review of Sludge Property for Faecal Sludge

Since septic tanks are installed under the ground and properties and conditions of sludge are not clear, it is decided to use modeling for the facility planning of the WWTP and estimating the treatment process and water quality, etc. Appendix-3 for modeling is referred.

Capacity of 2 m^3 is adopted as the standard septic tank from the result of the interviews, and 1,200 L/day (6 family members, 200 LCD) is assumed as the flow rate.

Result of Analysis:	Inflow:	BOD	1,635mg/L	Effluent:	BOD	394 mg/L
		Total Kj-N	200mg/L		SS	470 mg/L
		Total P	50mg/L		TKN	131 mg/L
		Total Alkalinity	10mmol/L		NH_3	122mg/L
		ISS	1500mg/L			
		SRT	1001days			

Based on the results of the above study, approximately 400 mg/L is assumed as the effluent BOD for the faecal sludge. This is considered to be the average wastewater discharged from septic tanks on a daily basis, including the Phewa Lake catchment area. Therefore, appropriate wastewater management is necessary to improve the water quality and living environment in the area.

A5.4 Sewerage Tariff System, De-sludge and Transportation Tariff for Septic Tank

A5.4.1 Sewerage Tariff System

Sewerage fee is not charged because sewerage has not been introduced. However, based on the results in the Kathmandu Basin, 50% of the water bill can be collected as sewerage fee etc., when the sewerage is installed.

A5.4.2 Septic Tank Sludge Collection Fee

The de-sludge and transportation fee for the sludge from septic tank is charged NPR5,000 per collection from citizens and offices, and is additionally charged NPR 2,000 for requests from remote area. The de-sludge and transportation fee for septic tank sludge is an authorization matter of PMC. Although the amount of expenditure of the private company (labor expense, maintenance cost of the de-sludge and transportation equipment, fuel expense, etc.) is undisclosed, actually it is a profitable business for the company.

A5.5 Necessity of Wastewater Management and Effect of Pollution Load Reduction in Lake Phewa

A5.5.1 Purpose

It is to clarify how much the pollutant load flowing into Lake Phewa will be reduced by installing the sewage treatment facility. For reference, the effect in water quality improvement of Lake Phewa is also presented.

A5.5.2 Method

Table A5-9 shows the assumptions and values used in the trial calculation of the pollution load reduction due to the installation of sewage treatment facilities.

Table A5-9 Assumptions and Values for Trial Calculation of Pollution Load Reduction

No.	Assumptions and Figures	Remarks
1	**Current:** 50% of human waste and 100% of gray water from Ward 1 to 6, 18 and 22 to 24 flow into Lake Phewa.	Sewerage system in Ward 1to 6 and 18 Faecal sludge system in Ward 22 to 24
2	**Future 1 (Without wastewater system):** Same as current situation, 50% of human waste and 100% of	

No.	Assumptions and Figures	Remarks
	gray water generated from Wards 1 to 6, 18 and 22-24 will flow into Lake Phewa. The population will increase as shown in item number 5.	
3	**Future 2 (With wastewater system)** All human wastes and gray water generated from Wards 1 to 6 and 18 will be transported to the WWTP and will not flow into Lake Phewa. All human wastes and gray water generated from Ward 22-24 will be transported to fecal sludge treatment plant and will not flow into Lake Phewa.	
4	Current: Population: 146,183 (Ward 1-6,18), 16,385 (Ward 22-24)	Add 60% in Ward 6 and 30% in Ward 1-5 and 18 as non-domestic water volume rate to the 107,904 people calculated from Reference material 1*
5	Future 1: Population: 219,498 (Wards 1-6,18), 16,385 (Ward 22-24)	Add 60% in Ward 6 and 30% in Ward 1-5 and 18 as non-domestic water volume rate to 161,314 people calculated from Reference material 1*
6	Future 2: Population: 219,498 (Wards 1-6, 18), 16,385 (Ward 22-24)	
7	Unit pollution loads of human wastes: 25.2 (g) per capita per day	Reference material 2*
8	Unit pollution loads of gray water: 20.7 (g) per capita per day	Reference material 2*

Sauce: Refer Appendix-4 for reference materials 1 and 2
Sauce: JET

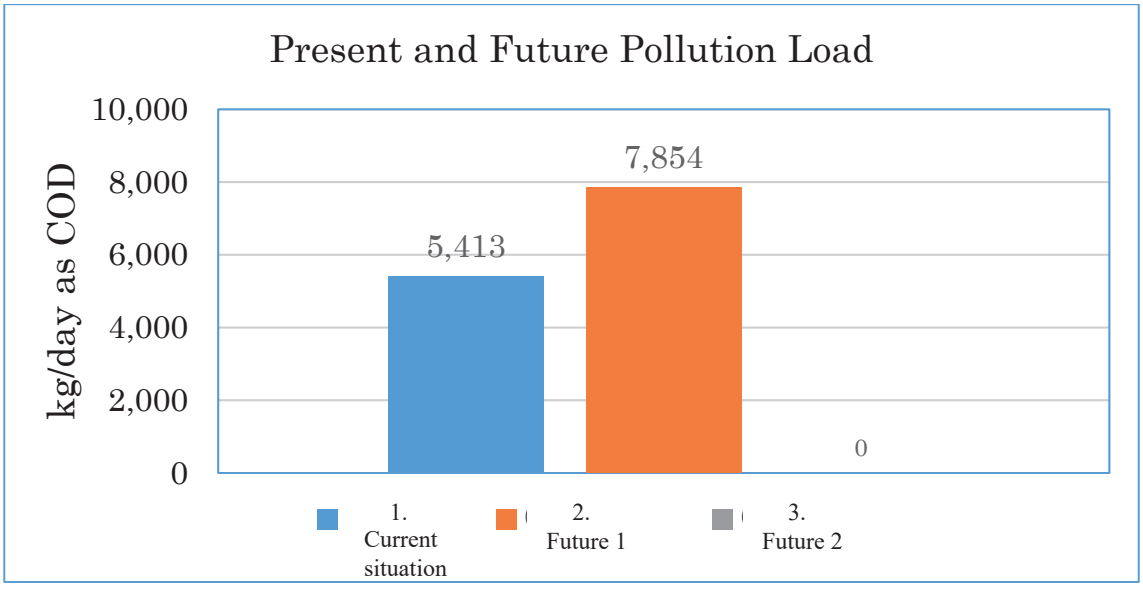
A5.5.3 Trial Calculation Result of Generated Load

The generated load is calculated by multiplying the basic unit of human wastes and gray water shown above by the population. The calculation results are shown in Table A5-10 and Figure A5-8.

Table A5-10 Trial Calculation Result of Generated Load

No.	Generated Load (kg/day)	Year
1. Current situation	(25.2×0.5+20.7×1.0)×(146,183+16,385) = 5,413	2022
2. Future 1 (no maintenance)	(25.2×0.5+20.7×1.0)×(219,498+16,385) = 7,854	2050
3.Future2 (with maintenance)	(25.2×0.5+20.7×1.0)×0 = 0	2050

Sauce: JET



Source: JET

Figure A5-8 Current Status (2022) and Future Pollution Load (2050)

A5.5.4 Considerations

(1) Prerequisites

In calculating the future water quality of Lake Phewa, the following preconditions were set.

1) Assumption 1

The inflow pollution loads into Lake Phewa is divided into the natural source and the domestic source. The natural source is the inflow from the Harpen River and the forest at the upstream side. The domestic source will be the inflow from the urban storm drains, Phirke River and Sedi River. In addition, the domestic source is assumed to flow in from Ward 1 to 6 and 18.

2) Assumption 2

The inflow pollutant load is completely mixed in Lake Phewa and discharged downstream.

3) Assumption 3

Calculate the load amount for each of the dry season and rainy season and weight it by the number of months (dry season: seven months from January to April and October to December, rainy season: five months from May to September).

(2) Data Used and Calculation Method

1) Current Situation

Based on the results of the 2002 JICA survey and the results of the 2021-2022 JET survey, the current inflow is set as shown in Table A5-11.

Table A5-11 Inflow Volume (Current Condition)

Inflow	Dry Season Discharge (m^3/s)	Rainy Season Discharge (m^3/s)	Remarks
Natural source Harpen River	2.4	21	JET Survey results in 2021-2022. Halve the $42m^3/s$ in rainy season for average volume
Forest	0.80	0.80	JICA Survey Results in 2002
Domestic source Urban drainage	0.003	5.27	(Dry season) JET survey results in 2021-2022 (Rainy season) Runoff from urban drainage basins*
Phirke River	0.16	3.91	JET Survey results in 2021-2022
Sedi River	1.04	1.04	JICA Survey Results in 2002

Sauce:* Assuming that the target basin is 50% of Ward 6 (633ha), runoff coefficient is 0.6, and rainfall intensity is 10mm/h
Sauce: JET

The current inflow water quality is set as shown in Table A5-12 based on the 2002 JICA survey results and the 2021-2022 survey results.

Table A5-12 Influent Water Quality (Current Condition)

Inflow	Dry Season Water Quality（COD） (mg/L)	Rainy Season Water Quality（COD） (mg/L)	Remarks
Natural source Harpen River	3.0	5.5	JET Survey results in 2021-2022
Forest	1.0	1.0	JICA Survey Results in 2002
Domestic source Urban drainage	156	16.6	JET Survey results in 2021-2022

Inflow	Dry Season Water Quality（COD） (mg/L)	Rainy Season Water Quality（COD） (mg/L)	Remarks
Phirke River	13	5.1	JET Survey results in 2021-2022
Sedi River	2.1	2.1	JICA Survey Results in 2002

Sauce: JET

2) Future 1: Without Wastewater System

The amount of water inflow without wastewater system is set as shown in Table A5-13.

Table A5-13 Inflow Volume (without Wastewater System)

Inflow	Dry Season Discharge m^3/s	Rainy Season Discharge m^3/s	Remarks
Natural source Harpen River	2.4	21	JET Survey results in 2021-2022. Halve the $42m^3/s$ in wet season for average volume
Forest	0.80	0.80	JICA Survey Results in 2002
Domestice source Urban drainage	0.003	5.27	(Dry season) Measurement results in 2021-2022 (Rainy season) Runoff from urban drainage basins*
Phirke River	0.16	3.91	JET Survey results in 2021-2022
Sedi River	1.04	1.04	JICA Survey Results in 2002

Sauce: JET

Inflow water quality in case of without wastewater system is set as shown in Table A5-14

Table A5-14 Influent Water Quality (without Wastewater System)

Inflow	Dry Season Water Quality（COD） mg/L	Rainy Season Water Quality（COD） mg/L	Remarks
Natural source Harpen River	3.0	5.5	JET Survey results in 2021-2022
Forest	1.0	1.0	JICA Survey Results in 2002
Domestic source Urban drainage	253 =156*1.50*1.08	26.9 =16.6*1.50*1.08	JET Survey results in 2021-2022, considering population growth rate of 1.50 and domestic pollution growth factor 1.08 in 2050
Phirke River	21.1 =13*1.50*1.08	8.3 =5.1*1.50*1.08	
Sedi River	3.4 =2.1*1.50*1.08	3.4 =2.1*1.50*1.08	

Sauce: JET

3) Future 2: With Wastewater System

The inflow volume with wastewater system is set as shown in Table A5-15.

Table A5-15 Inflow Volume (with Wastewater System)

Inflow	Dry Season Discharge m^3/s	Rainy Season Discharge m^3/s	Remarks
Natural source Harpen River	2.4	21	JET Survey results in 2021-2022. Halve the $42m^3/s$ in wet season for average volume
Forest	0.80	0.80	JICA Survey Results in 2002
Domestic source Urban drainage	0	0	All of the sewage generated by the

Inflow	Dry Season Discharge m^3/s	Rainy Season Discharge m^3/s	Remarks
Phirke River	0	0	construction of the sewage treatment facility is transported to the WWTP.
Sedi River	0	0	

Sauce: JET

The influent water quality with wastewater system is set as shown in Table A5-16.

Table A5-16 Influent Water Quality (with Wastewater System)

Inflow	Dry season water quality（COD） mg/L	Rainy season water quality （COD） mg/L	Summary
Natural source Harpen River	3.0	5.5	JET Survey results in 2021-2022
Forest	1.0	1.0	JICA Survey Results in 2002
Domestic source Urban drainage	0	0	All of the sewage generated by the construction of the sewage treatment facility is transported to the WWTP.
Phirke River	0	0	
Sedi River	0	0	

Sauce: JET

4) Calculation formula

Based on the above assumptions 1, 2 and 3, the concentration C of Lake Phewa is calculated as follows for both the dry season and the rainy season.

$$C = (Q1C1 + Q2C2) \ / \ (Q1 + Q2)$$

Where,
Q1:Natural system inflow
Q2:Lifestyle inflow
C1:Natural water quality
C2:Domestic water quality

The average concentration throughout the year is obtained by the following formula.

$$C = ((\underline{Q1C1 + Q2C2})\ W1 + (\underline{Q1C1 + Q2C2})\ W2) \ / \ ((\underline{Q1 + Q2})\ W1 + (\underline{Q1 + Q2})\ W2)$$

Dry season　Rainy season　Dry season　Rainy season

Where,
W1:Dry season weighting factor (=7/12)
W2:Wet season weighting factor (=5/12)

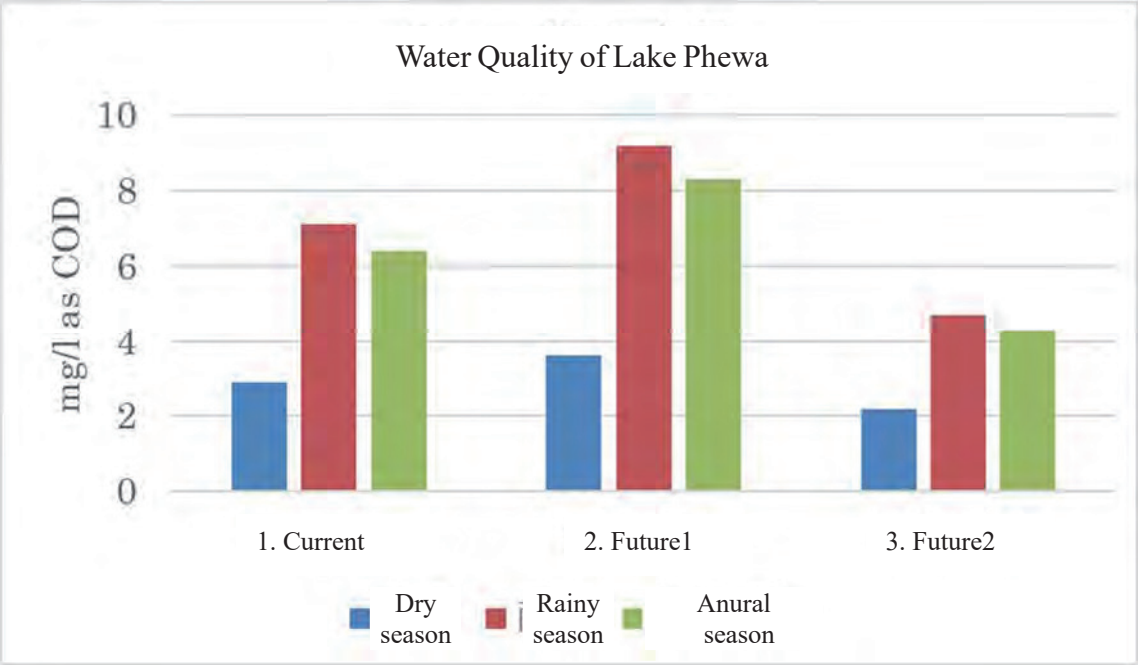
(3) Future Water Quality of Lake Phewa

Table A5-17 below and Figure A5-9 shows the water quality of Lake Phewa for the above three cases of a. Current situation, b. Future 1 (wastewater treatment facility not installed), and c. Future 2 (wastewater treatment facility installed).

Table A5-17 Status of Water Quality of Lake Phewa

Lake Phewa COD mg/L	a. Current Situation	b. Future 1 (without Wastewater System)	c. Future 2 (with Wastewater System)
Dry season	2.9	3.6	2.2
Rainy season	7.1	9.2	4.7
Annual average	6.4	8.3	4.3

Sauce: JET



Sauce: JET

Figure A5-9 Current Status (2022) and Future Water Quality (2050) of Lake Phewa

As per c. Future 2(with wastewater system), we assumed the reduction of pollutant loads by improved septic tank in Ward 22-24. The assumptions are as follows.

- 100% of human wastes and 50% of gray water are conveyed to Harpan River. The unit pollution load per day per capita is 252.*0.5+20.7*1.0=33.3(g).
- Assuming population of septic tank user in Ward 22-24 as 16,385, total pollution loads is 16,385*33.3=545(kg)
- Assuming total natural source pollution load from Harpan River and forest as 53.1(g/sec), Daily loads is 4,587(kg). Based on this value, the ratio of total pollution from septic tank is 11 % (=545/4,587*100). This amount is reduced from the pollution load of Harpen River

(4) Inflow Load to Lake Phewa considering Delivery Rate of Generated Load

Here, the load of the living system obtained from the inflow amount and water quality in "1) Current situation" is as follows. In addition, the weighting of the dry season and the rainy season shown in “4) Calculation formula” is taken into account.

$$(\underline{0.003*156+0.16*13+1.04*2.1})*(7/12) + (\underline{5.27*16.6+3.91*5.1+1.04*2.1})*(5/12) = 48.4 \text{ (g/s)}$$

Dry season Rainy season

48.4*60*60*24 = 4,184 (kg/day)

The value of 4,184 (kg/day) obtained here corresponds to about 77% of the current generated load of 5,413 (kg/day) shown in Table A5-10. This load ratio is called the delivery rate, and it shows a value of 0.6 to 0.8 in general rivers. This time, the target basin is an urban area, and the inflow rate shows a higher value than in the case of general rivers. It is shown that the assumed conditions used in this trial calculation were also appropriate, since the infiltration rate of about 77% is judged to be a reasonable value.

A5.5.5 Conclusion

As a result of examining the effects of developing sewage treatment facilities, the following conclusions can be drawn.

- Pollution load is currently 5,413 (kg/day). It will rise to 7,854 (kg/day) in 2050 if sewage treatment facilities are not installed, but will decrease to 0 (kg/day) if sewage treatment facilities are installed.
- The current water quality of Lake Phewa is 6.4 (mg/L) in terms of COD concentration. This value will be increased to 8.3 (mg/L) in case without wastewater system.
- If sewage treatment facilities are constructed and the impact of sewage inflow into Lake Phewa is eliminated, the COD concentration in Lake Phewa will decrease to 4.3 (mg/L).
- The concentration ratio of the generated pollutant load is estimated to be about 77%. It can be said that the assumptions used in this trial calculation were also appropriate, as the value of the concentration ratio is 0.6 to 0.8 in general rivers.

Part-B Formulating Master Plan for Wastewater Management

B1 Basic Policy on Wastewater Treatment

B1.1 MP Planning Frames

The entire Pokhara City shall be covered. This target population is 858 thousand people in 2025 as described in Section A2.3.1.

B1.2 Subject for Management

Subject for management is wastewater from toilets and miscellaneous wastewater (wastewater from kitchens, shower rooms, etc.).

B1.3 Wastewater Treatment System

Wastewater treatment system is as follows;

- To arrow only sewerage or impermeable septic tank
- To prohibit newly installing permeable septic tank
- To discharge effluent of septic tank in drains, agriculture land, etc. or ground through soak pit
- To treat all of sludge at WWTP or STP
- To arrow continuous use of the existing (permeable) septic tanks, but to put obligation to install impermeable ones at the time of building renewal / rehabilitation

B1.4 Target Year of MP

The basic goals applied to the MP are shown in Table B1-1, and were planned based on the national development plan and PMC development goals.

As mentioned in Chapter A2.6, PMC's development targets are too high numerical targets to achieve by 2030. Therefore, the goals are to be achieved by 2050.

Table B1-1 Basic Goals Applied to MP

Items	National Goal 2030[1]	PMC's Goal 2030[2]	Present 2022	This MP	
				2030	2050
Single Households using modern sanitation[3] facilities (%)	95% Improvement sanitation	100% Modern sanitation	73%(2015)[4]	100% in 2030 Safe for drinking water[5] and 100% impermeable for newer buildings constructed / rehabilitated after the MP	100% impermeable on-site sanitation or connecting to sewerage
Urban households with toilets connected to sewerage (%)	90% incl/. Proper On-site sanitation	100%	0%	100% of the first stage sewerage development by 2030 (to be adjusted in figure, according to zoning plan and investment plan)	100% of Sewerage Zone basically covering the urban area[6]
Population using Toilets (%)	98%	100%	81% (2015)	100%	100%

Source: JET

1 Sustainable Development Goals Baseline Report, National Planning Commission, 2017
2 First 3-year Periodic Plan (2021/22-2023/24)
3 Modern Sanitation: Flash toilet and impermeable septic tank, at least
4 Almost all of septic tanks are penetrate type, so the actual achievement is almost zero.
5 Safe for drinking water: Impermeable septic tank, if shallow wells are used in closing area
6 Urban Area: Other than defined Wards by "Users Committee Formation, Operation and Management Procedure 2018" of PMC

B1.5 Objective Area for Wastewater Management

The objective area for wastewater management is entire area of PMC.

B1.5.1 Sewerage Treatment Area

The sewerage area is inside of blue frame as shown in Figure B1-1, and the urban area is inside of black frame as shown in Figure B1-1 excluding forests and river flooding areas in accordance with the land use situation. The wastewater from the sewerage area is treated by WWTP.

B1.5.2 On-site Sanitation Area

Wastewater in the area other than the sewerage area in Pokhara City is to be treated by on-site sanitation from the view point of City-Wide Inclusive Sanitation (hereinafter referred to as "CWIS").

The impermeable septic tanks shall be adopted for the treatment method of on-site sanitation.

(1) Issues of the Existing Septic Tank (Permeable Type)

As mentioned above, most of the septic tanks are currently permeable type. The issue with this method are as follows;

- As a structural feature, there is only one treatment tank and a permeable type. Therefore, wastewater might soak into the ground before it is sufficiently treated.
- Most of septic tanks do not have inspection or sludge removal openings. Therefore, it is necessary to hole on the top slab in order to inspect inside.
- Miscellaneous wastewater is not subject to treatment, except for few septic tanks.

(2) Wastewater Treatment System by On-site Sanitation

At present, complaints about pollution caused by treated water from permeable septic tanks are not confirmed. Considering the future population growth, it is necessary to consider a sewerage treatment system to meet the above issues of the existing septic tanks. The Wastewater treatment system is examined as shown in Table B1-2.

Table B1-2 Comparison of On-site Sanitation Systems

System	A: Existing Septic Tank (Permeable Type) →Modification to Impermeable Septic Tank	B: Impermeable Septic Tank	C: Jokaso
Treatment method	Anaerobic	Anaerobic	Aerobic
System overview	Modification of the existing septic tank to an impermeable type. Treated water discharges into gutters and farmlands, or soaks into ground from soak pit. If there is no inspection or sludge removal opening, a new one will be installed.	Installation of a new impermeable septic tank Treated water discharges into gutters and farmlands, or soaks into ground from soak pit.	Treatment system similar to Japanese Jokaso Treated water discharges into gutters and farmlands, or soaks into ground from soak pit. In order to treat wastewater aerobically, it is necessary to secure electric power for blowers, etc.

Source: JET

In the three types of treatment systems, treatment systems A and C have the following concerns. Therefore, treatment system B, "newly installed impermeable septic tank" has an advantage.

Although it is necessary for treatment system B to inform residents of the task of de-sludge, this content

covers treatment systems A and C.

[Issues of treatment system A]

- It is difficult to formulate a remodeling plan because there is no design information for the existing septic tank and it does not include in the construction permit application.
- There are many difficulties for modification works because there are construction obstacles such as structures above or around the existing septic tanks, and it is difficult to hole for sludge inspection and collection.
- Miscellaneous wastewater does not inflow into the existing septic tank except for few septic tanks. Therefore, it seems not to secure enough tank capacity to treat miscellaneous wastewater as well.

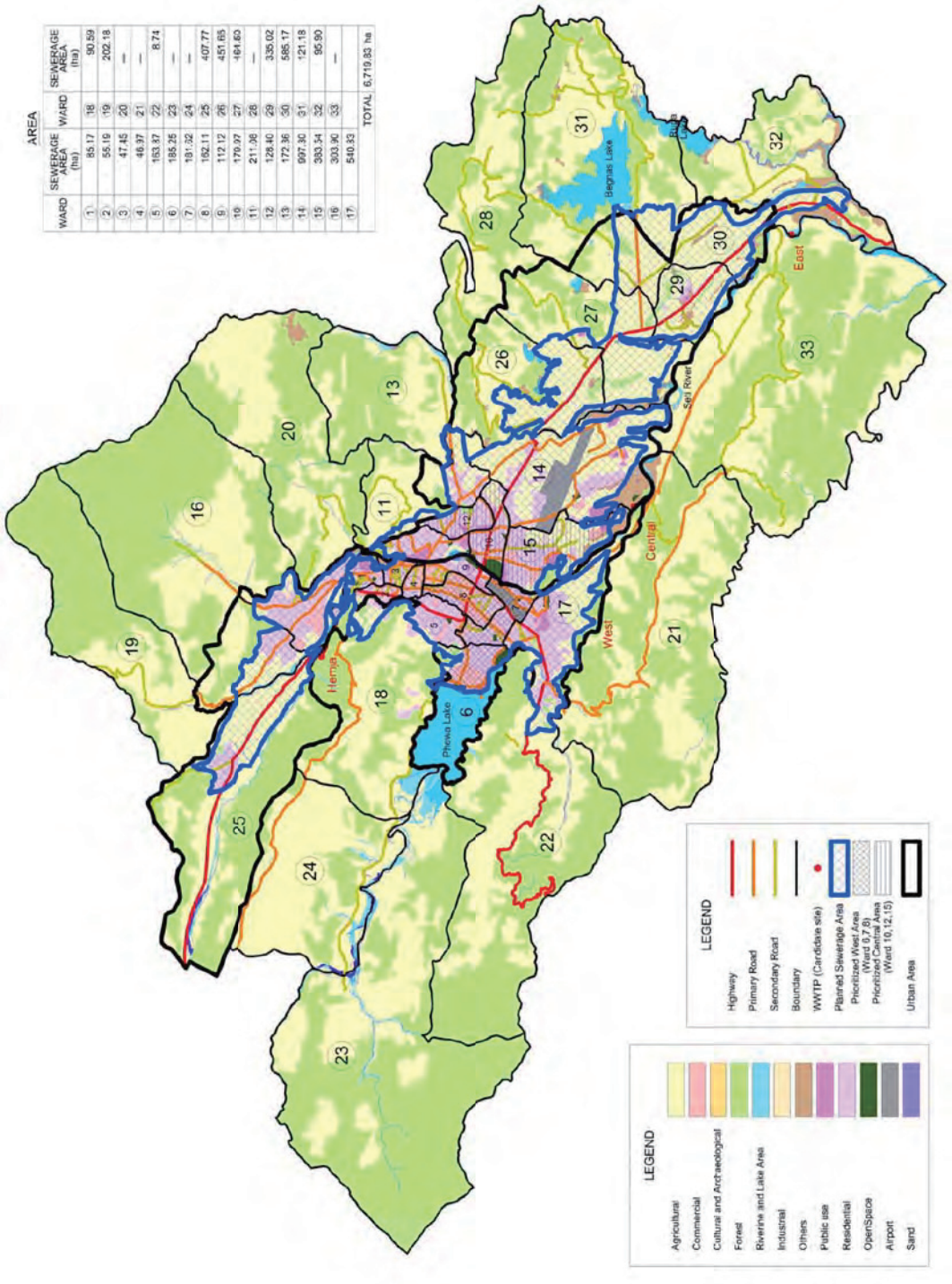
[Issues of treatment system C]

- Construction and maintenance cost for the Jokaso are the highest.
- Appropriate operation management is important to maintain treatment performance, but the existing permeable septic tanks are generally recognized as maintenance-free.

Based on the above, the standard treatment system for on-site sanitation adopts to an impermeable septic tank (Treatment system B) in this MP. However, Treatment system C is preferable if the people install it voluntarily.

B1.5.3 Planned Population of Sewerage and On-site Facility Area

Planned population is estimated by each ward in Figure B1-1. According to the above demarcation of boundaries, the planned population is divided into the sewerage service area and on-site area by ward as shown in Table B1-3 and Table B1-4.



Note: Sewerage Area (Area enclosed by blue line), On-site Facility Area (Pokhara City except sewerage area)
Source: JET

Figure B1-1 Sewerage Area and On-site Facility Area

Table B1-3 Planned Population of Sewerage and On-site Area (1/2)

PMC Total Population

Ward	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2021	20,740	11,670	12,650	12,192	19,791	19,692	17,213	34,867	22,228	24,693	19,674	15,526	22,831	17,681	22,764	27,111	35,766
2025	21,272	12,336	13,057	12,455	22,881	21,348	19,057	36,762	23,507	27,114	21,709	17,212	25,756	20,485	25,713	29,816	41,152
2030	21,938	13,169	13,566	12,784	26,121	23,605	21,300	39,129	25,106	30,179	24,222	19,252	29,412	23,990	29,400	33,197	47,885
2035	22,603	14,002	14,074	13,113	29,362	25,863	23,543	41,497	26,704	33,245	26,736	21,291	33,069	27,496	33,086	36,578	54,618
2040	23,269	14,835	14,583	13,442	32,602	28,120	25,786	43,865	28,303	36,310	29,250	23,330	36,725	31,001	36,772	39,959	61,351
2045	23,934	15,667	15,091	13,771	35,843	30,377	28,029	46,232	29,901	39,375	31,764	25,369	40,381	34,506	40,459	43,340	68,084
2050	24,600	16,500	15,600	14,100	39,083	32,634	30,272	48,600	31,500	42,440	34,278	27,409	44,038	38,011	44,145	46,722	74,817

Population of Sewerage Area

Population Ratio of Sewerage Area	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	90%	100%	70%	100%	100%	80%	100%
Ward	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2021	20,740	11,670	12,650	12,192	19,791	19,692	17,213	34,867	22,228	24,693	17,707	15,526	15,982	17,681	22,764	21,688	35,766
2025	21,272	12,336	13,057	12,455	22,881	21,348	19,057	36,762	23,507	27,114	19,538	17,212	18,029	20,485	25,713	23,852	41,152
2030	21,938	13,169	13,566	12,784	26,121	23,605	21,300	39,129	25,106	30,179	21,800	19,252	20,589	23,990	29,400	26,557	47,885
2035	22,603	14,002	14,074	13,113	29,362	25,863	23,543	41,497	26,704	33,245	24,063	21,291	23,148	27,496	33,086	29,262	54,618
2040	23,269	14,835	14,583	13,442	32,602	28,120	25,786	43,865	28,303	36,310	26,325	23,330	25,707	31,001	36,772	31,967	61,351
2045	23,934	15,667	15,091	13,771	35,843	30,377	28,029	46,232	29,901	39,375	28,588	25,369	28,267	34,506	40,459	34,672	68,084
2050	24,600	16,500	15,600	14,100	39,083	32,634	30,272	48,600	31,500	42,440	30,850	27,409	30,826	38,011	44,145	37,377	74,817

Population of On-site Area

Population Ratio of On-site Area	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	0%	30%	0%	0%	20%	0%
Ward	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
2021	0	0	0	0	0	0	0	0	0	0	1,967	0	6,849	0	0	5,423	0
2025	0	0	0	0	0	0	0	0	0	0	2,171	0	7,727	0	0	5,964	0
2030	0	0	0	0	0	0	0	0	0	0	2,422	0	8,823	0	0	6,640	0
2035	0	0	0	0	0	0	0	0	0	0	2,673	0	9,921	0	0	7,316	0
2040	0	0	0	0	0	0	0	0	0	0	2,925	0	11,018	0	0	7,992	0
2045	0	0	0	0	0	0	0	0	0	0	3,176	0	12,114	0	0	8,668	0
2050	0	0	0	0	0	0	0	0	0	0	3,428	0	13,212	0	0	9,345	0

Source: JET

Table B1-4 Planned Population of Sewerage and On-site Area (2/2)

PMC Total Population

Ward	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total
2021	11,169	14,204	3,369	7,979	6,874	4,203	5,308	16,394	15,233	12,812	3,723	11,980	14,470	9,864	14,275	9,506	518,452
2025	12,221	15,466	3,369	7,979	6,874	4,203	5,308	18,177	16,780	14,364	3,723	13,500	16,215	10,474	15,942	9,506	565,733
2030	13,536	17,043	3,369	7,979	6,874	4,203	5,308	20,406	18,715	16,304	3,723	15,401	18,396	11,236	18,027	9,506	624,281
2035	14,852	18,621	3,369	7,979	6,874	4,203	5,308	22,635	20,649	18,244	3,723	17,301	20,577	11,999	20,112	9,506	682,832
2040	16,167	20,198	3,369	7,979	6,874	4,203	5,308	24,865	22,583	20,184	3,723	19,201	22,759	12,761	22,197	9,506	741,380
2045	17,482	21,776	3,369	7,979	6,874	4,203	5,308	27,094	24,517	22,124	3,723	21,101	24,940	13,524	24,282	9,506	799,925
2050	18,797	23,354	3,369	7,979	6,874	4,203	5,308	29,323	26,451	24,065	3,723	23,001	27,121	14,286	26,367	9,506	858,476

Population of Sewerage Area

Population Ratio of Sewerage Area	30%	65%	0%	0%	10%	0%	0%	80%	80%	85%	0%	100%	90%	30%	20%	0%	Total
Ward	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	
2021	3,351	9,232	0	0	687	0	0	13,115	12,186	10,890	0	11,980	13,023	2,959	2,855	0	423,128
2025	3,666	10,053	0	0	687	0	0	14,542	13,424	12,209	0	13,500	14,593	3,142	3,188	0	464,774
2030	4,061	11,078	0	0	687	0	0	16,325	14,972	13,858	0	15,401	16,556	3,371	3,605	0	516,284
2035	4,455	12,104	0	0	687	0	0	18,108	16,519	15,508	0	17,301	18,520	3,600	4,022	0	567,794
2040	4,850	13,129	0	0	687	0	0	19,892	18,066	17,157	0	19,201	20,483	3,828	4,439	0	619,300
2045	5,245	14,154	0	0	687	0	0	21,675	19,614	18,806	0	21,101	22,446	4,057	4,856	0	670,806
2050	5,639	15,180	0	0	687	0	0	23,458	21,161	20,455	0	23,001	24,409	4,286	5,273	0	722,313

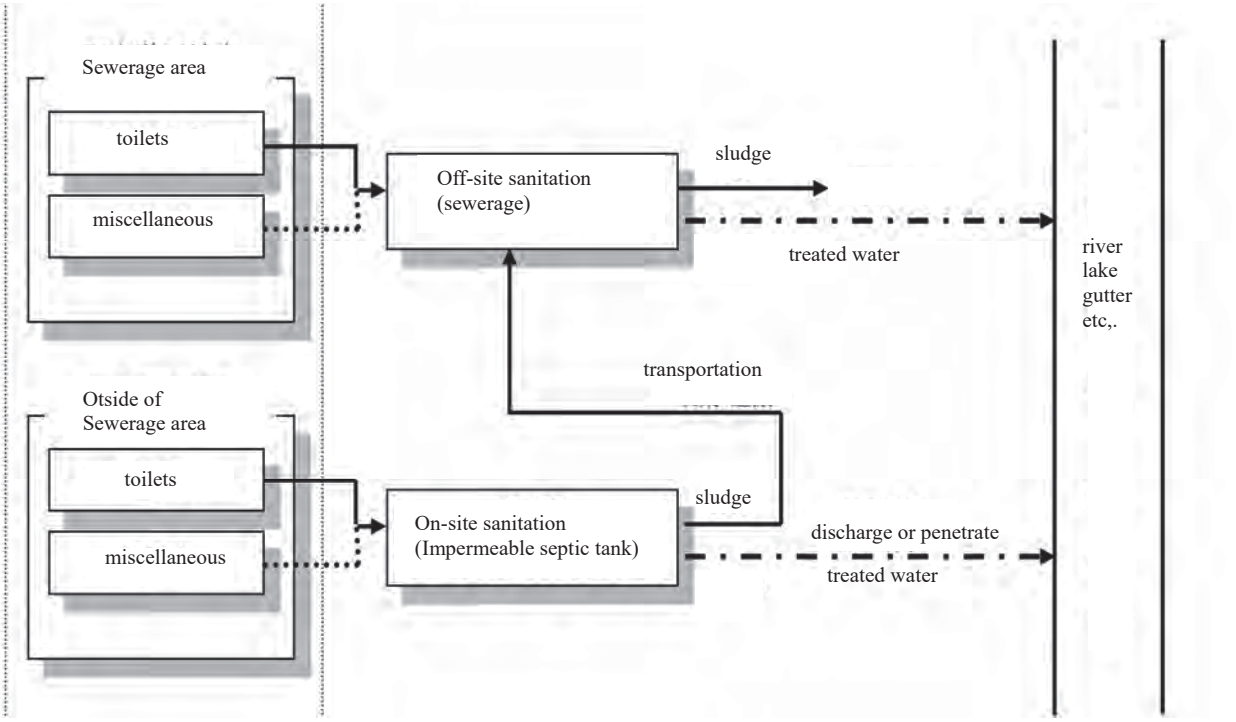
Population of On-site Area

Population Ratio of On-site Area	70%	35%	100%	100%	90%	100%	100%	20%	20%	15%	100%	0%	10%	70%	80%	100%	Total
Ward	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	
2021	7,818	4,972	3,369	7,979	6,187	4,203	5,308	3,279	3,047	1,922	3,723	0	1,447	6,905	11,420	9,506	95,324
2025	8,555	5,413	3,369	7,979	6,187	4,203	5,308	3,635	3,356	2,155	3,723	0	1,622	7,332	12,754	9,506	100,959
2030	9,475	5,965	3,369	7,979	6,187	4,203	5,308	4,081	3,743	2,446	3,723	0	1,840	7,865	14,422	9,506	107,997
2035	10,397	6,517	3,369	7,979	6,187	4,203	5,308	4,527	4,130	2,736	3,723	0	2,057	8,399	16,090	9,506	115,038
2040	11,317	7,069	3,369	7,979	6,187	4,203	5,308	4,973	4,517	3,027	3,723	0	2,276	8,933	17,758	9,506	122,080
2045	12,237	7,622	3,369	7,979	6,187	4,203	5,308	5,419	4,903	3,318	3,723	0	2,494	9,467	19,426	9,506	129,119
2050	13,158	8,174	3,369	7,979	6,187	4,203	5,308	5,865	5,290	3,610	3,723	0	2,712	10,000	21,094	9,506	136,163

Source: JET

B1.5.4 Wastewater Treatment System and Method in the Target Year of MP

Figure B1-2 shows the sewerage treatment system in the target year of MP for Pokhara City. Wastewater management bodies and wastewater treatment policy in each area are shown in Table B1-5 and Table B1-6 respectively.



Source: JET

Figure B1-2 Wastewater Treatment System (Target Year: 2050)

Table B1-5 Wastewater Management Body (Target Year: 2050)

Wastewater Treatment Facility	Target Wastewater	Wastewater Management Body
Sewerage	Toilet wastewater, miscellaneous wastewater	Installation by Pokhara City, etc. O&M by Pokhara City
Impermeable septic tank	Toilet wastewater, miscellaneous wastewater	Installation by Costomers, etc. O&M by Pokhara City

Source: JET

Table B1-6 Wastewater Treatment Policy in Each Area

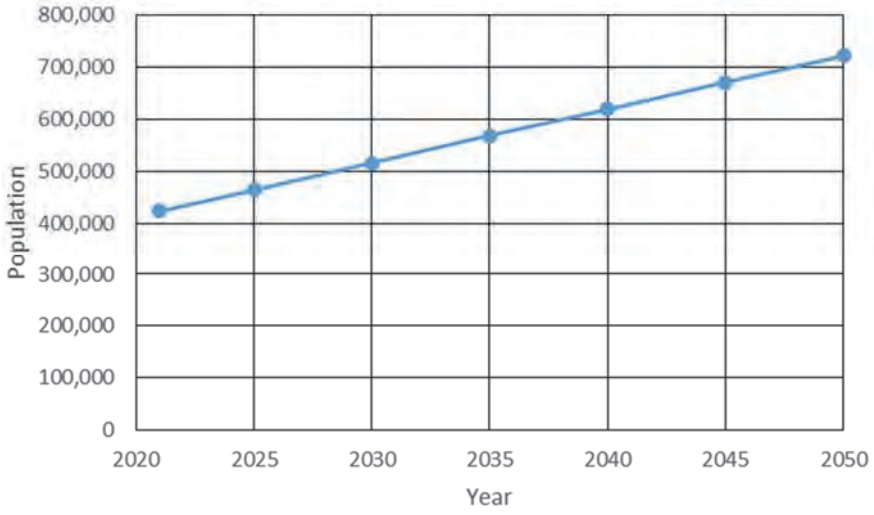
Area		House	Reference Number	Sewerage Connection, Handling of Septic Tank
Sewerage area	Connectable area of sewerage	New house	1-1	- Connect to the sewerage system without installing a new septic tank.
		Rebuilding	1-2	- Connect to the sewerage system without installing a new septic or modifying the existing septic tank. - Basically the existing septic tank shall be removed. - In case of difficulty of movement, wastewater pipe shall connect to the public wastewater pit directly (Not through the existing septic tank).
		Existing house	1-3	- Connect to the sewerage system within the years set by PMC after wastewater system is connectable. - Basically, the existing septic tank shall be removed. - In case of difficulty of movement, wastewater pipe shall connect to the public wastewater pit directly (Not through the existing septic tank).
	Area of Waiting for Sewerage connection	New house	1-4	- New impermeable septic tank shall be installed. - In case sewerage connection is available, see 1-3.
		Rebuilding	1-5	- Either "New impermeable septic tank shall be installed" or "Modification from the existing septic

Area		House	Reference Number	Sewerage Connection, Handling of Septic Tank
				tank to impermeable septic tank" - In case sewerage connection is available, see 1-3.
		Existing house	1-6	- Continuous use of the existing permeable septic tank is available. - In case of rebuilding, see 1-5. - In case sewerage connection is available, see 1-3.
On-site sanitation area		New house	2-1	- New impermeable septic tank shall be installed.
		Rebuilding	2-2	- See 1-5
		Existing house	2-3	- Continuous use of the existing permeable septic tank is available until rebuilding.

Source: JET

B1.5.5 Changes in Population in Sewerage Areas

Figure B1-3 shows the changes of the population in the sewerage area from 2021 to the target year of MP (2050).



Source: JET

Figure B1-3 Changes of Population in Sewerage Area

B2 Off-site (Sewerage) Facility Plan

B2.1 Detailed Survey for Sewerage Master Planning

B2.1.1 Water Consumption

Data obtained from the Nepal Water Supply Corporation (NWSC) and the Water Users' and Sanitation Committees (WUSC) for the period of 2017 to 2022 indicates the following:

- Average consumption in the NWSC supply area was 151 LCD (liter per capita per day). Consumption in the lakeside area of PMC Ward 6 from 2017 to 2019 was 195 LCD. Other than Ward 6, ward wise consumption was ranged from 116 LCD to 161 LCD.
- Consumption in PMC Ward 6 from 2020 to 2021 dropped by 21 % to 154 LCD as tourism declined because of the COVID-19 pandemic.
- Reduction in PMC Wad 7, 17 due to COVID-19 was around 10 %.
- In 2021, consumption in the flat area of Wards 26, 27, 29, 30 serviced by the Lekhnath Water Supply was 116 LCD and consumption in the hilly area of Ward 13 serviced by the Kahun Water Supply was 75 LCD.

NWSC meter reading records are available for 3 separate periods and different wards as shown in Table B2-1. Record No1 is data before COVID-19 pandemic and Records No.2 and 3 are pandemic affected data.

Table B2-1 Meter Reading Record of NWSC

Record No.	Area No.		Period	Data Lines on Spreadsheet
	NWSC Administrative Area	PMC Ward		
1	No. 6～13	Wards 5 to10, Wards 12 to 15, and Ward 17	July 2017- June 2019	681,542
2	No. 1 to 13	Wards 1 to 15, Wards 17 and 18	July 2019 - February 2022	1,346,140
3	No. 25	Wards 16,19	June 2020 - January 2022	31,440

Source: JET

Analysis of all the meter readings is not possible because of the tremendous amount of data. Instead, a representative number of samples were selected randomly from each NWSC administrative area. There are several anomalies in the meter reading records:

- Many meters have a reading of zero indicating no consumption: 42.4% in Record No.1, 55.7% in Record No.2, and 38.1% in Record No.3. There are some cases where the reading is in fact zero and other cases where the meter is damaged or not installed.
- Some connections have a reading of zero scattered periodically throughout the specified period.
- The meter reading interval is not consistent.
- Although there are separate classifications for government, industry, and commercial customers, the number of connections for these are small, and most of them are included in the household category.

Analysis results for Record No.1 before COVID-19 are shown in Table B2-2. Per capita consumption is calculated assuming 4-persons per connection. Examples of calculation sheets are presented in Appendix-5.

NWSC administrative area No.10 (PMC Ward 6) had the highest water consumption per capita and NWSC administrative area No.9 (PMC Wards 7 and 17) had the lowest water consumption per capita. The impact of COVID-19 caused by the decline of the tourist population is evaluated by comparing the sample connections in Record No.1 (pre-pandemic) to those for the same connections in Record No.2 (pandemic affected) for NWSC administrative area No.10 (PMC Ward 6) and NWSC administrative area No. 9 (PMC Wards 7 and 17). Per capita consumption for NWSC administrative area No. 10 dropped to 154 LCD and NWSC administrative area No.9 dropped to 104 LCD which is a reduction of 21% ((1 – 154/195) x100) and 10% ((1 – 104/116x100) respectively. Calculation Sheets are presented in Appendix -6.

The per capita consumption of lakeside PMC Ward 6 is extremely high. This is attributed to the many hotels and tourists that stay in this area. The large amount of wastewater generated in this area must be considered when planning the sewerage system. The average per capita consumption in Table B2-2 excluding PMC Ward 6 is 145 LCD.

Table B2-2 Analysis Results for Record No.1

NWSC Administrative Area No.	PMC Ward	No. of Samples	Consumption (m^3/Connection・Month)			Unit Consumption (LCD)＊
			Max	Min	Average	
6	4,8,9	150	105.8	2.3	18.8	155
7	10,12,13	200	82.0	1.3	17.8	146
8	14,15	150	129.4	1.3	18.4	151
9	7,17	150	80.3	1.5	14.1	116
11	10	150	70.2	1.3	15.2	125
12	7,8	150	66.8	1.4	19.5	160

NWSC Administrative Area No.	PMC Ward	No. of Samples	Consumption (m^3/Connection・Month)			Unit Consumption (LCD)＊
			Max	Min	Average	
13	5,7	150	63.0	2.0	19.5	160
Sub- Total		1,100	129.4	1.3	17.6	145
10	6	150	186.6	1.8	23.7	195
Total		1,250	186.6	1.3	18.4	151

Note: ＊Liter/Capita/Day
Source: JET based of NWSC data

Table B2-3 shows the analysis results for Records 2 and 3 for the period affected by COVID-19. NWSC administrative area No. 5 is the total of all available data, and the others are randomly selected samples. The average per capita consumption is calculated to be 152 LCD.

Table B2-3 Analysis Results for Records No. 2 and 3

NWSC Administrative Area No.	PMC Ward	Sample No.	Consumption (m^3/Connection・Month)			Unit Consumption (LCD)＊
			Max	Min	Average	
25	16,19	100	63.7	4.1	18.8	155
1	1,2	100	91.9	2.1	18.9	155
2	1,2	100	71.8	2.4	19.5	160
3	2,3,4,18	100	68.3	3.4	17.9	147
4	11,12	100	55.5	3.1	16.5	136
5	4,8	76	86.5	1.4	19.6	161
Total		576	91.9	1.4	18.5	152

Note: *Liter/Capita/Day
Source: JET based of NWSC data

Unit consumption is relatively high in areas serviced by the WUSCs where water is supplied by gravity and there is no water charge, e.g. 239LCD in PMC Ward 23. On the other hand, unit consumption in the Lekhnath Water Supply serving the flat area of PMC Wards 26, 27, 29, 30 is 116LCD and consumption in the hilly area the Kahun Water Supply serving Ward 13 is 75LCD in 2021.

B2.1.2 Industrial Wastewater

PMC does not have a list of business establishments; therefore, it is not possible to ascertain with precision the amount of industrial wastewater that could be generated. The survey establishes the following:

- There is an industrial complex (Pokhara Industrial Area) in Ward 10. Seventy-five factories are in operation in 2021, close to the maximum capacity for the area. Groundwater is the sole water source. Water use is 895m^3/day, and discharge of wastewater is 582m^3/day. The daily maximum is the same as the average daily discharge (582m^3/day). Since the average operating time of the factories is 10 hours, the maximum discharge is 58.2m^3/hour.
- The industrial area has a combined sewer system with a single pipeline for wastewater and storm water drainage. There is no information on the discharge point. Black (toilet) water is treated by septic tanks at each factory.
- In addition to factories in the industrial area, 105 companies are registered with Pokhara Chamber of Commerce and Industry. Most of the companies produce wood merchandise such as furniture and arts and crafts products. There are no factories with particularly high discharges and none that pose water quality concerns.
- There are about 450 to 460 factories in PMC other than those in the industrial area. Industrial wastewater is estimated to be about 3,500 m^3/day.

A survey was conducted by the Pokhara Chamber of Commerce and Industry and Pokhara Industrial

Area Management Office located in Ward 10 to understand the actual state of factory effluent.

As of February 2022, 133 companies are registered with the Pokhara Chamber of Commerce and Industry and registered factories are122, excluding service industries and retail shops. According to the Pokhara Chamber of Commerce and Industry, 75% of PMC companies are registered. There are 75 factories in the Pokhara industrial area, of which 17 are registered with Pokhara Chamber of Commerce and Industry.

(1) Pokhara Chamber of Commerce and Industry

The breakdown of the 122 registered factories is shown in Table B2-4. This may not be the full picture as not all companies are registered. Nevertheless, none of the businesses are known to use substantial amounts of water or discharge high concentrations of organic matter or dangerous substances.

However, food manufacturing industries can potentially produce substantially high organic loads, and metal factories may discharge harmful substances. It is necessary to check the quality of wastewater discharged before these types of industries are connected to the proposed sewerage system.

Table B2-4 Factories Registered with Pokhara Chamber of Commerce and Industry

No.	Types of Factories	Products	Total No.
1	Soft drink	Beverage/drinking Water	1
2	Dairy	Milk, curd, ice-cream	10
3	Food processing	Noodles, cakes, baked goods (cakes, biscuits, cookies), spices, beaten rice	4
4	Metal fabrication	Hydro mechanical equipment, aluminum fabrication, machine parts, steel furniture, utensils, transformers	14
5	Plastic	Plastic bottles, recycling	3
6	Packaging	Paper boxes	2
7	Construction	Tiles, concrete poles and blocks, hume pipes	3
8	Woodworking	Furniture, arts and crafts	80
9	Others	Animal feed, oxygen gas, weaving, incense, books, stationary, shoes, soaps	5
Total			122

Source: JET based on the data of Pokhara Chamber of Commerce and Industry

(2) Pokhara Industrial Area Management Office

As of March 2022, 75 factories are operating in the 25.49 ha Pokhara industrial area, where there are other facilities such as banks, clinics, and nursery schools. The breakdown of these factories is shown in Table B2-5.

Table B2-5 Factories in Pokhara Industrial Area

No.	Types of Factories	Products	Total No.
1	Soft drink	Beverage/drinking water	2
2	Dairy	Milk, curd, ice-cream	5
3	Food	Noodles, baked goods (cakes, biscuits, cookies), spices, beaten rice	14
4	Metal fabrication	Hydro mechanical equipment, aluminum fabrication, machine parts, steel furniture, utensils, transformers	23
5	Plastic	Plastic bottles, recycling	4
6	Packaging	Paper boxes	3
7	Construction	Tiles, concrete poles and blocks, hume pipes	6
8	Woodworking	Furniture, arts and crafts	3
9	Others	Animal feed, oxygen gas, weaving, incense, books, stationary, shoes, soaps	15
Total			75

Source: JET based on the data of Pokhara Industrial Area Management Office

Groundwater is used throughout the industrial area. A pumping system run by the management office supplies water to 72 factories, and the other three factories have their own wells. The breakdown of water consumption is shown in Table B2-6.

Table B2-6 Water Consumption in Pokhara Industrial Area

No.	Company	Average Water Consumption (m^3/day)
1	Pokhara Industrial Area Management Office	653
2	Shree Annapurna Foods and Beverage Private Limited	150
3	Shree Himshree Foods Private Limited	12
4	Shree Sujal Dairy Private Limited	80
Total		895

Source: JET

20 factories that are thought to have high water consumption were surveyed. The survey results are shown in Table B2-7.

- These factories consume 698.2m^3/day (242 + 456.2), accounting for 78% (698.2/895) of the total consumption in the industrial area.
- Wastewater discharge, excluding boiler and raw material water, is 450.9m^3/day, and the conversion factor of consumed water to wastewater is about 65% (450.9/698.2).
- Total wastewater discharge from Pokhara industrial area is estimated to be 582m^3/day (895m^3/day x 0.65).
- The maximum hourly wastewater discharge is 58.2m^3/hour assuming an average operating time of 10 hours.

There are 17 factories in the industrial area registered with the Pokhara Chamber of Commerce and Industry. Since the number of factories in the industrial area is 75, the registration rate with the chamber of commerce is about 23%. Since the number of registered factories of the Chamber of Commerce is 122, it is estimated that the number of factories in PMC is approximately 530 (122/0.23). Of these, 75 are in the industrial area, and the rest (455 factories) are outside the industrial area in PMC. Assuming that the wastewater is discharged at the same rate as the industrial area, it is estimated that the total discharge is 3,531m^3/day (582m^3/day x 455/75).

Table B2-7 Water Consumption and Wastewater in Pokhara Industrial Area

No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Products		Drinking Water	Drinking Water	Dairy	milk, curd, ghee, ice-cream, etc.	Milk	Bakery	Bakery	Bakery	Biscuit	Biscuit	Noodles	Noodles	Plastic Bottle Recycling	Oxygen Gas	Oxygen Gas	Concrete	Hume Pipe	Concrete Block	Liquid Soap	Metal	
Water Source (m^3/day)	Own well	150	-	-	80	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	242
	Management office System	-	170	23	-	15	3.35	11	5	7	21		120	22.5	20	18	5	7	4	3	1.35	456.2
	Others	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80
Water Use (m^3/day)	Boiler	-	-	-	-	1.5	-	-	-	-	-	5	80	4.5	-	-	-	-	-	-	-	91
	Raw material	70	60	-	-		1.2	4.4	1	1.4	3	2	15	3.4			3	3.5	3.6	0.6	-	172.1
	Cooling/temperature control	-	-	-	-	-	2.15	-	-	-	-	-	-	6.8	19	12.6	-	-	-	-	-	40.55
	Product treatment /cleaning	80	110	23	-	13.5		6.6	4	5.6	18	2.5	20	6.8	1	5.4	2	3.5	0.4	2.4	1.35	306.05
	Others	-	-	-	-	-	-	-	-	-	-	2.5	5	1.1	-	-	-	-	-	-	-	8.6
Drainage (m^3/day)	Discharge	80	110	23	130	13.5	2.15	6.6	4	5.6	18	4	20	18	1	5.4	2	3.5	0.4	2.4	1.35	450.9
Discharge Water Quality	BOD (mg/l)	-	-	-	50~60	-	-	-	178	-	-	53	98.1,28.8	-	-	-	-	-	-	-	-	-
	COD (mg/l)	-	-	-	150	-	-	-	410	-	-	181	248.1,84.9	-	-	-	-	-	-	-	-	-
	SS (mg/l)	-	-	-	-	-	-	-	383	-	-	240	115,119	-	-	-	-	-	-	-	-	-
	Turbidity (NTU)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	pH	6.9	6.98,7.21	-	-	-	-	-	-	-	-	7	5.5,6.8	-	-	-	-	-	-	-	-	-
Operation Time (hr.)		-	14	-	-	1	12	8	12	8	18	-	-	8	10	5	8	8	10	3	11	10.2

Source: JET

B2.1.3 New Airport (Pokhara Regional International Airport)

Pokhara Regional International Airport with an area of 160.9 ha, is scheduled to open in 2023. The water source is a deep tube well and the amount of water used is estimated to be 390 to 500m^3/month, and the wastewater discharge about 280 to 370m^3 / month (9 to 12m^3/day).[7]

Septic tanks and a WWTP will be constructed and connected to the PMC sewerage system in the future.

B2.1.4 Tourism

- The daily number of international tourists in 2018/2019 was calculated to be 3,800 to 5,000 in October and November.
- The daily number of tourists including domestic tourists is estimated to be 13,300 to 17,800.
- Based on the available hotel accommodation in PMC, the maximum number of visitors per day is about 25,000 persons.

Table B2-8 shows the number of international tourists that visited Pokhara from July 2018 to July 2019. The tourist season peaks in October and November, at 155% of the monthly average.

Table B2-8 International Tourists Visiting Pokhara, Gandaki Province in FY 2018

Date	Number of Tourists			Monthly Fluctuation
	Indian	Other Countries	Total	
JUL/AUG 2018	7,128	13,693	20,821	84%
AUG/SEP 2018	9,184	12,533	21,717	87%
SEP/OCT 2018	13,606	17,538	31,144	125%
OCT/NOV 2018	12,495	26,080	38,575	155%
NOV/DEC 2018	17,525	19,584	37,109	149%
DEC 2018/JAN 2019	12,788	14,526	27,314	110%
JAN/FEB 2019	5,561	14,229	19,790	79%
FEB/MAR 2019	6,008	13,443	19,451	78%
MAR/APR 2019	7,183	14,345	21,528	86%
APR/MAY 2019	8,026	15,522	23,548	95%
MAY/JUN 2019	15,120	10,256	25,376	102%
JUN/JUL 2019	6,314	6,288	12,602	51%
TOTAL	120,938	178,037	298,975	-
Average per month	10,078	14,836	24,915	100%

Source: Province Government, Ministry of Industry, Tourism and Environment, Gandaki Province

Table B2-9 compares the tourism data found the Detailed Engineering Design report (2014), and the Preparatory Study for water supply improvement project in Pokhara (2016), to the data of Gandaki Province.

Table B2-9 Information Sources on International Tourists in Pokhara

	Detailed Engineering Design (2014)	Water Supply Report (2016)	Gandaki Province[8]
No. of tourists (Persons/Year)	176,680 (Tourist Statistics, 2012)	220,000 (Record of 2010) 351,719 (Projection for 2025)	298,975 (Record of 2018/2019)
Average days of stay (Day/Person)	4	2.9	3-4
Days of stay	706,720	638,000 (2010)	896,925-1,195,900

7 Environmental Impact Assessment (EIA) of New Pokhara Regional International Airport, Civil Aviation Authority of Nepal (CAAN), January 2015

8 Province Government, Ministry of Industry, Tourism and Environment, Gandaki Province

	Detailed Engineering Design (2014)	Water Supply Report (2016)	Gandaki Province[8]
(Persons・Day/Year)		1,019,985 (2025)	(2018-2019)
Daily average (Persons/Day)	1,936 (2012)	1,748 (2010)	2,457-3,276 (2018-2019)
		2,794 (2025)	
Daily maximum (Persons/Day)	3,001 (2012)	2,709 (2010)	3,808-5,078 (2018-2019)
		4,330 (2025)	

Source: JET

As shown in Table B2-9, the daily number of international tourists was about 3,808 to 5,078 before the pandemic. Although there is no data to isolate domestic tourist numbers, it is estimated that they are about 2 to 3 times that of international tourists. Assuming domestic tourists are 2.5 times the number of international tourists, the maximum number of tourists per day is estimated to be 13,328 (3,808 x 3.5) to 17,773 (5,078 x 3.5).

There are 324 members in the Pokhara Hotel Association with a participation rate of 40% in November 2021. Calculated by ward there are approximately 814 hotels in PMC. If the average number of beds per hotel is about 30, the total number of beds is calculated to be 24,420. The accommodation capacity for tourists per day is estimated to be 25,000.

B2.2 Sewerage Master Plan

B2.2.1 Target Year

The sewerage master plan uses the same mid (2030) and final (2050) target year as those in the wastewater management master plan.

B2.2.2 Wastewater Collection System

The following types of collection systems are generally employed for comprehensive sewerage systems:

- Interceptor system: wastewater is diverted from existing surface drains and conveyed to interceptor sewers for treatment.
- Combined sewer system: Wastewater and storm water are collected in the same pipe.
- Separate sewer system: Wastewater and storm water are collected in separate pipes.

Table B2-10 shows comparison of the above collection systems.

Table B2-10 Comparison of Collection Systems

Item		Interceptor System		Combined Sewer System		Separate Sewer System	
Construction	Construction	Easy construction of only interceptor sewer	◎	Relatively easy because of 1 network	○	Relatively difficult because of 2 networks	△
	Cost	Cheap	◎	Cheaper than separate system and higher than interceptor system	○	High when 2 networks are constructed.	×
						Cheaper than combined sewer system when only sanitary sewer system is constructed.	○
Effect of Water Environment	Gutters and drains	Water qualities are not improved.	×	Water qualities are improved.	○	Water qualities are improved.	○
	Rivers and lakes	Combined flow including wastewater is flowing into public water bodies	△	Combined flow including wastewater is flowing into public water bodies	△	Wastewater is treated before discharging public water bodies	○
	Intake of water supply	Some influences	△	Some influences	△	No influence	○
perati on		In dry season, sediment settles in pipe	△	In dry season, sediment settles in pipe	△	It is possible to collect all wastewater when	○

Item		Interceptor System		Combined Sewer System		Separate Sewer System	
	Sewer	Overflow measures are required in the future		Overflow measures are required in the future		households connect to the new sewer	
	WWTP	Inflow increases during wet weather potentially leading to process overflow	△	Inflow increases during wet weather potentially leading to process overflow	△	Flows and strength of wastewater are steadier	○
Living condition		Water quality in surrounded gutters and drains are not improved. Maintenance of septic tank is still required. Vacuum tanker for sludge removal from septic tank moves around the town with odour	△	Water quality in surrounded gutters and drains are improved. Maintenance of septic tank is still required. Vacuum tanker for sludge removal from septic tank moves around the town with odour	△	Water quality in surrounded gutters and drains are improved. Living conditions can be improved if resident do not have a septic tank	○

Notes: ◎: particularly excellent, ○: excellent, △: moderate, ×: poor
Source JET

The interceptor system is often employed where gray water and overflow from septic tanks are discharged to the surface drainage system. Combined systems are employed where the surface drainage system has serious problems and both stormwater drainage and wastewater management systems must be constructed simultaneously.

The surface drainage system is functioning relatively well in PMC. Septic tanks with infiltration beds and soak pits for gray water are widely used in PMC and not much wastewater is flowing in surface gutters and drains. Most of the organic load from wastewater discharge is reaching the public water body through the groundwater system. BOD5 of Seti canal and Phirke River at inflow points to Lake Phewa in the dry season is 9.15 mg/L and 4.33 mg/L respectively.

Under the above conditions, a separate system with proper connections for both black and gray water is employed in this plan.

B2.2.3 Sewerage Treatment Areas and Candidate Sites for WWTPs

Since it is necessary to construct sewers from the downstream, if the treatment area is enlarged, the initial investment will be large and the effect will be delayed, resulting in poor efficiency. On the other hand, WWTPs benefit from economies of scale, so even if the treatment area is made smaller and the number of treatment plants increased, the efficiency will drop.

Treatment areas should be set in consideration of topography, priority of wastewater treatment and efficiency. It is also important to designate the areas with high priority and development efficiency as one treatment area at the present time, and to develop them as soon as possible to accelerate the manifestation of effects. Areas with high population density in terms of load reduction and the Lake Phewa basin in terms of water quality conservation have priority and development efficiency.

Table B2-11 shows the population density calculation for each ward in the sewerage planning area at present and target years of 2030 and 2050. In the calculation, airport (48ha) in Ward 7, industrial park (25.49ha) in Ward 10, and new airport (160.9ha) in Ward 14 are excluded from the planned sewerage area of Ward.

Table B2-11 Calculation of Population Density for Ward

Ward		1	2	3	4	5	6	7	8	9
Area (ha)		85.17	55.19	47.45	46.97	163.87	185.25	133.62	162.11	112.12
Population (Persons)	2021	20,740	11,670	12,650	12,192	19,791	19,692	17,213	34,867	22,228
	2030	21,938	13,169	13,566	12,784	26,121	23,605	21,300	39,129	25,106
	2050	24,600	16,500	15,600	14,100	39,083	32,634	30,272	48,600	31,500
Population Density (persons/ ha)	2021	244	211	267	260	121	106	129	215	198
	2030	258	239	286	272	159	127	159	241	224
	2050	289	299	329	300	239	176	227	300	281
Ward		**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Area (ha)		154.48	211.08	128.4	172.36	836.4	383.54	303.9	540.83	90.59
Population (Persons)	2021	24,693	17,707	15,526	15,982	17,681	22,764	21,688	35,766	3,351
	2030	30,179	21,800	19,252	20,589	23,990	29,400	26,557	47,885	4,061
	2050	42,440	30,850	27,409	30,826	38,011	44,145	37,377	74,817	5,639
Population Density (persons/ ha)	2021	160	84	121	93	21	59	71	66	37
	2030	195	103	150	119	29	77	87	89	45
	2050	275	146	213	179	45	115	123	138	62
Ward		**19**	**22**	**25**	**26**	**27**	**29**	**30**	**31**	**32**
Ares (ha)		202.18	8.74	407.77	451.65	464.5	335.02	585.17	121.18	95.9
Population (Persons)	2021	9,232	687	13,115	12,186	10,890	11,980	13,023	2,959	2,855
	2030	11,078	687	16,325	14,972	13,858	15,401	16,556	3,371	3,605
	2050	15,180	687	23,458	21,161	20,455	23,001	24,409	4,286	5,273
Population Density (persons/ ha)	2021	46	79	32	27	23	36	22	24	30
	2030	55	79	40	33	30	46	28	28	38
	2050	75	79	58	47	44	69	42	35	55

Source: JET

Based on Table B2-11, Wards are classified by population density in Table B2-12.

Table B2-12 Level of Population Density for Wards

Year		2021	2030	2050
Ward of Population Density Level	More than 200 Persons/ha	1,2,3,4,8	1,2,3,4,8,9	1,2,3,4,5,7,8,9,10,12
	100 to 200 Persons/ha	5,6,7,9,10,12	5,6,7,10,11,12,13	6,11,13,15,16,17,
	Less than 100 Persons/ha	11,13,16,17,14,15,18,19, 22,25,26,27,29,30,31,32	14,15,16,17,18,19,22, 25,26,27,29,30,31,32	14,18,19,22,25,26, 27,29,30,31,32

Source: JET

The urban area of PMC is largely divided into four districts by three rivers (Sati River, Kali River, and Bijaypur River). The elevations of the rivers bed varies from 20 to 40 m deep.

According to Table B2-12, Ward 1-13 in 2030 have population density of more than 100 persons/ha. Ward 1-9 are located west of Sati River and basin of Lake Phewa. Therefore, the area west of Sati River and east of Lake Phewa is the area with the highest priority and efficiency for sewerage development, and it is conceivable to concentrate on sewerage development as one treatment area.

The area with the next highest efficiency is the area including Wards 10 to 13, geographically east of the Sati River and west of the Bijaypur River. Ward 16, 19, 25 in the north and Wards 27, 29, 30, 32, 32 in the east do not have high population densities according to current estimates. Therefore, it is recommended to use a separate treatment area. However, Wards 16 and 19 are easily connect to Ward 1 by water pipe bridge, so the two wards include the same treatment area of Ward 1.

Under the above situation, following 4 treatment areas shown in Figure B2-1 are proposed taking into consideration the topographical conditions, priority for sewerage development, and cost efficiency:

- West Area: West side of the Sati River (Wards 1 to9, Wards16 to19, and Ward 22)
- Central Area: Between Sati River and Bijaypur River (Ward1, and Wards 10to15)
- Hemja Area: Northern area (ward 25)
- East Area: East side of Bijaypur River (wards 26, 27, and Wards 29 to32)

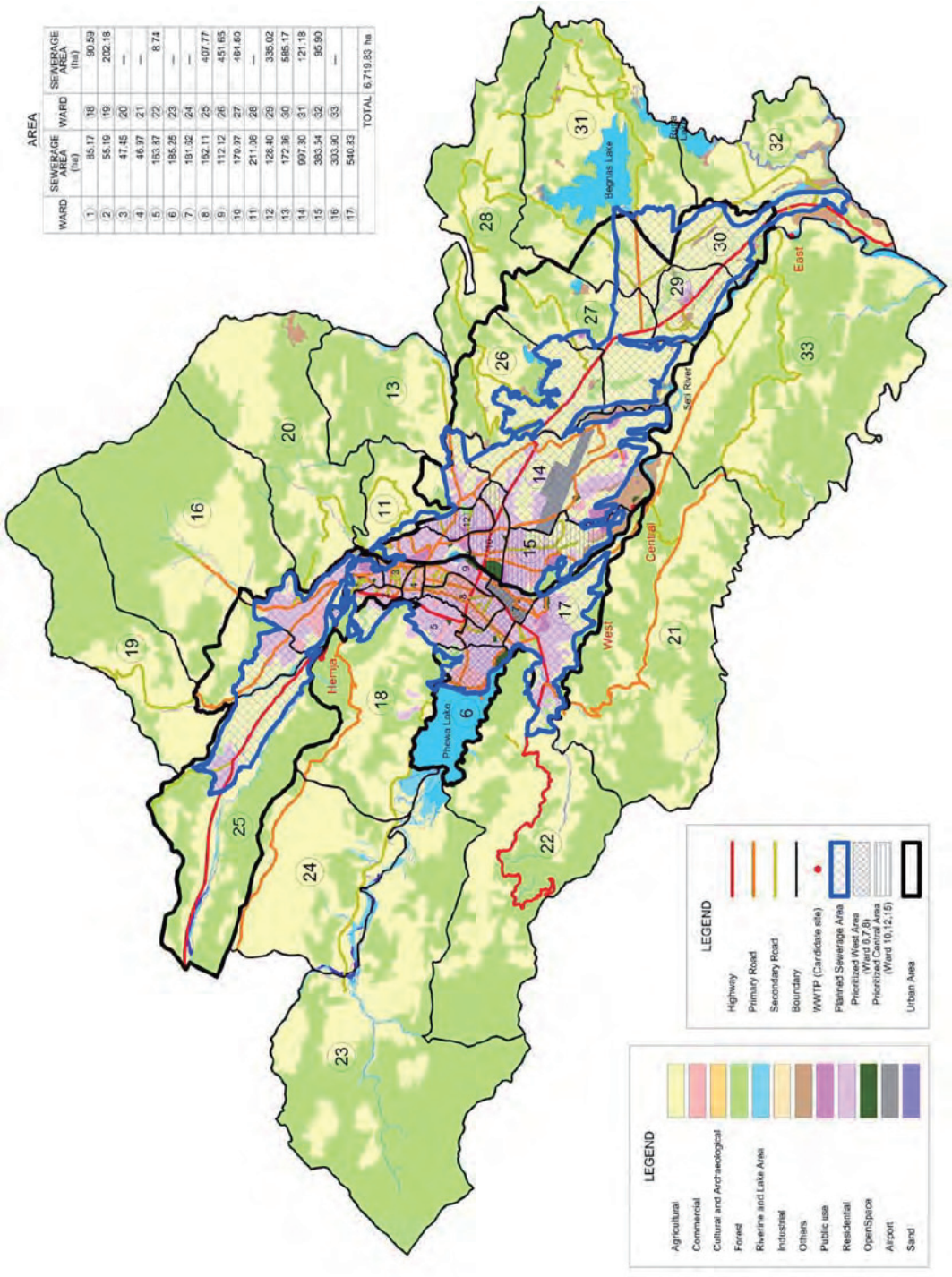
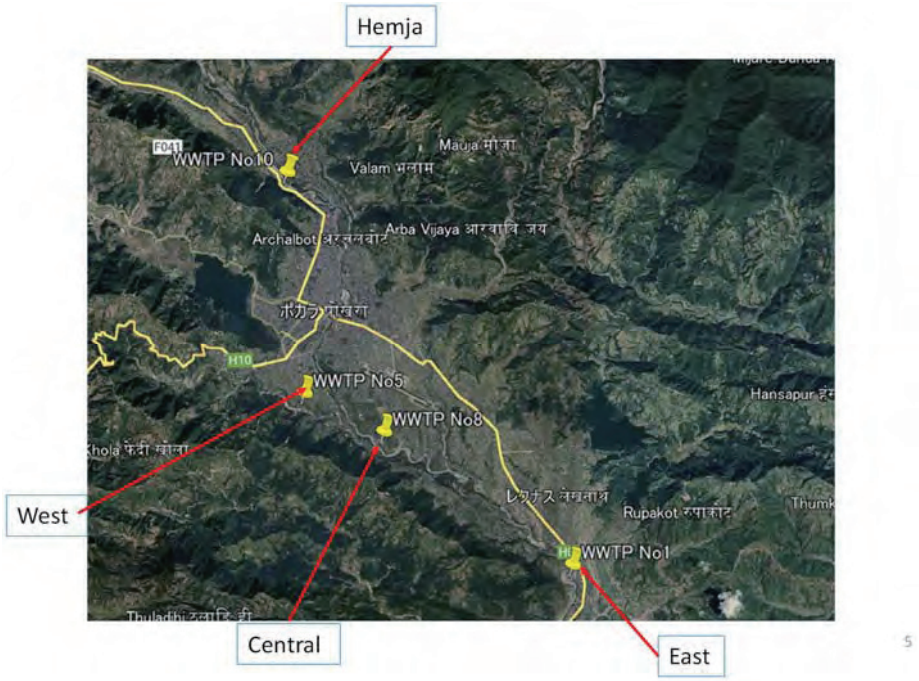


Figure B2-1 Sewerage Treatment Areas

Source: JET

A WWTP site has been identified for each treatment Area as shown in Figure B2-2.



Source: JET

Figure B2-2 Candidate Sites for WWTPs

B2.2.4 Wastewater Estimate

(1) Planned Population

Populations in each treatment Area are calculated based on the population inside the sewerage treatment area (Figure B2-2) as shown in Table B2-13 to Table B2-16.

Table B2-13 Planned Population of West Area

Ward	1	2	3	4	5	6	7
2021	20,740	11,670	12,650	12,192	19,791	19,692	17,213
2025	21,272	12,336	13,057	12,455	22,881	21,348	19,057
2030	21,938	13,169	13,566	12,784	26,121	23,605	21,300
2035	22,603	14,002	14,074	13,113	29,362	25,863	23,543
2040	23,269	14,835	14,583	13,442	32,602	28,120	25,786
2045	23,934	15,667	15,091	13,771	35,843	30,377	28,029
2050	24,600	16,500	15,600	14,100	39,083	32,634	30,272

Ward	8	9	16	17	18	19	22	Total
2021	34,867	22,228	21,688	35,766	3,351	9,232	687	241,767
2025	36,762	23,507	23,852	41,152	3,666	10,053	687	262,085
2030	39,129	25,106	26,557	47,885	4,061	11,078	687	286,986
2035	41,497	26,704	29,262	54,618	4,455	12,104	687	311,887
2040	43,865	28,303	31,967	61,351	4,850	13,129	687	336,789
2045	46,232	29,901	34,672	68,084	5,245	14,154	687	361,687
2050	48,600	31,500	37,377	74,817	5,639	15,180	687	386,589

Source: JET

Table B2-14 Planned Population of Central Area

Ward	10	11	12	13	14	15	Total
2021	24,693	17,707	15,526	15,982	17,681	22,764	114,353
2025	27,114	19,538	17,212	18,029	20,485	25,713	128,091
2030	30,179	21,800	19,252	20,589	23,990	29,400	145,210
2035	33,245	24,063	21,291	23,148	27,496	33,086	162,329
2040	36,310	26,325	23,330	25,707	31,001	36,772	179,445
2045	39,375	28,588	25,369	28,267	34,506	40,459	196,564
2050	42,440	30,850	27,409	30,826	38,011	44,145	213,681

Source: JET

Table B2-15 Planned Population of Hemja Area

Ward	25	Total
2021	13,115	13,115
2025	14,542	14,542
2030	16,325	16,325
2035	18,108	18,108
2040	19,892	19,892
2045	21,675	21,675
2050	23,458	23,458

Source: JET

Table B2-16 Planned Population of East Area

Ward	26	27	29	30	31	32	Total
2021	12,186	10,890	11,980	13,023	2,959	2,855	53,893
2025	13,424	12,209	13,500	14,593	3,142	3,188	60,056
2030	14,972	13,858	15,401	16,556	3,371	3,605	67,763
2035	16,519	15,508	17,301	18,520	3,600	4,022	75,470
2040	18,066	17,157	19,201	20,483	3,828	4,439	83,174
2045	19,614	18,806	21,101	22,446	4,057	4,856	90,880
2050	21,161	20,455	23,001	24,409	4,286	5,273	98,585

Source: JET

(2) Method for Wastewater Estimation

The amount of wastewater consists of domestic flow (DF), non-domestic flow (NDF), and infiltration /intrusion (I/I).

DF is calculated as follows:

DF= (Population) x (Unit Domestic Water Consumption) x (Conversion Factor)
where Conversion Factor = DF/Water Consumption

Non-Domestic Flow (NDF) consists of commercial, industrial, and institutional wastewater. NDF is generally calculated by NDF ratio, which is a percentage of DF. Infiltration and intrusion (I/I) is calculated based on the ratio of generated wastewater (DF + NDF).

(3) Unit Domestic Water Consumption and Unit Domestic Wastewater

Domestic water consumption is usually based on water supply data or information contained in the water supply plan. Table B2-17 shows the unit water consumption from four different data sources: NWSC Ward 9 (PMC Wards 7 and 17), which has the lowest per capita water consumption in the NWSC water

supply area, water supply data from WUSC, unit consumption from the NWSC water supply plan[9], and the unit consumption value in the present Detailed Design (D/D).

Table B2-17 References for Unit Domestic Water Consumption

Item	LCD	Remarks
NWSC Ward 9		
Before Covid-19	116	PMC Wards 7,17 (2018)
During Covid-19	104	PMC Wards 7,17 (2020)
Supply data of WUSC	75	PMC Ward 13 (out of sewerage area)
	116	PMC Wards 26,27,29,30
Water supply plan of NWSC	120	Target Year: 2025
Present D/D	130	Target Year: 2040

Source: JET

The target year of the water supply plan is 2025, after which there is no plan to increase production. Unit domestic consumption is set according to the water supply plan and slightly increases in the future as follows:

2030: 120LCD
2050: 130LCD

While in arid regions, mean sewage flows may be as little as 40% of water consumption, according to Indian Manual[10], in well developed areas; flows may be as high as 90%. Sri Lank standard[11] stipulates that in Asia, conversion factors typically fall within the range 70 to 90%. An average return ratio of 80 % is probably realistic for urban areas in Sri Lanka unless field survey data indicate otherwise.
In this plan, the conversion factor for domestic wastewater employs 80%, and unit domestic wastewater is set as follows:

2030: 96LCD
2050: 104LCD

(4) Non-domestic Wastewater Ratio

According to NWSC data, the ratio for lakeside Ward 6 is about 60% ((195-120)/120x100), and the others are 0 to 34% (116-161LCD) with average of 26%. Therefore, non-domestic wastewater ratio of Ward 6 is set at 60%, and the other areas are set at 30%.
Industrial wastewater is equivalent to wastewater of 36,781 people (= 3,531m^3/0.096), which is 8.7% of the planned area population in 2021 (423,128 people). In addition, as described in the section on tourist population, the maximum number of tourists is 25,000 per day, which is 5.9% of the population of the planned area (423,128). These industrial wastewater and wastewater from tourist population are considered to be included in the non-domestic water rate of 60 % (Ward 6) and 30 % (Other Wards).

(5) Wastewater Discharge

Wastewater entering the sewer system is estimated in the detailed survey and summarized in Table B2-18. The value for Pokhara industrial area is calculated from the factory survey. Wastewater from the new international airport is estimated to be 280 to 370m^3/month, and 325m^3/month (11m^3/day) is taken as the daily average. The daily maximum is set at 370m^3/month (12m^3/day). Peak flow is calculated assuming the operating time for the airport to be 10 hours.

9 Preparatory Survey Report for improvement of Pokhara Water Supply, September 2016
10 Manual on Sewerage and Sewage Treatment System, Ministry of Urban Development, New Delhi, Central Public at Health and Environmental Engineering Organization in Collaboration with Japan International Cooperation Agency, November 2013
11 Design Manual D7 Wastewater Treatment, March 1989, Water Supply and Sanitation Sector Project □USAID SRI LANKA PROJECT 383-0088□

There is no development plan formulated for the existing airport at present. If there is any future development, the amount of wastewater discharge will be assumed to be that of Ward 7, where the existing airport is located. As shown in Table B2-19, the daily average wastewater discharge for the existing airport site is calculated as 982m^3/day in 2030 and 1,511m^3/day in 2050.

Table B2-18 Wastewater Discharge by Location

Facility	Item	2030	2050
Pokhara industrial area	Daily average	581 m^3/day	581 m^3/day
	Daily maximum	581 m^3/day	581 m^3/day
	Peak flow	58.1 m^3/hour	58.1 m^3/hour
New airport	Daily average	11 m^3/ day	11 m^3/ day
	Daily maximum	12 m^3/ day	12 m^3/ day
	Peak flow	1.2 m^3/ hour	1.2 m^3/ hour
Site of the present airport	Daily average	982 m^3/ day	1,511 m^3/ day
	Daily maximum	1,178 m^3/ day	1,813 m^3/ day

Source: JET

Table B2-19 Wastewater Calculations for Existing Airport Site

No.	Item	Unit	2030	2050	Remark
A	Population	Person	21,300	30,272	
B	Unit Water Consumption	m^3/capita/day	0.12	0.13	Water Supply Plan 2025
C	Return Ratio	-	0.8	0.8	
D	Unit Domestic Wastewater	m^3/capita/day	0.096	0.104	D=B x C
E	Domestic Flow	m^3/day	2,045	3,148	E = A x D
F	Non-Domestic Ratio	-	30%		
G	Non-Domestic Flow	m^3/day	613	944	
H	Generated Wastewater (Daily Average)	m^3/day	2,658	4,093	H= E + G
I	Ward 7 area	ha	130		
J	Airport Site (existing)	ha	48		
K	Daily Average Airport Site (existing)	m^3/day	982	1,511	K = H / I x J

Source: JET

(6) Fluctuation

Fluctuation of wastewater flow is figured out as shown in Table B2-20 based on the 2025 water supply plan and the Indian manual.[12]

Table B2-20 Wastewater Flow Fluctuation

Item	Ratio	Application	Remarks
Daily maximum	1.2 times daily average	WWTP	Water Supply plan, 2025
Peak flow	2.25 times daily average	Collection system (sewers and pumps)	Indian manual

Source: JET

12 Manual on Sewerage and Sewage Treatment System, Ministry of Urban Development, New Delhi, Central Public at Health and Environmental Engineering Organization in Collaboration with Japan International Cooperation Agency, November 2013

(7) Infiltration/intrusion

The Indian manual6 states 10% or less of the design sewage volume, and the Japanese guidelines[13] set 10% to 20% of the maximum daily sewage volume. Since the new sewerage system uses a lot of plastic pipes, the infiltration at the joints will not be significant. In this plan, 10% of the daily maximum is employed for I/I.

(8) Wastewater Volume

Based on the above, wastewater volume for each treatment area in the target year of 2050 is calculated as shown in Table B2-21.

Table B2-21 Wastewater Volume per Treatment Zone

No.	Item	Unit	West	Hemja	Central	East	Total	Remark
A	Population	Person	386,589	23,458	213,681	98,585	722,313	
B	Unit Water Consumption	m^3/capita/day	0.13				-	Water Supply Plan 2025
C	Return Ratio	-	0.8				-	
D	Unit Domestic Wastewater	m^3/capita/day	0.104				-	D=B x C
E	Domestic Flow	m^3/day	40,205	2,440	22,223	10,253	75,121	E = A x D
F	Non-Domestic Ratio	-	Ward 6: 60% Other Ward : 30%				-	
G	Non-Domestic Flow	m^3/day	13,080	732	6,667	3,076	13,812	West: Ward 6 32,634 person
H	Point Inflow (Daily Average)	m^3/day	1,511	0	593	0	1,511	West: Airport site Central:New Airport + Industrial area
I	Generated Wastewater (Daily Average)	m^3/day	54,796	3,172	29,483	13,329	100,780	I = E + G+H
J	Daily Maximum Ratio	-	1.2				-	Water Supply Plan 2025
K	Point Inflow (Daily Maximum)	m^3/day	1,813	0	594	0	2,407	West: Airport site Central:New Airport + Industrial Park
L	Generated Wastewater (Daily Maximum)	m^3/day	65,755	3,806	35,262	15,995	120,818	L =(I - H) x J + K
M	Peak Factor	-	2.25					Indian Manual
N	Point Inflow (Peak Flow)	m^3/day	3,400	0	594	0		West: Airport site Central:New Airport + Industrial Park
O	Peak Flow	m^3/day	123,291	7,137	65,597	29,990	226,015	O =(I - H) x M +N
P	Infiltration ratio	m^3/day	0.1				-	
Q	Infiltration	m^3/day	6,576	381	3,526	1,600	12,083	Q = L x P
R	Total Inflow (Daily Average)	m^3/day	61,372	3,553	33,009	14,929	112,863	R = I + Q
S	Total Inflow (Daily Maximum)	m^3/day	72,331	4,187	38,788	17,595	132,901	S = L + Q
T	Total Inflow (Peak Flow)	m^3/day	129,867	7,518	69,123	31,590	238,098	T = O +Q

Source: JET

Table B2-22 shows approximate values for each treatment zone, as treatment capacity is the daily maximum value.

Table B2-22 Treatment Capacity of WWTPs

Treatment Area	Capacity (m^3/day)
West	72,500
Central	39,000
Hemja	4,500
East	18,000

Source: JET

13 Sewerage facility planning and design guideline and commentary, Japan Sewage Association ,2019

(9) Influent Wastewater Characteristics

Characteristics of influent to the WWTP are calculated according to unit domestic wastewater volume and unit load per person provided by Indian Manual as shown in Table B2-23.

Table B2-23 Influent Wastewater Characteristics at WWTP

Item	Unit Load in Indian Manual (grams/cap.d)	Unit Domestic Wastewater Including Infiltration (m^3/cap.d)	Concentration (mg/L)
BOD_5	27	0.1075	251
SS	40.5		377
T-N	5.4		50.2
T-P	0.8		7.4

Source: JET

B2.2.5 Lessons from the Existing Wastewater Treatment Facilities

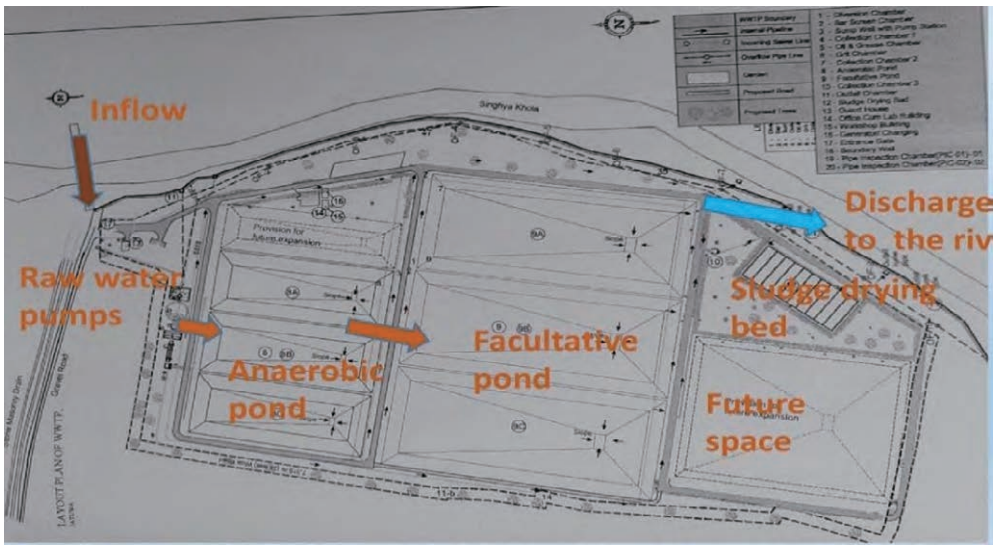
For the design of wastewater treatment methods in Pokhara City, JET visited and collected information on the existing representative treatment plant in Nepal.

(1) Biratnagar Wastewater Treatment Facilities

The operation was started by a local contractor in 2019 with one year O&M under BOT scheme funded by ADB. After that, the client took over the plant in 2020 and is managing the operation by themself. The designed water flow is about 20,000 m^3 per day, and the treatment process is the stabilization pond method, as shown in Figure B2-3Figure B2-1, Photo B2-1 and Photo B2-2.

According to the plant manager and the electro-mechanical personnel, lots of household connections are delayed, and the present inflow water flow is less than 10 % of the designed one, so the treatment is good due to the small inflow load. In addition, since there are almost no mechanical and electric facilities except for the inflow pump station, no serious problems except for the power failure and blockage of the main pump are observed. The sludge precipitated in the stabilization ponds must be regularly withdrawn into the sludge drying bed, but has not been carried out yet because the inflow amount is too small. Instead, as shown in the picture below, sludge generated by households is received into the drying bed at a 500 NPR per tanker.

The verbal confirmation was made, but the construction cost was about 200 million NPR, and the maintenance cost was about 15 million NPR per year, which shows that it is very inexpensive. Since it is stabilization pond, its maintenance is easy, but it will be difficult to realize it in Pokhara City because it requires a large area.



Source: Final report detailed engineering design of secondary towns urban environmental improvement, 2013

Figure B2-3 Biratnagar WWTP Layout



Anaerobic Pond



Anaerobic Pond



Facultative Pond



Facultative Pond

Source: JET

Photo B2-1 Biratnagar Stabilization Pond



Source: JET

Photo B2-2 Biratnagar Sludge Drying Bed

(2) Guheshwori WWTP

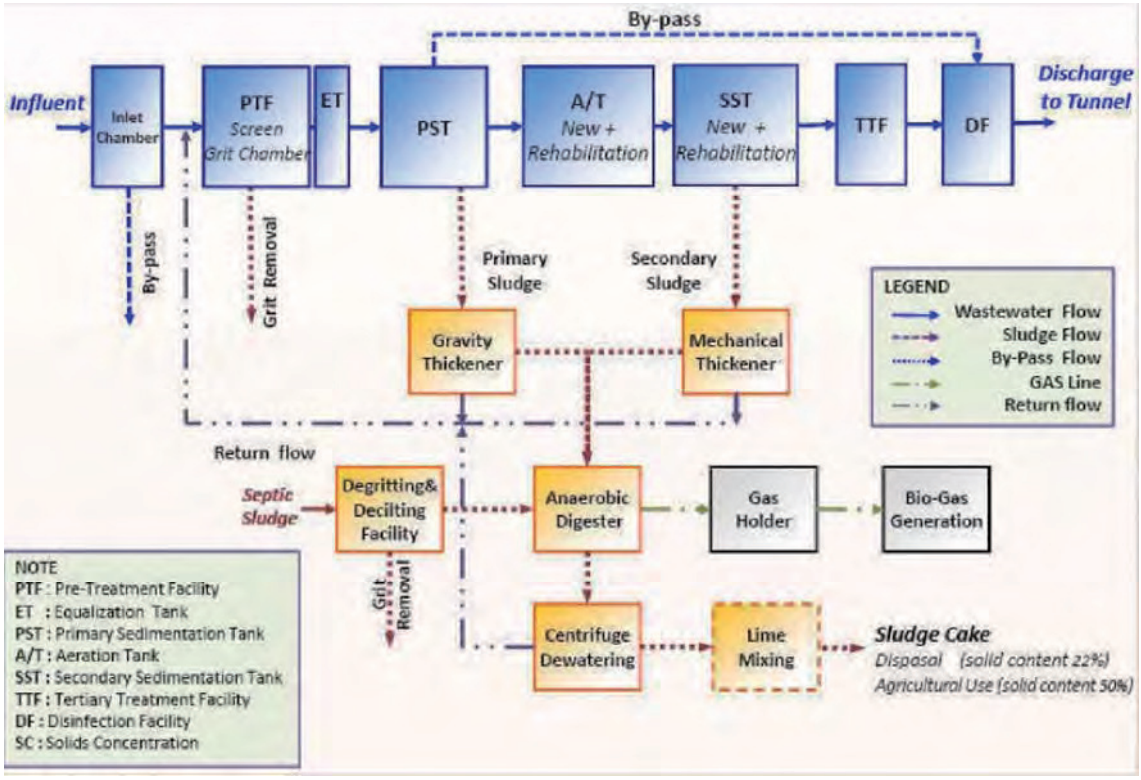
The project was funded by ADB through DBOT scheme with 10-year O&M period. The plant was put into operation in 2020 after the treatment facilities were upgraded by Indian contractor. The designed water flow is about 32,400 m^3 per day, and treatment process is the conventional active sludge method,

as shown in Figure B2-4.
As shown in Figure B2-5, the process flow is similar to that of Japanese standard with separate concentrated dewatering method, and it is considered that the same flow is basically applicable to Pokhara City. The introduction of digestion tanks, gas holders, digestion gas power generation facilities, mechanical thickening facilities, and mechanical filtration for water reuse may be considered in the future, but the decision will be made after consultation with PMC during the following Pre-F/S stage. Operation and maintenance are difficult for electrolytic chlorinator, but the water supply plant in Pokhara City is planned to be utilized by dissolving the bleaching powder, and it will be discussed in the future considering the situation in Pokhara.
Sludge is fed into the digestion tank through the receiving equipment. Since the dewatered sludge is taken by a private company free of charge, the client has not incurred disposal costs, and it is considering selling the dewatered sludge for a fee in the future.
The current inflow water flow is about 60 to 70 % of the design one. The inflow water quality during dry weather seems to be slightly higher than the design water quality, probably due to the fact that the inflow is intercepted from the combined sewerage system. It is said that the operation method is currently being adjusted, partly because the target water quality is set strictly. Since the plant has just started operation, all the facilities are new and look relatively solid and complete.
The construction cost is about 2,558 million NPR, and the maintenance cost is about 331 million NPR per 10 years, which seems to be reasonable price.



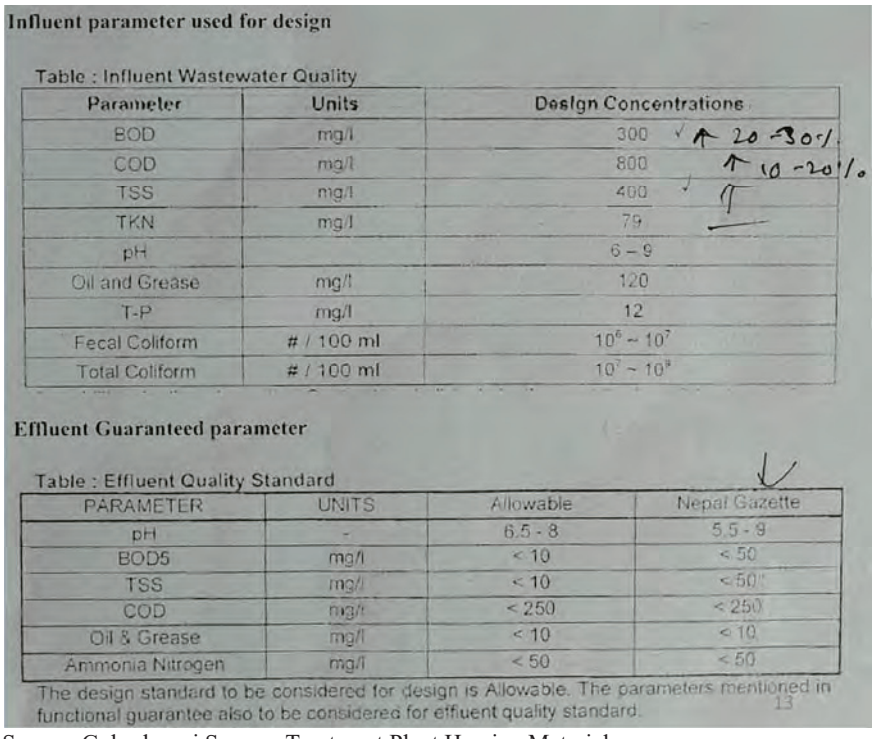
Note: Figures include future expansions at the back of the left.
Source: JET

Figure B2-4 Guheshwori WWTP (Final Plan Layout)



Source: Water and wastewater management of Kathmandu Valley

Figure B2-5 Guheshwori WWTP Process Flow



Influent parameter used for design

Table : Influent Wastewater Quality

Parameter	Units	Design Concentrations
BOD	mg/l	300
COD	mg/l	800
TSS	mg/l	400
TKN	mg/l	79
pH		6 – 9
Oil and Grease	mg/l	120
T-P	mg/l	12
Fecal Coliform	# / 100 ml	$10^6 \sim 10^7$
Total Coliform	# / 100 ml	$10^7 \sim 10^8$

Effluent Guaranteed parameter

Table : Effluent Quality Standard

PARAMETER	UNITS	Allowable	Nepal Gazette
pH	-	6.5 - 8	5.5 - 9
BOD5	mg/l	< 10	< 50
TSS	mg/l	< 10	< 50
COD	mg/l	< 250	< 250
Oil & Grease	mg/l	< 10	< 10
Ammonia Nitrogen	mg/l	< 50	< 50

The design standard to be considered for design is Allowable. The parameters mentioned in functional guarantee also to be considered for effluent quality standard.

Source: Guheshwori Sewage Treatment Plant Hearing Materials

Figure B2-6 Guheshwori WWTP Designed Water Quality

B2.2.6 Draft Layout of Wastewater Treatment Plant

Ten sites proposed for construction, four of which are shown in the figure below, due to the location of WWTP area and ease of acquisition.

The schematic layout of the four treatment plants and points to note are shown in Figure B2-7 through Figure B2-13.

(1) West WWTP



Source: JET

Figure B2-7 Site Condition of West WWTP (Plan)



Note: PST: Primary Sedimentation Tank, FST: Final Sedimentation Tank, PS: Pumping Station
Source: JET

Figure B2-8 West WWTP Alternatives 1 and Outline Layout (Plan)



Note: PST: Primary Sedimentation Tank, FST: Final Sedimentation Tank, PS: Pumping Station
Source: JET

Figure B2-9 West WWTP Alternatives 2 and Outline Layout (Plan)



Note: PST: Primary Sedimentation Tank, FST: Final Sedimentation Tank, PS: Pumping Station
Source: JET

Figure B2-10 West WWTP Alternatives 3 and Outline Layout (Plan)

(2) Central WWTP



Note: PST: Primary Sedimentation Tank, FST: Final Sedimentation Tank, PS: Pumping Station
Source: JET

Figure B2-11 West WWTP Alternatives 3 and Outline Layout (Plan)

(3) Hemja WWTP



Note: PST: Primary Sedimentation Tank, FST: Final Sedimentation Tank, DHS: Down-flow Hanging Sponge, PS: Pumping Station
Source: JET

Figure B2-12 Hemja WWTP Outline Layout (Plan)

(4) East WWTP



Note: PST: Primary Sedimentation Tank, FST: Final Sedimentation Tank, DHS: Down-flow Hanging Sponge, PS: Pumping Station
Source: JET

Figure B2-13 East WWTP Outline Layout (Plan)

B2.2.7 Design Flow of WWTP

Each treatment plant will have four trains in the overall plan. Since West treatment area and Central treatment area have large processing capacity, the master plan establishes priority areas and divides them into phases 1 and 2, respectively. Therefore, the size of the facilities in Phase 1 will be 2/4 of the total number of treatment plants in consideration of the planned inflow, and the whole (4/4 of the total number of treatment plants) will be constructed in Phase 2. However, Pre-F/S will be conducted for priority projects, and detailed review will be conducted again at that time.

Table B2-24 Design Flow for WWTP

WWTP		Target Ward	Design Inflow (m^3/day)	Design Flow (m^3/day)	Remarks
West	Phase-1.1	6, 7	11,800	18,125	1/4 train
	Phase-1.2	8	19,200	36,250	2/4 train
	Phase-2.1	2, 3, 4, 5, 9	36,700	54,375	3/4 train
	Phase-2.2	1, 16, 17, 18, 19, 22	72,500	72,500	4/4 train
Central	Phase-1.1	10	7,400	9,750	1/4 train
	Phase-1.2	12, 15	18,700	19,500	2/4 train
	Phase-2.1	11	23,600	29,250	3/4 train
	Phase-2.2	13,14	39,000	39,000	4/4 train
Hemja	-	25	4,500	4,500	4/4 train
East	Phase-1.1	29, 30	8,500	9,000	2/4 train
	Phase-1.2	26, 27, 31, 32	18,000	18,000	4/4 train

Source: JET

B2.2.8 Inflow and Treated Water Quality of WWTP

The quality of the water flowing into the wastewater treatment plant and the quality of the treated water are as shown in Table B2-25 from Section B2.2.4.

Table B2-25 Inflow and Treated Water Quality of WWTP

	Design Influent	Design Effluent	Nepal Guideline
BOD (mg/L)	251	30	< 50
COD (mg/L)		-	< 250
TSS (mg/L)	377	30	< 50
TKN (mg/L)	50.2	-	N/A
T-P (mg/L)	7.4	-	N/A
pH		-	5.5-9
Oil & grease		-	< 10
Ammonia Nitrogen		-	< 50

Source: JET

B2.2.9 Wastewater Treatment Method

(1) Design Policy

The study is conducted with the following three PMC requests,

- It will not require advanced technology.
- A simple and easy operation and maintenance system are preferred.
- Ideally, 30-40 million NPR per year for operation and maintenance costs should be (up to 100 million NPR per year).

As mentioned above, since there is the latest wastewater treatment plant operated by Kathmandu's conventional active sludge method, it is thought that it will be possible to acquire the experience of its operation and maintenance from private business operators in the future and to utilize it in Pokhara City. The same treatment method is recommended in the overall plan 2050, but in the initial stage of 2030, the processing flow is made to minimize the process and electro-mechanical items as much as possible.

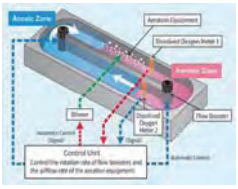
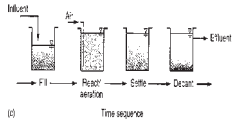
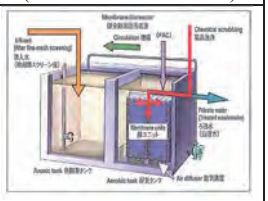
(2) Comparison of Wastewater Treatment Methods

Since the discharge standard of Nepal is not strict, it would be recommend the stabilization pond method, which is inexpensive to construct and easy to maintain, such as Biratnagar, but it is not applicable to Pokhara City because it requires a large site. Therefore, **the standardized conventional activated sludge method** adopted in Guheshwori of Katmandu will be used as the basis. As an alternative, Downflow Hanging Sponge method (hereinafter say DHS), which is a Japanese technology that can drastically reduce power consumption and is easy to maintain, or the Activated Sludge method, which can save energy and save space by increasing the depth of the reaction tank to 7 m, may be considered if a sufficient site cannot be secured.

Table B2-26 Comparison of Wastewater Treatment Methods

System	① Stabilization Pond	② Extended Aeration (EA: Oxidation Ditch Shape)	③ CAS (Conventional Activated Sludge)
Image			
Features	✓Hydraulic Retention time (HRT) is extremely long, since oxygen supply is	Primary clarifier and digester are generally not required.	HRT is relatively short with highly loaded.

	conducted by natural oxidation and photosynthesis of algae. ✓Sludge treatment facility is not needed.	Larger footprint is required than CAS .	Primary sedimentation tank is required for fluctuation in sewage flow and quality, and to equalize/mitigate the load. Digested gas power generation can be incorporated to the system.
Land Footprint	Largest (30 ha)	Larger than CAS	Medium (6ha)
Effluent Quality	within Nepal standard	Good	Good
CAPEX	Lowest	Reasonable than CAS	Medium (5,000 MNPR in 62 MLD)
OPEX/year	Very reasonable	Reasonable than CAS	Medium (54 MNPR in 62 MLD)
O&M Difficulty	Very Easy	Relatively Easy	Medium
Environmental Effect	Medium (Natural method, but requires a large land area)	Not Environmental Friendly (Requires a relatively large land area)	Medium
Reference in Nepal	Biratnagar	Guheshwori previously operated	Guheshwori, and other 4 WWTPs in Kathmandu
Evaluation	<u>Impossible</u> due to no land footprint	<u>Impossible</u> due to no land footprint	<u>Standard method</u> (Selected in D/D, 2014)

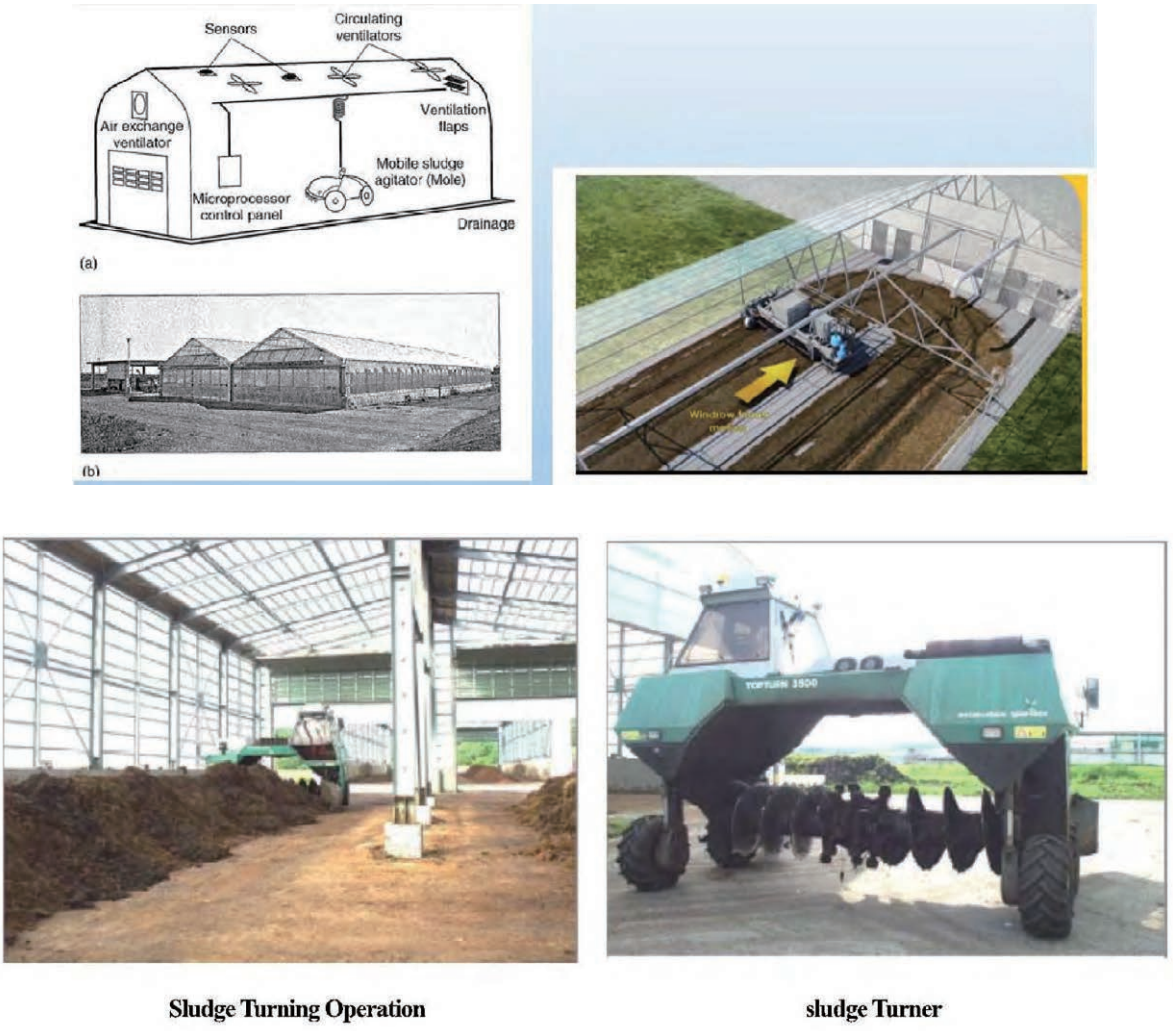
System	④ Developed EA	⑤ DHS (Downflow Hanging Sponge)	⑥ SBR (Sequencing Batch Reactor)	⑦ MBR (Membrane Bio Reactor)
Image				
Features	✓New technology developed based on conventional EA. ✓Easy control of influent load. ✓Shorter HRT than conventional EA. ✓Design Max. water depth can be applied up to 7 m.	✓New technology developed based on trickling filter method using sponges. ✓Easy control of influent load. ✓Shorter HRT than CAS. ✓Energy saving, less sludge production, and no problem with odor or filter flies.	✓Time sequencing consist of filling, aeration, settle, withdrawing supernatant, and sludge drawing in a single basin. ✓The system requires at least 2 basins for continuous cyclic operation, causing that process design and control management are more complicated.	✓Liquid-solids separation is accomplished thorough immersed membranes, excluding colloidal and suspended solids because of membrane pore size, in the activated sludge mixed liquor. ✓Any sedimentation basins are not required.
Land Footprint	Smaller than EA, CAS	Less 70% of CAS	Smaller than CAS	Smaller than CAS
Effluent Quality	Better than conventional EA	Within Nepal standard	Similar to conventional EA	Very good
CAPEX	Similar to standard EA	Reasonable than CAS	Economical for small plant	High
OPEX/year	Power consumption	Very reasonable	Reasonable than	High

	is lower than conventional EA	Power consumption save 60% more than CAS	CAS	
O&M Difficulty	Easy, flexible operation can be expected when receiving septage sludge	Very easy	Difficult, Complicated time sequence	Difficult, required O&M skill
Environmental Effect	Environmental Friendly (Not requires a large land area)	Very Environmental Friendly (Not requires a large land area, energy saving, less sludge production)	Environmental Friendly (Not requires a large land area)	Very Environmental Friendly (Not requires a large land area, good effluent quality)
Reference in Nepal	None, but similar to Guheshwori's EA previously operated.	None (5,000 m/d plant in Agra, India).	None	None

Source: JET

B2.2.10 Sludge Reuse

In the overall plan, waste sludge generated from the digestion and dewatering process is considered to be sludge with organic content suitable for agricultural land use, so the plan is to secure a necessary construction space in advance for a simple composting facility as shown in Figure B2-14 after the sludge volume is reduced by a sludge dewatering. At present, there is no plan of active agricultural utilization from the agricultural side, and it is planned to carry out the landfill disposal in the disposal site of the city after the reduction by the sludge dewatering machine. In the case that a private company, etc. by a track record in Kathmandu also use dewatered sludge in Pokhara City, it will be the responsibility of the user to remove the sludge from the site. Regarding the proposal to build a mechanical composting facility on the site, as is done in Japan, this will not be considered because the high construction cost will not be balanced with the income.



Sludge Turning Operation **sludge Turner**

Source: Wastewater Engineering

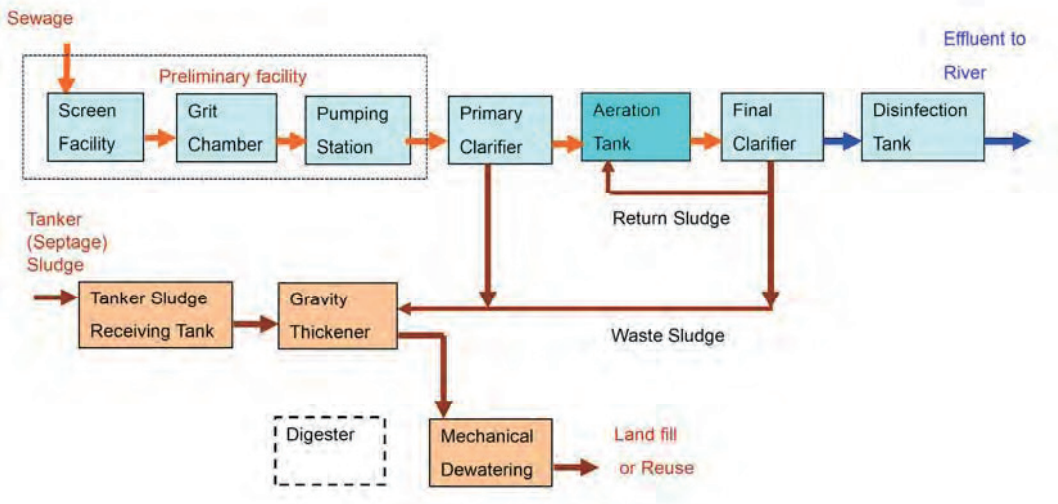
Figure B2-14 Sludge Reuse Image

B2.2.11 Treatment Flow for the Proposed Wastewater Treatment Plant

In order to restrain initial investment and simplify maintenance, mixed concentration using gravity thickeners is recommended for Phase 1 of West and Central Treatment Plants instead of separated concentration. Sludge digestion facilities will be considered in the overall plan, but will not be constructed in Phase 1 of West and Central treatment plants. Figure B2-15 and Figure B2-16 show the process flows for Phases 1 and 2 of West and Central treatment plants, respectively. The advantages of Phase 1 based on these considerations are as follows.

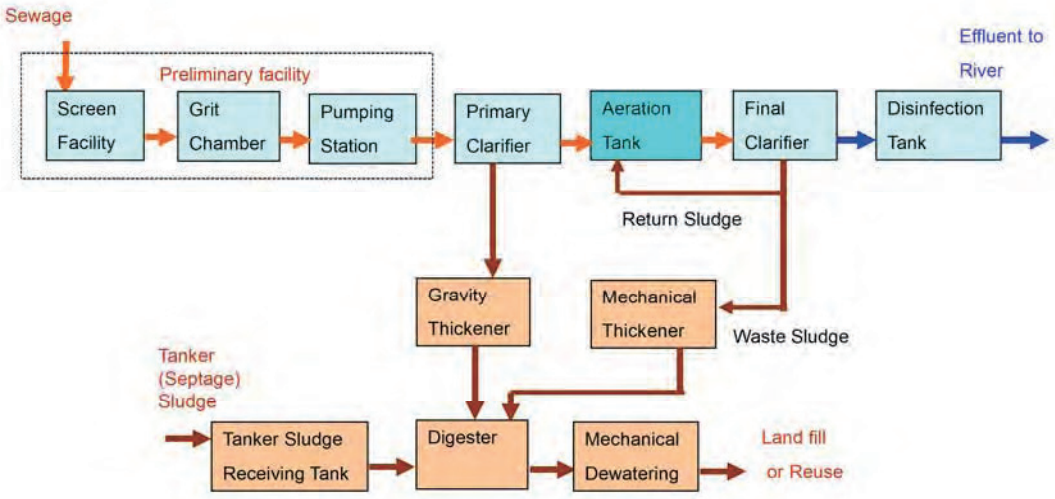
- Initial investment can be reduced because mechanical thickening and digestion facilities are unnecessary.
- Operation and maintenance are also easier because there are fewer mechanical and electrical facilities.

In the future, it will be planned to construct a digestion gas power generation facility, similar to the one in Kathmandu.



Source: JET

Figure B2-15 Process Flow (2030)



Source: JET

Figure B2-16 Process Flow (2050)

B2.2.12 Sewer Plan

In each sewerage treatment zone established in this MP, the collection method of wastewater through sewage pipes was examined in consideration of the local topographical conditions, trunk road conditions, planned locations of new WWTPs, etc. As mentioned in B2.2, there are four (4) sewage treatment zones (West, Central, Hemja, East), and a pipeline plan was made for each treatment zone. All sewage systems will be in separate sewer, and the transport system will be the gravity flow system.

However, since Pokhara is a rugged area, sewage pumping stations and manhole pumps will be installed at important points in areas where it is difficult to collect by gravity.

In addition, for the West sewerage zone and the Central sewerage zone, priority areas are set in this master plan, and they are divided into Phase 1 and Phase 2 development stages.

(1) Design Condition

The design conditions were set as shown in Table B2-27 with reference to the existing sewerage development plan report.

Table B2-27 Design Conditions for Sewer

Item	Condition
Velocity formula	Manning's formula
Pipe type	Hume Pipe / Roughness factor: 0.013
Standard gradient/ Flow velocity	0.8m/sec
Percentage of allowance	20%
Earth covering	More than 1.0 m
Interval of Manholes (m)	30 m
Minimum size of the pipe	More than φ150mm

Sauce：JET

(2) Sewer Design

As shown in Table B2-27, calculate the required pipe diameter of the sewer pipe considering the planned sewage flow rate in each treatment zone. The maximum pipe diameter of the trunk sewer is calculated as shown in Table B2-28, and the sewage flows into each treatment plant with these pipe diameters.

Table B2-28 Maximum Diameter of Sewer in each Treatment Zone

Zone	Maximum Pipe Size (mm)
West	DN900
Central	DN700
Hemja	DN400
East	DN600

Sauce：JET

The trunk line is planned along the national highway or main road that runs through the center of the treatment area. In addition, the sub-trunk lines and secondary pipelines will be planned on existing roads where pipelines can be laid within the sewerage zone.

Schematic plans of sewage pipes and sewer pipe lengths in each treatment zone are shown in Figure B2-17 and Table B2-29, respectively.

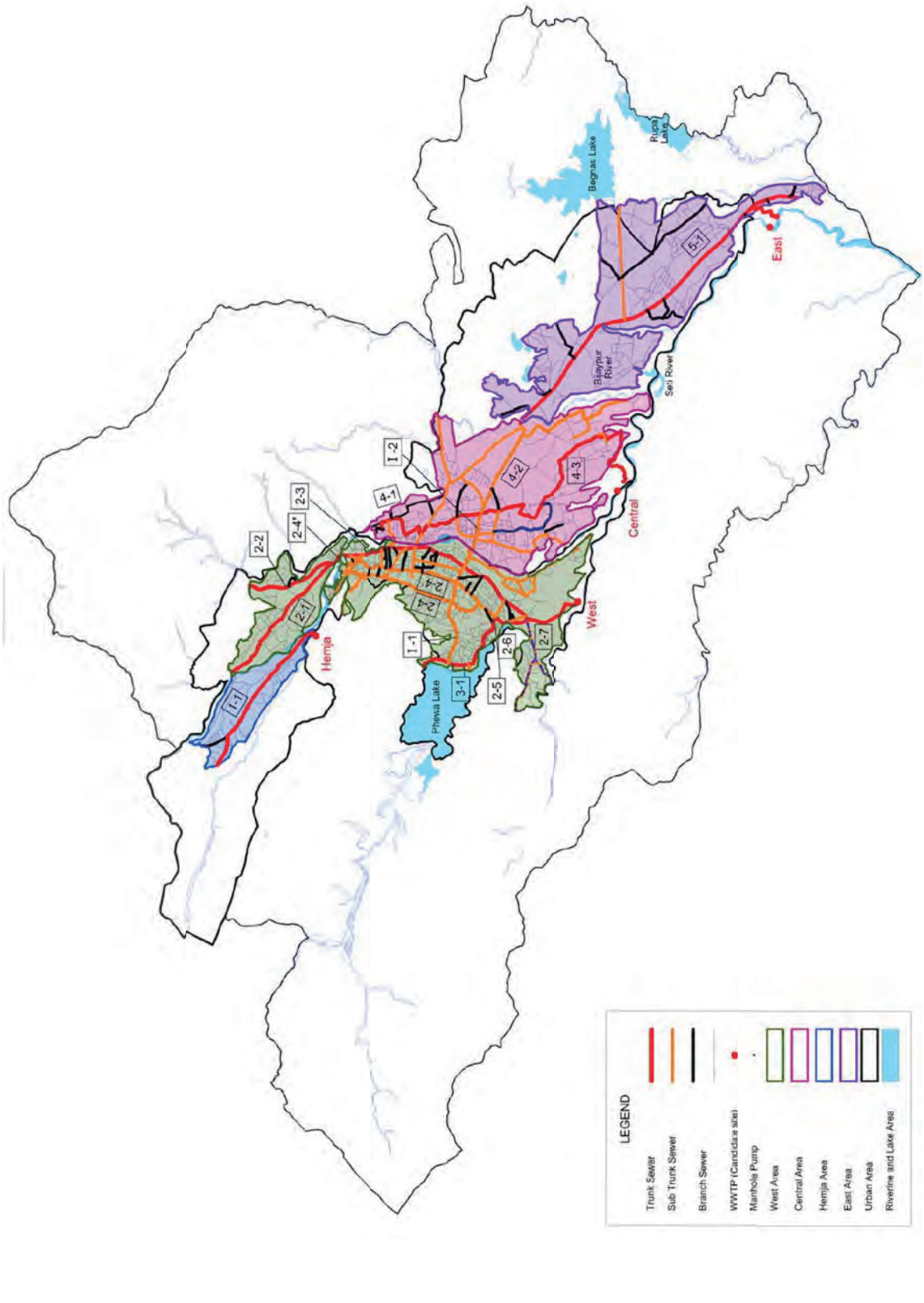


Figure B2-17 Outline Design of Sewer (West, Central, Hemja, East)

Source: JET

Table B2-29 Length of Sewer in Each Treatment Area

Area	Trunk Sewer	Sub Trunk Sewer	Branch Sewer	Total
West	19.6 km	31.4 km	270.0 km	318.7 km
Central	12.4 km	20.0 km	230.0 km	259.8 km
Hemja	4.9 km	0.8 km	40.0 km	45.6 km
East	11.7 km	3.4 km	190.0 km	204.0 km

Source: JET

3) Installation of Sewage Pumping Station and Manhole Pumps

Sewage pumping stations and manhole pumps will be adopted in areas where gravity accumulation is difficult. In consideration of the current topography, a sewage pump station is planned where land can be acquired, and a manhole pump is planned where power supply is possible and future maintenance is possible. Table B2-30 shows the estimated number of installations in each treatment area.

Table B2-30 Approximate Number of Pumping Stations in Each Area

Area	Nos. of Pumping Station
West	185 locations
Central	162 locations
Hemja	25 locations
East	110 locations
Total	482 locations

Source: JET

B3 On-site Facility Plan

B3.1 Detailed Survey for On-site Facility Master Planning

B3.1.1 Process for Establishing an On-Site Facility Plan

The following information is needed to develop an on-site facility plan.

- Number of people and households by sewage treatment type, number of septic tanks
- Amount of on-site facility sludge
- Number of vacuum trucks required for on-site facility sludge

The process for calculating and setting the above items is as follows.

Step 1: Number of population and households by sewage treatment, number of septic tanks

- Establish a "sewerage zone" and an "area outside the sewerage zone" and make projections for each zone.
- The sewage treatment type shall be sewage, septic tank (bottom of septic tank: impermeable), and septic tank (bottom of septic tank: permeable).

Step 2: On-site facility sludge volume

- Newly constructed septic tanks (bottom of septic tank: impermeable) and septic tanks that have been sludge withdrawn as of 2022 are subject to sludge withdrawal.
- The number of newly installed septic tanks (bottom of septic tank: impermeable) is set based on the results of the prediction in (1).
- The frequency of sludge withdrawal from the new septic tanks should be consistent with the draft septic tank ordinance, etc.

Step 3: Number of vacuum trucks required for on-site facility sludge

- Calculate the number of vacuum trucks required, taking into account the amount of sludge from on-site facilities, vacuum truck tank capacity, etc.

B3.1.2 Overview of Sewerage Development

On-site sanitation development is closely related to sewerage development. Therefore, it is necessary to proceed to plan both developments in parallel.

Since the details of sewerage development are described in Chapter B2, the overview of sewerage development which is necessary for planning on-site sanitation development is summarized below.

(1) Sewerage Zone

In order to fast onset of the water environment conservation effect, the sewerage zone is divided into four zones such as West, Central, Hemja and East sewerage zone.

(2) Sewerage Development Schedule

Considering the priority of water environment conservation, the developments is planned West, Central, Hemja and East sewerage zone in order. The year of switch from on-site sanitation to sewerage system will be scheduled as shown in Table B3-1.

Table B3-1 Commencement Year of Sewerage Service

Sewerage Zone	Commencement Year of Sewerage Service
West (Phase-1)	2031
West (Phase-2)	2034
Central (Phase-1)	2038
Central (Phase-2)	2041
Hemja	2045
East	2048

Source: JET

(3) Period until Completion of Sewerage Connection

After the commencement of sewerage service, the wastewater from customers will be connected to sewer. The period of connection to sewer in West sewerage zone where the fastest sewerage development zone in Pokhara City is will be estimated within five years. In the other zones, it is assumed that earlier sewerage connection within four years for Central sewerage zone and within 3 years for Hemja and East sewerage zone will be achieved by increasing willing to connect and awareness of sewerage development through public relation activities.

(4) Stepwise Sewerage Development Plan

Table B3-2 shows the stepwise sewerage development plan and the sewerage development ratio in each year. For example, 1.0 means that the sewerage development in its year is 100%. These will be referred to the annual plan of the on-site sanitation system.

Table B3-2 Stepwise Sewerage Development Plan

	Sewerage Coverage Area						On-site Sewerage Coverage Area
	West Treatment Area		Central Treatment Area		Hemja Treatment Area	East Treatment Area	
	Phase-1	Phase-2	Phase-1	Phase-2			
Ward No. (Target Area)	6、7、8	1、2、3、4、5、9、17	10、12、15	14	—	29	20、21、23、24、28、33
Ward No. (Target for Some Wards) ※ ( ) The numbers are Parentage of Sewered Population = Population Sewered Area/Ward Population	—	16 (80%) 18 (30%) 19 (65%) 22 (10%)	—	11 (90%) 13 (70%)	25 (80%)	26 (80%) 27 (85%) 30 (90%) 31 (30%) 32 (20%)	11 (10%) 13 (30%) 16 (20%) 18 (70%) 19 (35%) 22 (90%) 25 (20%) 26 (20%) 27 (15%) 30 (10%) 31 (70%) 32 (80%)

	Sewerage Coverage Area						On-site Sewerage Coverage Area
	West Treatment Area		Central Treatment Area		Hemja Treatment Area	East Treatment Area	
	Phase-1	Phase-2	Phase-1	Phase-2			
Year Connection Start	2031	2034	2038	2041	2045	2048	—
year	Parentage of Sewered Population						
2023	0.00	0.00	0.00	0.00	0.00	0.00	—
2024	0.00	0.00	0.00	0.00	0.00	0.00	—
2025	0.00	0.00	0.00	0.00	0.00	0.00	—
2026	0.00	0.00	0.00	0.00	0.00	0.00	—
2027	0.00	0.00	0.00	0.00	0.00	0.00	—
2028	0.00	0.00	0.00	0.00	0.00	0.00	—
2029	0.00	0.00	0.00	0.00	0.00	0.00	—
2030	0.00	0.00	0.00	0.00	0.00	0.00	—
2031	0.20	0.00	0.00	0.00	0.00	0.00	—
2032	0.40	0.00	0.00	0.00	0.00	0.00	—
2033	0.60	0.00	0.00	0.00	0.00	0.00	—
2034	0.80	0.20	0.00	0.00	0.00	0.00	—
2035	1.00	0.40	0.00	0.00	0.00	0.00	—
2036	1.00	0.60	0.00	0.00	0.00	0.00	—
2037	1.00	0.80	0.00	0.00	0.00	0.00	—
2038	1.00	1.00	0.25	0.00	0.00	0.00	—
2039	1.00	1.00	0.50	0.00	0.00	0.00	—
2040	1.00	1.00	0.75	0.00	0.00	0.00	—
2041	1.00	1.00	1.00	0.25	0.00	0.00	—
2042	1.00	1.00	1.00	0.50	0.00	0.00	—
2043	1.00	1.00	1.00	0.75	0.00	0.00	—
2044	1.00	1.00	1.00	1.00	0.00	0.00	—
2045	1.00	1.00	1.00	1.00	0.33	0.00	—
2046	1.00	1.00	1.00	1.00	0.66	0.00	—
2047	1.00	1.00	1.00	1.00	1.00	0.00	—
2048	1.00	1.00	1.00	1.00	1.00	0.33	—
2049	1.00	1.00	1.00	1.00	1.00	0.66	—
2050	1.00	1.00	1.00	1.00	1.00	1.00	—

Source: JET

B3.1.3 Laws and Standards Related to On-site Sanitation

Regarding septic tanks of the on-site sanitation facilities as described above, there are no established standards for installation, use, inspection, maintenance and desludging, etc in Pokhara City. Therefore, it is necessary to make consideration so that these measures for of procedure and law can be carried out.

(1) Jokaso Law in Japan

As a reference, the summary of Jokaso Law in Japan is shown in Table B3-3.

The Jokaso Law stipulates that the Jokaso Law requires maintenance, inspection, cleaning, and water quality inspections for the Jokaso after installation. The person responsible for implementing these tasks is the administrator of Jokaso, who is an owner, occupant or other person of the right to manage the Jokaso.

A Jokaso is a facility that removes contaminants from wastewater using the action of microorganisms and sedimentation by gravity. In addition to keeping the appropriate usage, if a problem occurs in the function of the septic tank, it is necessary to remove the cause and restore the function. There are merits such as the avoidance of usage methods that deteriorate the function of the Jokaso and the prompt handling of problems with the Jokaso, etc., if the person who owns or uses the Jokaso is able to maintain and manage it themselves. However, it is difficult for the government to accurately grasp and take measures against non-compliance or inadequate implementation of legal matters.

It is important to simplify the procedures and documents, and to increase the effectiveness of the selection of the person in charge of implementation and legal matters in consideration of the local circumstances in order to consider the system in Pokhara City.

Table B3-3 Summary of Jokaso Law in Japan

Item	Implementation Manager	Legal Matters	Measures in Case of Non-compliance or Insufficient Performance of Statutory Items
Installation	Jokaso manager* (obligation to submit installation notification)	- Technical standards for construction - Registration related to septic tank construction business (Governor) - Allocation of septic tank installation workers	- Recommendation by the Governor - Modification plan or abolishment order by a specific administrative agency
Maintenance and inspection	Jokaso manager* (Can be commission to a company or Jokaso manager registered by the Governor)	- Technical standards for maintenance and inspections (at least 3 times per year) - Registration related to septic tank construction business (Governor) - Allocation of septic tank installation workers	- Advice, guidance, recommendation, order for improvement measures, termination of using Jokaso by the Governor
Cleaning	Jokaso manager* (Can be commission to a cleaning company approved by the Mayor	- Cleaning technical standards (once a year) - Permission for Jokaso cleaning business (Mayor)	- Advice, guidance, recommendation, order for improvement measures, termination of using Jokaso by the Governor
Water quality inspection	Jokaso manager* (obligation of inspection) (The inspection body is an inspection agency designated by the Governor.)	- Water quality inspection after installation (from 3 to 6 months) - Periodic inspection (once a year)	- Advice, guidance, recommendation and order for inspection by the Governor
Preparation of Jokaso ledger	Governor	- Items to be described in Jokaso ledger ➢ Location of Jokaso ➢ Name of Jokaso ➢ Implementation status of water quality inspection ➢ Installation date, type of Jokaso tank ➢ Date of commencement and termination ➢ Implementation status of maintenance and inspection ➢ Implementation status of cleaning	—

Note: * Jokaso manager: The owner, occupant, or other person of a septic tank who has the authority to manage the septic tank.
Source: JET

(2) Procedures for Installation and Use of Septic Tanks in Pokhara City

Procedures for installing and using septic tanks are shown in Table B3-4 based on the following policy. In addition, the proposal for the ordinance on the installation of septic tanks and water quality management is shown in Appendix-7.

- Application procedures and required documents from septic tank managers (septic tank owners, occupants, and other persons who have the authority to manage the septic tank) to Pokhara City are minimized in order to reduce the risk by forgetting to apply. (The procedures for the septic tank manager are “application for installation”, “request for troubleshooting”, and “application for permission to connect to the sewage system”. Otherwise, Pokhara City takes the lead in managing the septic tanks.)
- The management system of the Jokaso Law in Japan consists of "maintenance and inspection”, "water quality inspection," and "cleaning". However, it can be simplified because the septic tanks have no adjustable equipment and structure for operation unlike the Jokaso. (The contents of management are "inspection pre-using", "regular inspection" and "sludge removal". In addition, since compliance with usage rules is important for maintaining the function of septic tanks, the usage rules are communicated during the “pre-using inspection” and “regular inspection” conducted every 12 months continuously.)
- All newly installed impermeable septic tanks are registered in the septic tank ledger. (Based on

the registered information, Pokhara City manages and executes the implementation schedule of "pre-using inspection", "regular inspection," and "sludge removal.)

- In order to ensure the appropriate construction, and to avoid deviation from the standards, a registration system will be introduced for business operators engaged in construction, maintenance and management, and desludge.

Table B3-4 Procedure for Installation and Use of Septic Tanks

Item	Implementation Content	Implementation Period	Implementing Body
Installation	- The septic tank manager submits a building permit application to the PMC	At applying for a building permit	- Septic tank manager: Submission - PMC: Receipt and examination
Construction	- Construction by Contractor based on "Construction Standards"	After notification of building permit	- Septic tank manager: Order to contractor
Pre-using Inspection	- PMC inspects based on inspection standards - PMC notifies usage rules to septic tank users, etc.	At building permit/ confirmation inspection	- PMC: Inspection, registration of septic tank information in the septic tank ledger
Periodic inspection	- O&M company inspects based on inspection standards - O&M company notifies usage rules to septic tank users, etc.	At 12 months after registering in the ledger, and every 12 months thereafter	- PMC: Notify the septic tank manager of the implementation date based on the ledger information, Outsources to O&M company,
Desludge*	- Desludge by deslude company based on desludge standards	At 24 months after registering the ledger, in case of water level over half depth of the septic tank (PMC outsources desludge to desludge company.) in case of water level under half depth of the septic tank (Confirmation every 12 months.)	- PMC: Notify the septic tank manager of the implementation date based on the ledger information, Outsources desludge to desludge company.
Malfunction of septic tank	- The septic tank manager contacts to the PMC in case of a malfunction (clogging, odor, etc.).	At malfunction	- Septic tank manager: Contact to PMC - PMC: Outsources on-site confirmation and response to O&M company.
Change of septic tank	- Submitted by the septic tank manager at changing the size, structure, etc. of septic tank.	Before commencement of construction	- Septic tank manager: Submission - PMC: Receipt and examination
Conversion to sewerage connection	- The septic tank manager submits an application for permission to connect to the sewerage system.	Before commencement of connecting to sewerage system.	- Septic tank manager: Submission - PMC Receipt and examination, and delete of septic tank information from the septic tank ledger
Business registration	- Submission of a registration application for engaging in the following businesses ・Construction work ・Maintenance and management ・Desludge business - PMC provides training for specialized knowledge and skills on septic tanks to business operators.	Before commencement of business	- Business operator: Submission - PMC: Receipt, registration, and training for septic tanks

Note: * Desludge means to remove sludge from septic tank and to transport to sludge treatment facilities.

Source: JET

(3) Rules for Using Septic Tanks

The rules for using the septic tank are as follows.

- The amount of water to flush the toilet should be appropriate.
- Do not flow anything that interferes with the normal functioning into the septic tank such as insecticides, detergents, deodorants, oils, paper diapers, hygiene products, etc.
- Do not flow wastewater from the factories, rainwater or other specific wastewater

B3.1.4 Forecast of Population, Households by Type of Wastewater Treatment Methods and Septic Tanks

(1) Forecast Method and Conditions

The number of households is estimated by each area of sewerage zone and outside of sewerage zone.

1) Sewerage Zone (in 2024 (at issuing the MP) to the Previous Year of Commencement for Connection to Sewerage)

- Increment households after 2024 are to build new houses and new impermeable septic tanks.

2) Sewerage Zone (in the Previous Year of Commencement for Connection to Sewerage to 2050)

- Increment households after 2024 are to build new houses and to connect to sewerage.
- Both the existing permeable and impermeable septic tanks are to change to sewerage system, and the rate of change to sewerage system is shown in Table B3-2.
- Considering the current situation of septic tanks, wastewater from 3 households is to flow into one septic tank

3) Outside of Sewerage Zone

- Increment households after 2024 are to build new houses and new impermeable septic tanks.
- The existing households as of 2023 use permeable septic tanks. These houses are to be built newly 2050. At building newly, the existing septic tanks are to be removed and new impermeable septic tanks are to be installed.
- Considering the current situation of septic tanks, wastewater from 1 household is to flow into one septic tank

(2) Forecast Result

Table B3-5 to Table B3-12 show the forecast results for each sewerage treatment area. In addition, Table B3-13 shows the forecast results of the number of new impermeable septic tanks.

Table B3-12 (forecast results for the entire Pokhara city) also shows the prediction results for the population and number of households. The conversion from population to households is to use the average household size by Ward from the 2011 census.

Table B3-5 Population Forecast Results (West Sewerage Zone Phase 1)

{ Population unit:person }

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	74,420											
2024	75,793	0	1,373	74,420	75,793	0	1,373	74,420	0	0	0	0
2025	77,167	0	2,747	74,420	77,167	0	2,747	74,420	0	0	0	0
2026	78,540	0	4,120	74,420	78,540	0	4,120	74,420	0	0	0	0
2027	79,914	0	5,494	74,420	79,914	0	5,494	74,420	0	0	0	0
2028	81,287	0	6,867	74,420	81,287	0	6,867	74,420	0	0	0	0
2029	82,661	0	8,241	74,420	82,661	0	8,241	74,420	0	0	0	0
2030	84,034	0	9,614	74,420	84,034	0	9,614	74,420	0	0	0	0
2031	85,409	18,182	7,691	59,536	85,409	18,182	7,691	59,536	0	0	0	0
2032	86,781	36,361	5,768	44,652	86,781	36,361	5,768	44,652	0	0	0	0
2033	88,156	54,542	3,846	29,768	88,156	54,542	3,846	29,768	0	0	0	0
2034	89,528	72,721	1,923	14,884	89,528	72,721	1,923	14,884	0	0	0	0
2035	90,903	90,903	0	0	90,903	90,903	0	0	0	0	0	0
2036	92,276	92,276	0	0	92,276	92,276	0	0	0	0	0	0
2037	93,649	93,649	0	0	93,649	93,649	0	0	0	0	0	0
2038	95,024	95,024	0	0	95,024	95,024	0	0	0	0	0	0
2039	96,396	96,396	0	0	96,396	96,396	0	0	0	0	0	0
2040	97,771	97,771	0	0	97,771	97,771	0	0	0	0	0	0
2041	99,144	99,144	0	0	99,144	99,144	0	0	0	0	0	0
2042	100,518	100,518	0	0	100,518	100,518	0	0	0	0	0	0
2043	101,891	101,891	0	0	101,891	101,891	0	0	0	0	0	0
2044	103,265	103,265	0	0	103,265	103,265	0	0	0	0	0	0
2045	104,638	104,638	0	0	104,638	104,638	0	0	0	0	0	0
2046	106,012	106,012	0	0	106,012	106,012	0	0	0	0	0	0
2047	107,385	107,385	0	0	107,385	107,385	0	0	0	0	0	0
2048	108,759	108,759	0	0	108,759	108,759	0	0	0	0	0	0
2049	110,132	110,132	0	0	110,132	110,132	0	0	0	0	0	0
2050	111,506	111,506	0	0	111,506	111,506	0	0	0	0	0	0

Source: JET

Table B3-6 Population Forecast Results (West Sewerage Zone Phase 2)

{ Population unit:person }

Year	Total			Sewerage coverage area				Outside of Sewerage coverage area				
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	202,964											
2024	207,000	0	4,971	202,029	181,312	0	3,607	177,705	25,688	0	1,364	24,324
2025	211,037	0	9,943	201,094	184,918	0	7,213	177,705	26,119	0	2,730	23,389
2026	215,075	0	14,916	200,159	188,527	0	10,822	177,705	26,548	0	4,094	22,454
2027	219,109	0	19,885	199,224	192,131	0	14,426	177,705	26,978	0	5,459	21,519
2028	223,145	0	24,856	198,289	195,738	0	18,033	177,705	27,407	0	6,823	20,584
2029	227,183	0	29,829	197,354	199,346	0	21,641	177,705	27,837	0	8,188	19,649
2030	231,219	0	34,800	196,419	202,952	0	25,247	177,705	28,267	0	9,553	18,714
2031	235,255	0	39,771	195,484	206,558	0	28,853	177,705	28,697	0	10,918	17,779
2032	239,290	0	44,741	194,549	210,164	0	32,459	177,705	29,126	0	12,282	16,844
2033	243,328	0	49,714	193,614	213,772	0	36,067	177,705	29,556	0	13,647	15,909
2034	247,364	46,360	43,867	157,137	217,377	46,360	28,854	142,163	29,987	0	15,013	14,974
2035	251,401	92,719	38,020	120,662	220,984	92,719	21,642	106,623	30,417	0	16,378	14,039
2036	255,438	139,085	32,167	84,186	224,592	139,085	14,425	71,082	30,846	0	17,742	13,104
2037	259,476	185,445	26,320	47,711	228,200	185,445	7,213	35,542	31,276	0	19,107	12,169
2038	263,509	231,803	20,472	11,234	231,803	231,803	0	0	31,706	0	20,472	11,234
2039	267,547	235,411	21,837	10,299	235,411	235,411	0	0	32,136	0	21,837	10,299
2040	271,583	239,018	23,201	9,364	239,018	239,018	0	0	32,565	0	23,201	9,364
2041	275,619	242,624	24,566	8,429	242,624	242,624	0	0	32,995	0	24,566	8,429
2042	279,656	246,231	25,931	7,494	246,231	246,231	0	0	33,425	0	25,931	7,494
2043	283,691	249,836	27,296	6,559	249,836	249,836	0	0	33,855	0	27,296	6,559
2044	287,729	253,444	28,661	5,624	253,444	253,444	0	0	34,285	0	28,661	5,624
2045	291,763	257,049	30,025	4,689	257,049	257,049	0	0	34,714	0	30,025	4,689
2046	295,803	260,659	31,390	3,754	260,659	260,659	0	0	35,144	0	31,390	3,754
2047	299,839	264,265	32,755	2,819	264,265	264,265	0	0	35,574	0	32,755	2,819
2048	303,875	267,871	34,120	1,884	267,871	267,871	0	0	36,004	0	34,120	1,884
2049	307,909	271,476	35,484	949	271,476	271,476	0	0	36,433	0	35,484	949
2050	311,947	275,083	36,864	0	275,083	275,083	0	0	36,864	0	36,864	0

Source: JET

Table B3-7 Population Forecast Results (Central Sewerage Zone Phase 1)

{ Population unit:person }

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	66,524											
2024	68,282	0	1,758	66,524	68,282	0	1,758	66,524	0	0	0	0
2025	70,039	0	3,515	66,524	70,039	0	3,515	66,524	0	0	0	0
2026	71,797	0	5,273	66,524	71,797	0	5,273	66,524	0	0	0	0
2027	73,556	0	7,032	66,524	73,556	0	7,032	66,524	0	0	0	0
2028	75,314	0	8,790	66,524	75,314	0	8,790	66,524	0	0	0	0
2029	77,072	0	10,548	66,524	77,072	0	10,548	66,524	0	0	0	0
2030	78,831	0	12,307	66,524	78,831	0	12,307	66,524	0	0	0	0
2031	80,589	0	14,065	66,524	80,589	0	14,065	66,524	0	0	0	0
2032	82,346	0	15,822	66,524	82,346	0	15,822	66,524	0	0	0	0
2033	84,104	0	17,580	66,524	84,104	0	17,580	66,524	0	0	0	0
2034	85,863	0	19,339	66,524	85,863	0	19,339	66,524	0	0	0	0
2035	87,622	0	21,098	66,524	87,622	0	21,098	66,524	0	0	0	0
2036	89,380	0	22,856	66,524	89,380	0	22,856	66,524	0	0	0	0
2037	91,139	0	24,615	66,524	91,139	0	24,615	66,524	0	0	0	0
2038	92,896	24,543	18,460	49,893	92,896	24,543	18,460	49,893	0	0	0	0
2039	94,654	49,086	12,307	33,261	94,654	49,086	12,307	33,261	0	0	0	0
2040	96,412	73,628	6,153	16,631	96,412	73,628	6,153	16,631	0	0	0	0
2041	98,171	98,171	0	0	98,171	98,171	0	0	0	0	0	0
2042	99,929	99,929	0	0	99,929	99,929	0	0	0	0	0	0
2043	101,687	101,687	0	0	101,687	101,687	0	0	0	0	0	0
2044	103,445	103,445	0	0	103,445	103,445	0	0	0	0	0	0
2045	105,203	105,203	0	0	105,203	105,203	0	0	0	0	0	0
2046	106,961	106,961	0	0	106,961	106,961	0	0	0	0	0	0
2047	108,719	108,719	0	0	108,719	108,719	0	0	0	0	0	0
2048	110,478	110,478	0	0	110,478	110,478	0	0	0	0	0	0
2049	112,236	112,236	0	0	112,236	112,236	0	0	0	0	0	0
2050	113,994	113,994	0	0	113,994	113,994	0	0	0	0	0	0

Source: JET

Table B3-8 Population Forecast Results (Central Sewerage Zone Phase 2)

{ Population unit:person }

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	64,079											
2024	66,015	0	2,283	63,732	56,386	0	1,665	54,721	9,629	0	618	9,011
2025	67,950	0	4,565	63,385	58,052	0	3,331	54,721	9,898	0	1,234	8,664
2026	69,884	0	6,846	63,038	59,717	0	4,996	54,721	10,167	0	1,850	8,317
2027	71,820	0	9,129	62,691	61,383	0	6,662	54,721	10,437	0	2,467	7,970
2028	73,755	0	11,411	62,344	63,048	0	8,327	54,721	10,707	0	3,084	7,623
2029	75,690	0	13,693	61,997	64,714	0	9,993	54,721	10,976	0	3,700	7,276
2030	77,624	0	15,974	61,650	66,379	0	11,658	54,721	11,245	0	4,316	6,929
2031	79,560	0	18,257	61,303	68,045	0	13,324	54,721	11,515	0	4,933	6,582
2032	81,495	0	20,539	60,956	69,709	0	14,988	54,721	11,786	0	5,551	6,235
2033	83,430	0	22,821	60,609	71,375	0	16,654	54,721	12,055	0	6,167	5,888
2034	85,365	0	25,103	60,262	73,040	0	18,319	54,721	12,325	0	6,784	5,541
2035	87,301	0	27,386	59,915	74,707	0	19,986	54,721	12,594	0	7,400	5,194
2036	89,236	0	29,668	59,568	76,372	0	21,651	54,721	12,864	0	8,017	4,847
2037	91,171	0	31,950	59,221	78,038	0	23,317	54,721	13,133	0	8,633	4,500
2038	93,106	0	34,232	58,874	79,703	0	24,982	54,721	13,403	0	9,250	4,153
2039	95,041	0	36,514	58,527	81,369	0	26,648	54,721	13,672	0	9,866	3,806
2040	96,976	0	38,796	58,180	83,033	0	28,312	54,721	13,943	0	10,484	3,459
2041	98,911	26,171	28,587	44,153	84,699	26,171	17,487	41,041	14,212	0	11,100	3,112
2042	100,846	47,348	23,374	30,124	86,364	47,348	11,657	27,359	14,482	0	11,717	2,765
2043	102,782	68,520	18,164	16,098	88,030	68,520	5,830	13,680	14,752	0	12,334	2,418
2044	104,716	89,695	12,950	2,071	89,695	89,695	0	0	15,021	0	12,950	2,071
2045	106,651	91,361	13,566	1,724	91,361	91,361	0	0	15,290	0	13,566	1,724
2046	108,586	93,026	14,183	1,377	93,026	93,026	0	0	15,560	0	14,183	1,377
2047	110,522	94,692	14,800	1,030	94,692	94,692	0	0	15,830	0	14,800	1,030
2048	112,456	96,357	15,416	683	96,357	96,357	0	0	16,099	0	15,416	683
2049	114,391	98,022	16,033	336	98,022	98,022	0	0	16,369	0	16,033	336
2050	116,327	99,687	16,640	0	99,687	99,687	0	0	16,640	0	16,640	0

Source: JET

Table B3-9 Population Forecast Results (Hemja Sewerage Zone)

{ Population unit:person }

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	17,285											
2024	17,731	0	574	17,157	14,185	0	357	13,828	3,546	0	217	3,329
2025	18,177	0	1,148	17,029	14,542	0	714	13,828	3,635	0	434	3,201
2026	18,623	0	1,722	16,901	14,898	0	1,070	13,828	3,725	0	652	3,073
2027	19,069	0	2,296	16,773	15,255	0	1,427	13,828	3,814	0	869	2,945
2028	19,514	0	2,869	16,645	15,612	0	1,784	13,828	3,902	0	1,085	2,817
2029	19,960	0	3,443	16,517	15,968	0	2,140	13,828	3,992	0	1,303	2,689
2030	20,406	0	4,017	16,389	16,325	0	2,497	13,828	4,081	0	1,520	2,561
2031	20,852	0	4,591	16,261	16,682	0	2,854	13,828	4,170	0	1,737	2,433
2032	21,298	0	5,165	16,133	17,038	0	3,210	13,828	4,260	0	1,955	2,305
2033	21,744	0	5,739	16,005	17,395	0	3,567	13,828	4,349	0	2,172	2,177
2034	22,190	0	6,313	15,877	17,752	0	3,924	13,828	4,438	0	2,389	2,049
2035	22,635	0	6,886	15,749	18,108	0	4,280	13,828	4,527	0	2,606	1,921
2036	23,081	0	7,460	15,621	18,465	0	4,637	13,828	4,616	0	2,823	1,793
2037	23,527	0	8,034	15,493	18,822	0	4,994	13,828	4,705	0	3,040	1,665
2038	23,973	0	8,608	15,365	19,178	0	5,350	13,828	4,795	0	3,258	1,537
2039	24,419	0	9,182	15,237	19,535	0	5,707	13,828	4,884	0	3,475	1,409
2040	24,865	0	9,756	15,109	19,892	0	6,064	13,828	4,973	0	3,692	1,281
2041	25,310	0	10,329	14,981	20,248	0	6,420	13,828	5,062	0	3,909	1,153
2042	25,756	0	10,903	14,853	20,605	0	6,777	13,828	5,151	0	4,126	1,025
2043	26,202	0	11,477	14,725	20,962	0	7,134	13,828	5,240	0	4,343	897
2044	26,648	0	12,051	14,597	21,318	0	7,490	13,828	5,330	0	4,561	769
2045	27,094	7,392	9,796	9,906	21,675	7,392	5,018	9,265	5,419	0	4,778	641
2046	27,540	14,783	7,542	5,215	22,032	14,783	2,547	4,702	5,508	0	4,995	513
2047	27,985	22,388	5,212	385	22,388	22,388	0	0	5,597	0	5,212	385
2048	28,431	22,745	5,429	257	22,745	22,745	0	0	5,686	0	5,429	257
2049	28,877	23,102	5,646	129	23,102	23,102	0	0	5,775	0	5,646	129
2050	29,323	23,458	5,865	0	23,458	23,458	0	0	5,865	0	5,865	0

Source: JET

Table B3-10 Population Forecast Results (East Sewerage Zone Phase 1)

{ Population unit:person }

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	82,955											
2024	85,115	0	3,123	81,992	58,517	0	1,541	56,976	26,598	0	1,582	25,016
2025	87,275	0	6,246	81,029	60,056	0	3,080	56,976	27,219	0	3,166	24,053
2026	89,435	0	9,369	80,066	61,599	0	4,623	56,976	27,836	0	4,746	23,090
2027	91,597	0	12,494	79,103	63,141	0	6,165	56,976	28,456	0	6,329	22,127
2028	93,758	0	15,618	78,140	64,682	0	7,706	56,976	29,076	0	7,912	21,164
2029	95,919	0	18,742	77,177	66,223	0	9,247	56,976	29,696	0	9,495	20,201
2030	98,079	0	21,865	76,214	67,763	0	10,787	56,976	30,316	0	11,078	19,238
2031	100,239	0	24,988	75,251	69,305	0	12,329	56,976	30,934	0	12,659	18,275
2032	102,400	0	28,112	74,288	70,846	0	13,870	56,976	31,554	0	14,242	17,312
2033	104,561	0	31,236	73,325	72,387	0	15,411	56,976	32,174	0	15,825	16,349
2034	106,721	0	34,359	72,362	73,929	0	16,953	56,976	32,792	0	17,406	15,386
2035	108,882	0	37,483	71,399	75,470	0	18,494	56,976	33,412	0	18,989	14,423
2036	111,043	0	40,607	70,436	77,009	0	20,033	56,976	34,034	0	20,574	13,460
2037	113,203	0	43,730	69,473	78,551	0	21,575	56,976	34,652	0	22,155	12,497
2038	115,363	0	46,853	68,510	80,093	0	23,117	56,976	35,270	0	23,736	11,534
2039	117,524	0	49,977	67,547	81,634	0	24,658	56,976	35,890	0	25,319	10,571
2040	119,685	0	53,101	66,584	83,174	0	26,198	56,976	36,511	0	26,903	9,608
2041	121,846	0	56,225	65,621	84,715	0	27,739	56,976	37,131	0	28,486	8,645
2042	124,006	0	59,348	64,658	86,256	0	29,280	56,976	37,750	0	30,068	7,682
2043	126,167	0	62,472	63,695	87,799	0	30,823	56,976	38,368	0	31,649	6,719
2044	128,327	0	65,595	62,732	89,338	0	32,362	56,976	38,989	0	33,233	5,756
2045	130,488	0	68,719	61,769	90,880	0	33,904	56,976	39,608	0	34,815	4,793
2046	132,648	0	71,842	60,806	92,422	0	35,446	56,976	40,226	0	36,396	3,830
2047	134,810	0	74,967	59,843	93,962	0	36,986	56,976	40,848	0	37,981	2,867
2048	136,970	32,549	64,344	40,077	95,503	32,549	24,781	38,173	41,467	0	39,563	1,904
2049	139,131	65,097	53,721	20,313	97,044	65,097	12,575	19,372	42,087	0	41,146	941
2050	141,291	98,585	42,706	0	98,585	98,585	0	0	42,706	0	42,706	0

Source: JET

Table B3-11 Population Forecast Results (Central Sewerage Zone Phase 1)

{ Population unit:person }

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	34,088											
2024	34,088	0	1,264	32,824	0	0	0	0	34,088	0	1,264	32,824
2025	34,088	0	2,528	31,560	0	0	0	0	34,088	0	2,528	31,560
2026	34,088	0	3,792	30,296	0	0	0	0	34,088	0	3,792	30,296
2027	34,088	0	5,056	29,032	0	0	0	0	34,088	0	5,056	29,032
2028	34,088	0	6,320	27,768	0	0	0	0	34,088	0	6,320	27,768
2029	34,088	0	7,584	26,504	0	0	0	0	34,088	0	7,584	26,504
2030	34,088	0	8,848	25,240	0	0	0	0	34,088	0	8,848	25,240
2031	34,088	0	10,112	23,976	0	0	0	0	34,088	0	10,112	23,976
2032	34,088	0	11,376	22,712	0	0	0	0	34,088	0	11,376	22,712
2033	34,088	0	12,640	21,448	0	0	0	0	34,088	0	12,640	21,448
2034	34,088	0	13,904	20,184	0	0	0	0	34,088	0	13,904	20,184
2035	34,088	0	15,168	18,920	0	0	0	0	34,088	0	15,168	18,920
2036	34,088	0	16,432	17,656	0	0	0	0	34,088	0	16,432	17,656
2037	34,088	0	17,696	16,392	0	0	0	0	34,088	0	17,696	16,392
2038	34,088	0	18,960	15,128	0	0	0	0	34,088	0	18,960	15,128
2039	34,088	0	20,224	13,864	0	0	0	0	34,088	0	20,224	13,864
2040	34,088	0	21,488	12,600	0	0	0	0	34,088	0	21,488	12,600
2041	34,088	0	22,752	11,336	0	0	0	0	34,088	0	22,752	11,336
2042	34,088	0	24,016	10,072	0	0	0	0	34,088	0	24,016	10,072
2043	34,088	0	25,280	8,808	0	0	0	0	34,088	0	25,280	8,808
2044	34,088	0	26,544	7,544	0	0	0	0	34,088	0	26,544	7,544
2045	34,088	0	27,808	6,280	0	0	0	0	34,088	0	27,808	6,280
2046	34,088	0	29,072	5,016	0	0	0	0	34,088	0	29,072	5,016
2047	34,088	0	30,336	3,752	0	0	0	0	34,088	0	30,336	3,752
2048	34,088	0	31,600	2,488	0	0	0	0	34,088	0	31,600	2,488
2049	34,088	0	32,864	1,224	0	0	0	0	34,088	0	32,864	1,224
2050	34,088	0	34,088	0	0	0	0	0	34,088	0	34,088	0

Source: JET

Table B3-12 Population and Household Forecast Results (entire Pokhara City)

{ Population unit:person }

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	542,315											
2024	554,024	0	15,346	538,678	454,475	0	10,301	444,174	99,549	0	5,045	94,504
2025	565,733	0	30,692	535,041	464,774	0	20,600	444,174	100,959	0	10,092	90,867
2026	577,442	0	46,038	531,404	475,078	0	30,904	444,174	102,364	0	15,134	87,230
2027	589,153	0	61,386	527,767	485,380	0	41,206	444,174	103,773	0	20,180	83,593
2028	600,861	0	76,731	524,130	495,681	0	51,507	444,174	105,180	0	25,224	79,956
2029	612,573	0	92,080	520,493	505,984	0	61,810	444,174	106,589	0	30,270	76,319
2030	624,281	0	107,425	516,856	516,284	0	72,110	444,174	107,997	0	35,315	72,682
2031	635,992	18,182	119,475	498,335	526,588	18,182	79,116	429,290	109,404	0	40,359	69,045
2032	647,698	36,361	131,523	479,814	536,884	36,361	86,117	414,406	110,814	0	45,406	65,408
2033	659,411	54,542	143,576	461,293	547,189	54,542	93,125	399,522	112,222	0	50,451	61,771
2034	671,119	119,081	144,808	407,230	557,489	119,081	89,312	349,096	113,630	0	55,496	58,134
2035	682,832	183,622	146,041	353,169	567,794	183,622	85,500	298,672	115,038	0	60,541	54,497
2036	694,542	231,361	149,190	313,991	578,094	231,361	83,602	263,131	116,448	0	65,588	50,860
2037	706,253	279,094	152,345	274,814	588,399	279,094	81,714	227,591	117,854	0	70,631	47,223
2038	717,959	351,370	147,585	219,004	598,697	351,370	71,909	175,418	119,262	0	75,676	43,586
2039	729,669	380,893	150,041	198,735	608,999	380,893	69,320	158,786	120,670	0	80,721	39,949
2040	741,380	410,417	152,495	178,468	619,300	410,417	66,727	142,156	122,080	0	85,768	36,312
2041	753,089	466,110	142,459	144,520	629,601	466,110	51,646	111,845	123,488	0	90,813	32,675
2042	764,799	494,026	143,572	127,201	639,903	494,026	47,714	98,163	124,896	0	95,858	29,038
2043	776,508	521,934	144,689	109,885	650,205	521,934	43,787	84,484	126,303	0	100,902	25,401
2044	788,218	549,849	145,801	92,568	660,505	549,849	39,852	70,804	127,713	0	105,949	21,764
2045	799,925	565,643	149,914	84,368	670,806	565,643	38,922	66,241	129,119	0	110,992	18,127
2046	811,638	581,441	154,029	76,168	681,112	581,441	37,993	61,678	130,526	0	116,036	14,490
2047	823,348	597,449	158,070	67,829	691,411	597,449	36,986	56,976	131,937	0	121,084	10,853
2048	835,057	638,759	150,909	45,389	701,713	638,759	24,781	38,173	133,344	0	126,128	7,216
2049	846,764	680,065	143,748	22,951	712,012	680,065	12,575	19,372	134,752	0	131,173	3,579
2050	858,476	722,313	136,163	0	722,313	722,313	0	0	136,163	0	136,163	0

[Households unit:household]

Year	Total				Sewerage coverage area				Outside of Sewerage coverage area			
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable
2023	142,163											
2024	145,200	0	3,967	141,233	119,754	0	2,682	117,072	25,446	0	1,285	24,161
2025	148,239	0	7,937	140,302	122,435	0	5,362	117,073	25,804	0	2,575	23,229
2026	151,276	0	11,906	139,372	125,118	0	8,048	117,070	26,160	0	3,858	22,302
2027	154,318	0	15,872	138,446	127,803	0	10,727	117,076	26,515	0	5,145	21,370
2028	157,353	0	19,838	137,515	130,482	0	13,408	117,074	26,871	0	6,430	20,441
2029	160,392	0	23,811	136,580	133,163	0	16,092	117,071	27,228	0	7,719	19,509
2030	163,431	0	27,779	135,652	135,846	0	18,775	117,071	27,585	0	9,004	18,581
2031	166,470	4,894	30,862	130,713	138,529	4,894	20,573	113,062	27,940	0	10,289	17,651
2032	169,505	9,788	33,943	125,778	141,211	9,788	22,368	109,055	28,298	0	11,575	16,723
2033	172,544	14,681	37,032	120,829	143,890	14,681	24,169	105,040	28,652	0	12,863	15,789
2034	175,585	32,015	37,250	106,319	146,573	32,015	23,101	91,457	29,011	0	14,149	14,862
2035	178,623	49,349	37,466	91,806	149,255	49,349	22,030	77,876	29,366	0	15,436	13,930
2036	181,662	62,161	38,196	81,303	151,938	62,161	21,475	68,302	29,722	0	16,721	13,001
2037	184,699	74,969	38,928	70,807	154,623	74,969	20,923	58,731	30,081	0	18,005	12,076
2038	187,741	94,161	37,607	55,972	157,304	94,161	18,315	44,828	30,436	0	19,292	11,144
2039	190,777	101,870	38,196	50,714	159,989	101,870	17,619	40,500	30,791	0	20,577	10,214
2040	193,816	109,573	38,789	45,453	162,667	109,573	16,923	36,171	31,148	0	21,866	9,282
2041	196,855	123,953	36,206	36,696	165,350	123,953	13,052	28,345	31,505	0	23,154	8,351
2042	199,893	131,137	36,486	32,271	168,033	131,137	12,049	24,847	31,861	0	24,437	7,424
2043	202,932	138,317	36,773	27,840	170,714	138,317	11,048	21,349	32,216	0	25,725	6,491
2044	205,970	145,499	37,055	23,416	173,396	145,499	10,044	17,853	32,574	0	27,011	5,563
2045	209,004	149,522	38,122	21,363	176,077	149,522	9,825	16,730	32,930	0	28,297	4,633
2046	212,043	153,544	39,187	19,312	178,755	153,544	9,607	15,604	33,288	0	29,580	3,708
2047	215,083	157,623	40,238	17,219	181,438	157,623	9,371	14,444	33,642	0	30,867	2,775
2048	218,122	168,164	38,431	11,526	184,122	168,164	6,278	9,680	33,999	0	32,153	1,846
2049	221,156	178,703	36,624	5,829	186,801	178,703	3,185	4,913	34,355	0	33,439	916
2050	224,197	189,485	34,712	0	189,485	189,485	0	0	34,712	0	34,712	0

Source: JET

Table B3-13 Number of New Impermeable Septic Tanks (Outside of Sewerage Zone)

unit : number of seeptic tanks

Area name	West-1		West-2		Central-1		Central-2		Hemja		East		On-site		Total	
Area type	Sewerage area	On-site area	Sewerage area	On-site area	Sewerage area	On-site area	Sewerage area	On-site area	Sewerage area	On-site area	Sewerage area	On-site area	Sewerage area	On-site area	Sewerage area	On-site area
Wastewater treatment method	Septic tank (impermeable)	Septic tank (permeable)	Septic tank (impermeable)	Septic tank (permeable)	Septic tank (impermeable)	Septic tank (permeable)	Septic tank (impermeable)	Septic tank (permeable)	Septic tank (impermeable)	Septic tank (permeable)	Septic tank (impermeable)	Septic tank (permeable)	Septic tank (impermeable)	Septic tank (permeable)	Septic tank (impermeable)	Septic tank (permeable)
Nmber of users	15	5	15	5	15	5	15	5	15	5	15	5	15	5	15	5
Year																
2023																
2024	123	0	321	345	152	0	140	154	29	53	130	404	0	329	895	1,285
2025	122	0	316	347	153	0	142	154	30	54	130	405	0	330	893	1,290
2026	124	0	320	345	152	0	141	152	29	54	130	403	0	329	896	1,283
2027	122	0	316	346	151	0	142	154	29	53	130	403	0	331	890	1,287
2028	122	0	320	346	154	0	140	154	29	53	131	405	0	327	896	1,285
2029	123	0	318	346	151	0	142	154	30	54	130	405	0	330	894	1,289
2030	124	0	319	345	152	0	140	152	29	53	130	405	0	330	894	1,285
2031	0	0	318	347	153	0	141	154	29	54	132	402	0	328	773	1,285
2032	0	0	318	345	152	0	142	154	30	54	129	404	0	329	771	1,286
2033	0	0	320	345	151	0	140	154	29	53	129	405	0	331	769	1,288
2034	0	0	0	347	153	0	142	154	29	53	131	403	0	329	455	1,286
2035	0	0	0	346	152	0	141	152	29	54	130	405	0	330	452	1,287
2036	0	0	0	345	153	0	141	154	30	53	129	403	0	330	453	1,285
2037	0	0	0	346	151	0	141	154	29	54	130	403	0	327	451	1,284
2038	0	0	0	345	0	0	140	154	29	53	131	405	0	330	300	1,287
2039	0	0	0	346	0	0	142	152	30	54	130	404	0	329	302	1,285
2040	0	0	0	346	0	0	141	154	29	53	129	406	0	330	299	1,289
2041	0	0	0	346	0	0	0	154	29	54	132	404	0	330	161	1,288
2042	0	0	0	345	0	0	0	154	29	53	130	402	0	329	159	1,283
2043	0	0	0	346	0	0	0	154	30	54	131	405	0	329	161	1,288
2044	0	0	0	347	0	0	0	152	29	53	130	404	0	330	159	1,286
2045	0	0	0	345	0	0	0	154	0	54	130	404	0	329	130	1,286
2046	0	0	0	346	0	0	0	154	0	53	130	402	0	328	130	1,283
2047	0	0	0	345	0	0	0	154	0	54	131	405	0	329	131	1,287
2048	0	0	0	346	0	0	0	152	0	53	0	403	0	332	0	1,286
2049	0	0	0	345	0	0	0	154	0	54	0	405	0	328	0	1,286
2050	0	0	0	350	0	0	0	152	0	54	0	398	0	319	0	1,273

Source: JET

B3.2 Amount of Sludge from On-site Sanitation

B3.2.1 Forecast for Amount of Sludge

(1) Forecast Method

- Targets for desludging are to be newly constructed impermeable septic tanks and the existing permeable septic tank as of 2022.
- Decision whether desludge is necessary or not is to be based on the measurement of scum thickness and sludge sedimentation depth as shown in Section B3.1.3. Therefore, the first desludge is to be at 24 months after registration of the septic tank ledger, and next desludge is to be every two years.
- Amount from the existing desludge is to continue as 50 m^3/day. Most of these septic tanks are located in West and Central sewerage zone. Therefore, amount of desludge is to decrease in accordance with increment of sewerage coverage in West and Central sewerage zone.
- The existing septic tanks other than above have no record of desludge, and requests for desludge from septic tank managers are not expected. Therefore, these are not included from forecast amount.
- The sludge amount is calculated by the following formula.

Planned average sludge amount = number of impermeable septic tanks two years ago × unit sludge generation

Planned desludge amount = Planned average desludge amount x Planned monthly maximum coefficient

Where,

Planned ave. sludge amount: Average daily sludge amount per year (= average for 365 days)

Planned sludge amount: Monthly ave. daily sludge amount considering fluctuations in collection amount

Monthly coefficient: Ratio of average daily sludge amount per month to average daily withdrawal amount per year

Monthly maximum coefficient of variation: Maximum value of monthly coefficient of variation

Planned monthly maximum coefficient: 1.15 (standard value when past performance is unknown)[14]

- Collection and transport days: 6 days/week
- Recommended dimensions of septic tanks, etc.

	Septic Tank for 5 Person (For 1 Household)	Septic Tank for 15 Person (For 3 Households)
Sewerage to be treated	WC, kitchen, shower	WC, kitchen, shower
Length (m)	2	3
Breadth (m)	0.9	1.25
Liquid Depth (m)	1.4	2
Sludge removal frequency	2 years	2 years
Sludge removal amount	2m^3/unit	6m^3/unit

(2) Forecast Amount

Table B3-14 shows the forecast results of desludging volume.

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Table B3-14 Forecast Amount of Sludge from On-site Sanitation

Year	Sludge amount (unit :m^3/day)						
	Total					Sewerage	
	Subtotal	Sewerage	Septic tank impermeable	Septic tank permeable	Planned sludge amount	Planned average sludge amount	Planned sludge amount
	Sewerage area	Outside of sewerage area	Existing collection area	total			
2023							
2024			34.9	34.9	40.0	43.5	50.0
2025			34.9	34.9	40.0	43.5	50.0
2026	14.7	7.0	34.9	56.6	65.0	70.5	81.0
2027	29.4	14.1	34.9	78.4	90.0	97.7	112.0
2028	44.1	21.1	34.9	100.1	115.0	124.7	143.0
2029	58.8	28.2	34.9	121.9	140.0	151.9	175.0
2030	73.5	35.2	34.9	143.6	165.0	178.9	206.0
2031	88.2	42.3	33.5	164.0	189.0	204.3	235.0
2032	102.9	49.3	32.5	184.7	212.0	230.1	265.0
2033	112.7	56.4	31.1	200.2	230.0	249.4	287.0
2034	122.6	63.4	26.9	212.9	245.0	265.2	305.0
2035	132.4	70.5	22.3	225.2	259.0	280.5	323.0
2036	126.6	77.5	19.2	223.3	257.0	278.2	320.0
2037	120.7	84.6	16.1	221.4	255.0	275.8	317.0
2038	117.7	91.6	11.2	220.5	254.0	274.7	316.0
2039	114.6	98.7	9.4	222.7	256.0	277.4	319.0
2040	100.4	105.7	7.7	213.8	246.0	266.3	306.0
2041	96.5	112.8	4.2	213.5	246.0	266.0	306.0
2042	92.7	119.8	2.8	215.3	248.0	268.2	308.0
2043	71.5	126.9	1.4	199.8	230.0	248.9	286.0
2044	66.0	133.9	0.0	199.9	230.0	249.0	286.0
2045	60.5	141.0	0.0	201.5	232.0	251.0	289.0
2046	55.0	148.0	0.0	203.0	233.0	252.9	291.0
2047	53.8	155.1	0.0	208.9	240.0	260.2	299.0
2048	52.6	162.1	0.0	214.7	247.0	267.5	308.0
2049	51.3	169.1	0.0	220.4	253.0	274.6	316.0
2050	34.4	176.2	0.0	210.6	242.0	262.4	302.0

Source：JET

B3.3 Sludge Transportation Plan for On-site Facilities

B3.3.1 Forecast of Required Number of Transport Vehicles for Sludge

(1) Forecast Method

The newly required number of vacuum cars is calculated by the following formula.

Required number of vehicles = Planned sludge amount of collection per collection day / tank capacity of transport vehicles / number of trips per day × margin rate - number of existing vehicles

Where,

Collection system: 6 days/week, closed on public holidays

Collection days: 293 days/years

Transport vehicle tank capacity: $4m^3$

Number of items collected per trip: 2

Number of trips per day: 2 trips/day

Vacuum vehicle service life: 15 years

Surplus rate: 1.10

(2) Forecast Result

As shown in Table B3-15, it is necessary to procure a total of 86 vacuum cars (= 6 + 39 + 41, maximum of 45 vehicles to be operated annually).

The above number is an estimated value assuming that off-site and on-site facilities are developed and operated according to the plan, and that desludge from on-site facilities is carried out based on ordinances. It is important to consider the achievement status and the sludge extraction status and review them as appropriate.

Table B3-15 Forecast Number of Required Vacuum Cars

unit : cars

Year	Existing collection by vehicle (5m³)					Collection by newly vehicle (4m³)											Total number of vehicle (4m³) in operation
	Existing vehicle (5m³)		Newly vehicle (4m³)						Newly vehicle (4m³)								
	In operation	Scrap	Required	Procurement (single year)	Procurement (cumulative)	In operation	Scrap	Surplus	Required	Required (considering the existing cars)	Procurement (single year)	Procurement (Cumulative)	Scrap	In operation	Additional procurement (cumulative)	Additional procurement (single year)	In operation	
	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	
2023																		0
2024																		0
2025																		0
2026	5								5	5	5	5		5	0	0	5	5
2027	5								9	9	4	9		9	0	0	9	9
2028	5								13	13	4	13		13	0	0	13	13
2029	5								18	18	5	18		18	0	0	18	18
2030	5								22	22	4	22		22	0	0	22	22
2031		5	6	6	6	6		0	26	26	4	26		26	0	0	26	32
2032			6		6	6		0	30	30	4	30		30	0	0	30	36
2033			6		6	6		0	34	34	4	34		34	0	0	34	40
2034			5		6	6		1	37	36	2	36		36	0	0	36	42
2035			4		6	6		2	40	38	2	38		38	0	0	38	55
2036			4		6	6		2	41	39	1	39		39	0	0	39	45
2037			3		6	6		3	41	38		39		39	0	0	39	45
2038			2		6	6		4	42	38		39		39	0	0	39	45
2039			2		6	6		4	43	39		39		39	0	0	39	45
2040			1		6	6		5	41	36		39		39	0	0	39	45
2041			1		6	6		5	42	37		39	5	34	3	3	37	43
2042			1		6	6		5	42	37		39	4	30	7	4	37	43
2043			0		6	6		6	40	34		39	4	26	8	1	34	40
2044			0		6	6		6	40	34		39	5	21	13	5	34	40
2045			0		6	6		6	40	34		39	4	17	17	4	34	40
2046					6		6		40	40		39	4	13	27	10	40	40
2047					6				42	42		39	4	9	33	6	42	42
2048					6				43	43		39	4	5	38	5	43	43
2049					6				44	44		39	2	3	41	3	44	44
2050					6				42	42		39	2	1	41	0	42	42

[Existing collection by vehicle (5m³)]

①：It is planned that the 5 vehicles(5m³) will continue to operate.

②：The existing vehicle(5m³) is set to reach the end of its service life in 2031 and be scrapped.

⑨：After the 3). The required number will be set taking into account the progress of sewerage development.

④：Procure 6 new vehicles (4m³), which is the maximum value of ③.

⑤：Cumulative total of ④

⑥：The service life of the vehicle (4m³) procured in ④ is 15 years.

⑦：The vehicle (4m³) procured in ④ will reach the end of its service life in the 16 year and will be scrapped. (The required number ③ will be zero after 2043 due to sewerage development, so additional procurement will not be carried out.)

⑧："⑧=⑥-③" As the number of vehicles (4m³) required decreases year by year due to sewerage development, there will be a surplus in the number of vehicles (4m³). The spare vehicles will be engaged in sludge collection (9).

[Collection by newly vehicle (4m³)]

⑨：The required number will be set taking into account the progress of sewerage development.

⑩："⑩=⑨-⑧" Reset the required number of machines taking into account the surplus number of machines in ⑧.

⑪：If the value of ⑩ is greater than the previous year, new procurement will be made. (From 2039 onwards, there are years in which the number is larger than the previous year, but if the number of units in operation in ⑰ is ⑩ or more, no data adjustment will be made from 2039 onwards.)

⑫：Cumulative total of ⑪

⑬：The vehicle (4m³) procured in ⑩ will reach the end of its service life in the 16 year and will be scrapped.

⑭："⑭ = Cumulative total of ⑫ - ⑬" Calculate the number of operating vehicles (4m³).

⑮："⑮ = ⑩ - ⑭" Calculate the additional number of units to be procured to secure the number of units in ⑩.

⑯：If the value of ⑮ is larger than the previous year, an additional vehicle (4m³) will be procured.

⑰："⑰ = ⑭ + ⑯" Calculate the number of operating vehicles taking into account procurement, scrapping, and additional procurement. (Since the calculation result exceeds ⑩, the data adjustment mentioned in ⑪ will not be performed.)

[total]

⑱："⑱ = ⑥ + ⑰" The total number of operating vehicles (4m³) is calculated using the formula on the left.

Source: JET

B3.3.2 Sludge Transportation Plan for On-site Sanitation

(1) Sludge to be Transported

- Sludge in newly installed impermeable septic tank
- Desludged from septic tanks as of 2022

(2) Transportation Vehicles

- Vacuum car (tank capacity: $4m^3$)
- Existing vehicle (tractor with vacuum tank, tank capacity: $5m^3$)

(3) Implementing Body

- Pokhara City (Outsourcing to a private company)

(4) Implementation Method

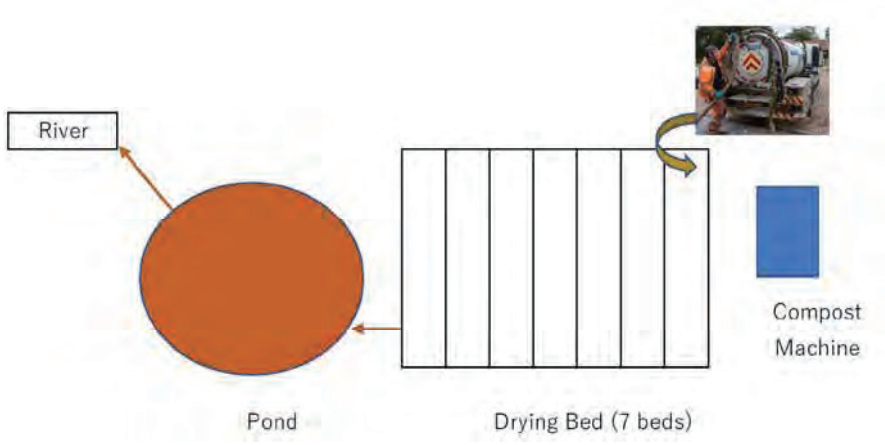
- A business operator who intends to operate a deslude business shall apply for business registration.
- Pokhara City will register business operators and hold trainings on septic tanks for business operators.
- Pokhara City will allow business operators to procure additional vehicles by their funds.

B3.3.3 Sludge Receiving from On-site Facilities

(1) Current Status of the Existing Sludge Receiving Facility

As shown in Figure B3-1, sludge is delivered by vacuum truck to the sludge receiving and the drying bed next to the waste disposal site, after which the supernatant water is discharged into the river through a pond. However, the construction equipment has not been used regularly to excavate the dried sludge, and the composting machine for reusing the sludge was purchased in 2018 but has not been operated or used, leaving the facility without proper operation and maintenance. In addition, during the rainy season, the overflowed sludge drips into the river.





Source: JET

Figure B3-1 Existing Sludge Receiving Facility

(2) Design Collection Sludge Volume

As shown in Table B3-14, the sludge withdrawal volume in 2030 is calculated to be 206 m^3 per day. However, realistically, existing sludge receiving and drying facilities are not functioning, and it is requested that an independent facility be constructed in order to reduce the discharge load to the environment. Therefore, it is desirable to construct a new independent sludge treatment plant (STP) with a capacity of 210 m^3/day by 2030, and after 2030, the sludge will be fed to the West WWTP on a priority basis, and the remainder will be treated at the independent facility, and the treatment volume will be reduced step by step. The amount of sludge input is judged to be appropriate within 0.5% of the wastewater treatment volume. Therefore, it is desirable to limit the amount of input based on this standard. In the future, it is thought that by installing sludge discharge ports for receiving sludge at each WWTP, the vacuum truck waiting time can be adjusted.

(3) Independent Sludge Treatment Plant (STP)

For the independent STP with a capacity of about 210 m^3 per day, we propose PMC the method shown in Figure B3-2, which has a proven track record in the Philippines. PMC has agreed to this method, and requested to design a storage hopper that can store sludge after dewatering. After arrival, of the vacuum car, it is a simple system in which sludge is fed into the storage tank through the screening machine on the top of the sludge storage tank directly by the attached pump, and sludge is squeezed as a dewatered cake by the sludge dewatering machine, and the supernatant water is treated by the horizontal unit type water treatment tank.

As a design condition for the independent treatment plant, sludge quality condition is estimated as follows;

- BOD: 7,000mg/L
- SS: 15,000mg/L

It has been proven that the filtrate water quality after dewatering in a multi-screw press dehydrator is one order of magnitude better than that of raw sludge due to the coagulation and filtration effect, and the following conditions are used.

- Design flow: 210m^3/day
- BOD: 250-750mg/L
- SS: 600- 1,800mg/L



Source: JET

Figure B3-2 Independent STP (Image)

(4) Receiving Sludge to West WWTP

A simple screen or sand removal system should be provided and an unobstructed pump should be used to feed an acceptable volume of sludge to the sludge storage tank or to the pre-treatment after dilution.

(5) Impact on Water Treatment at West WWTP

Up to 0.5% of the wastewater treatment flow will not be affected by the West WWTP. Therefore, up to 180 m^3/day, which is 0.5% of the average daily wastewater flow of 36,250 m^3/day in Phase 1 of the West WWTP, can be accepted. As shown in Table B3-14, the maximum collection of sludge is 322 m^3/day, so 112 m^3/day (=322 - 210) of sludge can be accepted at the West WWTP after subtracting the STP (210 m^3/day).

B4 Construction and O&M Cost for Wastewater Management

B4.1 Off-site (Sewage)

B4.1.1 Project Cost

The project cost of sewerage system is construction cost (direct cost, indirect cost) and other expenses estimated as follows.

(1) Direct Construction Cost

Direct construction costs are construction cost of WWTP, Sewage Pumping Station, Sewerage Pipeline, and House Connection.

(2) Indirect Cost and Other Expenses

Indirect cost and other expenses are estimated using the method shown in Table B4-1.

Table B4-1 Condition of Indirect Cost and Other Expenses

Item	Applicable	Remarks
Administration Cost	5% of Direct Construction Cost	Includes temporary facility cost, site management cost, and general items other than direct construction costs included in other construction contracts.
Engineering Cost	7% of Direct Construction Cost	

Item	Applicable	Remarks
Physical Contingency	5% of Direct Construction Cost	To cover unforeseen uncertainties at the time of investigation.
Land Acquisition Cost	The site of the sewage treatment plant is assumed to be public, and no cost.	If the site is privately owned, it is necessary to record the land acquisition cost separately.
VAT	VAT 13%	Applies to all construction costs

Source: JET

(3) Estimate Item of Sewerage System

Estimate item of sewerage system are shown in Table B4-2.

Table B4-2 Estimate Item of Sewerage System

Item	1. West 1	2. West 2	3. Central 1	4. Central 2	5. Hemja	6. East
Sewer Pipeline	82.3km	236.4km	93.1km	166.7km	45.6km	204.0km
Manhole Pumping station	75	141	101	83	24	36
WWTP	1Unit 72,500m^3/day West1: 1/4, 2/4 West2: 3/4, 4/4		1Unit 39,000m^3/day Central1: 1/4, 2/4, 3/4 Central2: 4/4		1Unit 4,500m^3/day	1Unit 18,000m^3/day
House Connection, Sanitary pipe	29,988	73,664	29,622	25,422	5,776	24,964

Source: JET

(4) Project Cost for Sewerage System

Project cost of sewerage system (construction cost and other expenses) is shown in Table B4-3. Each treatment plants are separated as follows;

West area : Phase-1.1, Phase-1.2, Phase-2.1 Phase-2.2
Central area : Phase-1.1, Phase-1.2, Phase-2.1 Phase-2.2
Hemja area : No separate
East area : Phase-1.1, Phase-1.2

The breakdown of costs is shown in Appendix-8.

Table B4-3 Project Cost for Sewerage System

Project Cost for Off-Site

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
1.1	West Phase-1.1					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	1,934,781,500	2,096,335,756
		Manhole Pumping station		LS	750,000,000	812,625,000
		WWTP	1	LS	2,356,250,000	2,552,996,875
		House Connection, Sanitary pipe		LS	2,099,160,000	2,274,439,860
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,213,832,555	1,315,187,574
	SUB TOTAL				8,354,024,055	9,051,585,065
(3)	VAT	13%			1,086,023,127	1,176,706,058
	TOTAL				9,440,047,182	10,228,291,123
1.2	West Phase-1.2					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	1,934,781,500	2,096,335,756
		Manhole Pumping station		LS	750,000,000	812,625,000

Project Cost for Off-Site

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
		WWTP	1	LS	2,356,250,000	2,552,996,875
		House Connection, Sanitary pipe		LS	2,099,160,000	2,274,439,860
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,213,832,555	1,315,187,574
	SUB TOTAL				8,354,024,055	9,051,585,065
(3)	VAT	13%			1,086,023,127	1,176,706,058
	TOTAL				9,440,047,182	10,228,291,123
2.1	West Phase-2.1					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	4,953,134,200	5,366,720,905
		Manhole Pumping station		LS	1,410,000,000	1,527,735,000
		WWTP	1	LS	2,356,250,000	2,552,996,875
		House Connection, Sanitary pipe		LS	5,156,480,000	5,587,046,080
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	2,358,896,914	2,555,864,806
	SUB TOTAL				16,234,761,114	17,590,363,666
(3)	VAT	13%			2,110,518,945	2,286,747,277
	TOTAL				18,345,280,059	19,877,110,943
2.2	West Phase-2.2					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	4,953,134,200	5,366,720,905
		Manhole Pumping station		LS	1,410,000,000	1,527,735,000
		WWTP	1	LS	2,356,250,000	2,552,996,875
		House Connection, Sanitary pipe		LS	5,156,480,000	5,587,046,080
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	2,358,896,914	2,555,864,806
	SUB TOTAL				16,234,761,114	17,590,363,666
(3)	VAT	13%			2,110,518,945	2,286,747,277
	TOTAL				18,345,280,059	19,877,110,943
3.1	Central Phase-1.1					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	2,143,029,200	2,321,972,139
		Manhole Pumping station		LS	1,010,000,000	1,094,335,000
		WWTP	1	LS	1,267,500,000	1,373,336,250
		House Connection, Sanitary pipe		LS	2,073,540,000	2,246,680,590
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,103,991,764	1,196,175,076
	SUB TOTAL				7,598,060,964	8,232,499,055
(3)	VAT	13%			987,747,925	1,070,224,877
	TOTAL				8,585,808,889	9,302,723,932
3.2	Central Phase-1.2					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	2,143,029,200	2,321,972,139
		Manhole Pumping station		LS	1,010,000,000	1,094,335,000
		WWTP	1	LS	1,267,500,000	1,373,336,250
		House Connection, Sanitary pipe		LS	2,073,540,000	2,246,680,590

Project Cost for Off-Site

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,103,991,764	1,196,175,076
	SUB TOTAL				7,598,060,964	8,232,499,055
(3)	VAT	13%			987,747,925	1,070,224,877
	TOTAL				8,585,808,889	9,302,723,932
4.1	Central Phase-2.1					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	3,274,537,800	3,547,961,706
		Manhole Pumping station		LS	830,000,000	899,305,000
		WWTP	1	LS	1,267,500,000	1,373,336,250
		House Connection, Sanitary pipe		LS	1,779,540,000	1,928,131,590
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,215,768,226	1,317,284,872
	SUB TOTAL				8,367,346,026	9,066,019,418
(3)	VAT	13%			1,087,754,983	1,178,582,524
	TOTAL				9,455,101,009	10,244,601,942
4.2	Central Phase-2.2					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	3,274,537,800	3,547,961,706
		Manhole Pumping station		LS	830,000,000	899,305,000
		WWTP	1	LS	1,267,500,000	1,373,336,250
		House Connection, Sanitary pipe		LS	1,779,540,000	1,928,131,590
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,215,768,226	1,317,284,872
	SUB TOTAL				8,367,346,026	9,066,019,418
(3)	VAT	13%			1,087,754,983	1,178,582,524
	TOTAL				9,455,101,009	10,244,601,942
5	Hemja					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	2,054,636,800	2,226,198,973
		Manhole Pumping station		LS	480,000,000	520,080,000
		WWTP	1	LS	585,000,000	633,847,500
		House Connection, Sanitary pipe		LS	808,640,000	876,161,440
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	667,807,056	723,568,946
	SUB TOTAL				4,596,083,856	4,979,856,859
(3)	VAT	13%			597,490,901	647,381,392
	TOTAL				5,193,574,757	5,627,238,251
6.1	East Phase-1					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	4,231,946,200	4,585,313,708
		Manhole Pumping station		LS	360,000,000	390,060,000
		WWTP	1	LS	1,170,000,000	1,267,695,000
		House Connection, Sanitary pipe		LS	1,747,480,000	1,893,394,580
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,276,602,454	1,383,198,758
	SUB TOTAL				8,786,028,654	9,519,662,046

Project Cost for Off-Site

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
(3)	VAT	13%			1,142,183,725	1,237,556,066
	TOTAL				9,928,212,379	10,757,218,112
6.2	East Phase-2					
(1)	Direct Construction Cost	Sewer Pipeline	1	LS	4,231,946,200	4,585,313,708
		Manhole Pumping station		LS	360,000,000	390,060,000
		WWTP	1	LS	1,170,000,000	1,267,695,000
		House Connection, Sanitary pipe		LS	1,747,480,000	1,893,394,580
(2)	Indirect Cost	Administration Cost, Engineering Cost, Physical Contingency	1	LS	1,276,602,454	1,383,198,758
	SUB TOTAL				8,786,028,654	9,519,662,046
(3)	VAT	13%			1,142,183,725	1,237,556,066
	TOTAL				9,928,212,379	10,757,218,112
	GRAND TOTAL	1~6			116,702,473,793	126,447,130,355

Source: JET

B4.1.2 Operation and Maintenance Cost for Sewerage System

(1) Condition of O&M Cost

Operation and Maintenance Cost (O&M Cost) for Sewerage System are estimated using the method shown in Table B4-4.

Table B4-4 Condition of O&M Cost

Item	Applicable	Remarks
Sewer Pipeline	0.05% of Direct Construction Cost of Sewer Pipeline	
Manhole Pumping station	5% of Direct Construction Cost of Manhole Pumping station	
WWTP	5% of Direct Construction Cost of WWTP	
VAT	VAT 13%	Applies to all O&M costs

Source: JET

(2) O&M Cost for Sewerage System

Annual O&M cost of sewerage system are shown in Table B4-5.

The breakdown of costs is shown in Appendix-8.

Table B4-5 O&M Cost for Sewerage System

Annual O&M Cost

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
1.1	West Phase-1.1					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	156,279,891	169,329,262
(2)	VAT	13%	1	LS	20,316,386	22,012,804
	TOTAL				176,596,277	191,342,066
1.2	West Phase-1.2					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	156,279,891	169,329,262
(2)	VAT	13%	1	LS	20,316,386	22,012,804
	TOTAL				176,596,277	191,342,066

Annual O&M Cost

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
2.1	West Phase-2.1					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	190,789,067	206,719,954
(2)	VAT	13%	1	LS	24,802,579	26,873,594
	TOTAL				215,591,646	233,593,548
2.2	West Phase-2.2					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	190,789,067	206,719,954
(2)	VAT	13%	1	LS	24,802,579	26,873,594
	TOTAL				215,591,646	233,593,548
3.1	Central Phase-1.1					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	114,946,515	124,544,550
(2)	VAT	13%	1	LS	14,943,047	16,190,792
	TOTAL				129,889,562	140,735,342
3.2	Central Phase-1.2					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	114,946,515	124,544,550
(2)	VAT	13%	1	LS	14,943,047	16,190,792
	TOTAL				129,889,562	140,735,342
4.1	Central Phase-2.1					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	106,512,269	115,406,044
(2)	VAT	13%	1	LS	13,846,595	15,002,786
	TOTAL				120,358,864	130,408,830
4.2	Central Phase-2.2					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	106,512,269	115,406,044
(2)	VAT	13%	1	LS	13,846,595	15,002,786
	TOTAL				120,358,864	130,408,830
5	Hemja					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	54,277,318	58,809,474
(2)	VAT	13%	1	LS	7,056,051	7,645,232
	TOTAL				61,333,369	66,454,706
6.1	East Phase-1					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	78,615,973	85,180,407
(2)	VAT	13%	1	LS	10,220,076	11,073,453
	TOTAL				88,836,049	96,253,860
6.2	East Phase-2					
(1)	Annual O&M Cost	Sewer Pipeline, Manhole Pumping station, WWTP	1	LS	78,615,973	85,180,407
(2)	VAT	13%	1	LS	10,220,076	11,073,453
	TOTAL				88,836,049	96,253,860
	GRAND TOTAL	1~6			1,523,878,165	1,651,121,998

Source: JET

B4.2 On-site

B4.2.1 Project Cost

The project cost of sludge treatment system for on-site is construction cost (direct cost, indirect cost) and other expenses estimated as follows.

(1) Direct Construction Cost

Direct construction costs of sludge treatment system for on-site is construction cost of Feacal Sludge Treatment Plant.

(2) Procurement Equipment Cost

Procurement equipment cost is procurement cost of Vacuum Car.

(3) Indirect Cost and Other Expenses

Indirect cost and other expenses are estimated using the method shown in Table B4-1.

Indirect costs for procurement equipment are also based on the same table.

(4) Estimate Item of Sludge Treatment System

Estimate item of sludge treatment system for On-Site are shown in Table B4-6.

Table B4-6 Estimate Item of Sludge Treatment System

Item	1. West 1	2. West 2	3. Central 1	4. Central 2	5. Hemja	6. East
Sludge Treatment Plant, 210m^3/day	1 Unit					
Vacuum Car 4m^3	5 Unit (Grant Aid), Total 86 Unit to 2050					

Source: JET

(5) Project Cost of Sludge Treatment System

Project cost of sludge treatment system are shown in Table B4-7.

The breakdown cost of sludge treatment system is shown in Appendix-8.

Table B4-7 Project Cost of Sludge Treatment Plant

Construction & Procurement of Equipment

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
1	Construction Cost					
(1)	Direct Construction Cost	Sludge Treatment Plant, 210m^3/day	1	LS	420,000,000	455,070,000
(2)	Land Acquisition Cost		1	LS	0	0
(3)	Administration Cost		1	LS	84,000,000	91,014,000
(4)	Physical Contingency		1	LS	21,000,000	22,753,500
	SUB TOTAL				525,000,000	568,837,500
(5)	VAT	13%	1	LS	68,250,000	73,948,875
	TOTAL 1				593,250,000	642,786,375
2	FS / Basic Design, Detail Design					
(1)	Engineering Cost		1	LS	63,000,000	68,260,500
(2)	VAT	13%	1	LS	8,190,000	8,873,865

Construction & Procurement of Equipment

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
	TOTAL 2				71,190,000	77,134,365
3	Procurement Equipment Cost					
(1)	Procurement Equipment Cost	Vacuum Car, 4m^3, 5unit	1	LS	100,000,000	108,350,000
(2)	VAT	13%	1	LS	13,000,000	14,085,500
	TOTAL 3				113,000,000	122,435,500
	GRAND TOTAL				777,440,000	842,356,240

Source: JET

B4.2.2 Operation and Maintenance Cost

(1) Condition of O&M Cost

Operation and Maintenance Cost (O&M Cost) for sludge treatment system are estimated using the method shown in Table B4-8.

Table B4-8 Condition of O&M Cost for Sludge Treatment System

Item	Applicable	Remarks
Sludge Treatment Plant	5% of Direct Construction Cost of Sludge Treatment Plant	
Vacuum Car	Estimate	Fuel Cost, O&M Cost, Liability insurance, Labor Cost (Driver, Assistant)
Septic Tank	0.05% of Direct Construction Cost of Septic Tank	
VAT	VAT 13%	Applies to all O&M costs

Source: JET

(2) O&M Cost of Sludge Treatment System

Annual O&M cost of sludge treatment system are shown in Table B4-9.

The breakdown costs is shown in Appendix-8.

Table B4-9 O&M Cost of Sludge Treatment Plant

No	Item		QTY	Unit	Amount (NPR)	Equivalent JPY
1	Sludge Treatment Plant					
(1)	Annual O&M Cost		1	LS	21,000,000	22,753,500
(2)	VAT	13%	1	LS	2,730,000	2,957,955
	TOTAL				23,730,000	25,711,455

Source: JET

B4.3 Cost Setting for Economic and Financial Analysis

B4.3.1 Schedules

Based on the construction implementation schedule of each district, the project implementation schedule for each fiscal year is shown below.

Table B4-10 Project Implementation Schedule for Each Fiscal Year

year	West		Central		Hemja	East
	Phase 1	Phase 2	Phase 1	Phase 2		
2027	23.3%					
2028	23.3%					

year	West		Central		Hemja	East
	Phase 1	Phase 2	Phase 1	Phase 2		
2029	23.3%					
2030	30.0%	23.3%				
2031		23.3%				
2032		23.3%				
2033		30.0%				
2034						
2035			30.0%			
2036			35.0%			
2037			35.0%			
2038				30.0%		
2039				35.0%		
2040				35.0%		
2041						
2042					30.0%	
2043					35.0%	
2044					35.0%	
2045						30.0%
2046						35.0%
2047						35.0%
2048						
2049						
2050						
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: JET

B4.3.2 Initial Capital Expenditures

The method for calculating the initial capital expenditures is as follows.

Initial Capital Expenditures = Foreign Currency (FC) + Local Currency (LC)

FC = (Direct Construction Cost + Administration Cost + Engineering Cost + Physical Contingency) x FC rate

LC = (Direct Construction Cost + Administration Cost + Engineering Cost + Physical Contingency) x LC Rate x SFC

SCF: Standard Conversion Factor = 0.93 (refer to B5.1.1 (1))

(1) Initial Capital Expenditure for Sewerage Projects

Initial capital expenditure for sewerage projects is as follows.

Table B4-11 Initial Capital Expenditure for Sewerage Projects

Standard Conversion Factor: 0.93 UNIT: Million NPR

Item	Direct Cost	Administration Cost (5%)	Engineering Cost (7%)	Physical Contingency (5%)	Sub total	Foreign Currency (FC)	Local Currency (LC)	Total	Remarks
West Phase-1									
Sewer Pipeline	3,870	193	271	193	4,527	905	3,368	4,274	FC 20%, LC80%
Manhole Pumping station	1,500	75	105	75	1,755	0	1,632	1,632	FC 0%, LC 100%
WWTP	4,713	236	330	236	5,514	3,308	2,051	5,359	FC 60%, LC 40%

Standard Conversion Factor: 0.93 UNIT: Million NPR

Item	Direct Cost	Administration Cost (5%)	Engineering Cost (7%)	Physical Contingency (5%)	Sub total	Foreign Currency (FC)	Local Currency (LC)	Total	Remarks
House Connection, Sanitary pipe	4,198	210	294	210	4,912	0	4,568	4,568	FC 0%, LC 100%
Total	14,280	714	1,000	714	16,708	4,214	11,620	15,833	
West Phase-2									
Sewer Pipeline	9,906	495	693	495	11,590	2,318	8,623	10,941	FC 20%, LC80%
Manhole Pumping station	2,820	141	197	141	3,299	0	3,068	3,068	FC 0%, LC 100%
WWTP	4,713	236	330	236	5,514	3,308	2,051	5,359	FC 60%, LC 40%
House Connection, Sanitary pipe	10,313	516	722	516	12,066	0	11,222	11,222	FC 0%, LC 100%
Total	27,752	1,388	1,943	1,388	32,470	5,626	24,964	30,590	
Central Phase-1									
Sewer Pipeline	4,286	214	300	214	5,015	1,003	3,731	4,734	FC 20%, LC80%
Manhole Pumping station	2,020	101	141	101	2,363	0	2,198	2,198	FC 0%, LC 100%
WWTP	3,803	190	266	190	4,449	2,669	1,655	4,324	FC 60%, LC 40%
House Connection, Sanitary pipe	4,147	207	290	207	4,852	0	4,512	4,512	FC 0%, LC 100%
Total	14,256	713	998	713	16,679	3,672	12,096	15,769	
Central Phase-2									
Sewer Pipeline	6,549	327	458	327	7,662	1,532	5,701	7,233	FC 20%, LC80%
Manhole Pumping station	1,660	83	116	83	1,942	0	1,806	1,806	FC 0%, LC 100%
WWTP	1,268	63	89	63	1,483	890	552	1,441	FC 60%, LC 40%
House Connection, Sanitary pipe	3,559	178	249	178	4,164	0	3,873	3,873	FC 0%, LC 100%
Total	13,036	652	912	652	15,252	2,422	11,931	14,354	
Hemja									
Sewer Pipeline	2,055	103	144	103	2,404	481	1,789	2,269	FC 20%, LC80%
Manhole Pumping station	480	24	34	24	562	0	522	522	FC 0%, LC 100%
WWTP	585	29	41	29	684	411	255	665	FC 60%, LC 40%
House Connection, Sanitary pipe	809	40	57	40	946	0	880	880	FC 0%, LC 100%
Total	3,928	196	275	196	4,596	891	3,445	4,337	
East									
Sewer Pipeline	8,464	423	592	423	9,903	1,981	7,368	9,348	FC 20%, LC80%
Manhole Pumping station	720	36	50	36	842	0	783	783	FC 0%, LC 100%
WWTP	2,340	117	164	117	2,738	1,643	1,018	2,661	FC 60%, LC 40%
House Connection, Sanitary pipe	3,495	175	245	175	4,089	0	3,803	3,803	FC 0%, LC 100%
Total	15,019	751	1,051	751	17,572	3,623	12,972	16,596	

Source: JET

Table B4-12 Direct Construction Cost for House Connection, Sanitary Pipe within Plot

Project Cost for House Connection (Private)

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item				QTY	Unit	Unit Price (NPR)	Amount (NPR)	Equivalent JPY
1	West Phase-1								
A	Direct Construction Cost	House Connection, Sanitary pipe	Type-1	Difficulty: Low-1	859	pcs	20,000	17,180,000	18,614,530
		House Connection, Sanitary pipe	Type-2	Difficulty: Low-2	2,449	pcs	26,000	63,674,000	68,990,779
		House Connection, Sanitary pipe	Type-3	Difficulty: High	6,685	pcs	60,000	401,100,000	434,591,850
	TOTAL							481,954,000	522,197,159
2	West Phase-2								
A	Direct Construction Cost	House Connection, Sanitary pipe	Type-1	Difficulty: Low-1	3,185	pcs	20,000	63,700,000	69,018,950
		House Connection, Sanitary pipe	Type-2	Difficulty: Low-2	5,450	pcs	26,000	141,700,000	153,531,950
		House Connection, Sanitary pipe	Type-3	Difficulty: High	15,951	pcs	60,000	957,060,000	1,036,974,510
	TOTAL							1,162,460,000	1,259,525,410
3	Central Phase-1								
A	Direct Construction Cost	House Connection, Sanitary pipe	Type-1	Difficulty: Low-1	2,132	pcs	20,000	42,640,000	46,200,440
		House Connection, Sanitary pipe	Type-2	Difficulty: Low-2	1,976	pcs	26,000	51,376,000	55,665,896
		House Connection, Sanitary pipe	Type-3	Difficulty: High	5,772	pcs	60,000	346,320,000	375,237,720
	TOTAL							440,336,000	477,104,056
4	Central Phase-2								
A	Direct Construction Cost	House Connection, Sanitary pipe	Type-1	Difficulty: Low-1	1,975	pcs	20,000	39,500,000	42,798,250
		House Connection, Sanitary pipe	Type-2	Difficulty: Low-2	1,825	pcs	26,000	47,450,000	51,412,075
		House Connection, Sanitary	Type-3	Difficulty: High	4,664	pcs	60,000	279,840,000	303,206,640

Project Cost for House Connection (Private)

NPR1 = 1.0835JPY
USD1 = 139.27JPY

No	Item				QTY	Unit	Unit Price (NPR)	Amount (NPR)	Equivalent JPY
		pipe							
	TOTAL							366,790,000	397,416,965
5	Hemja								
A	Direct Construction Cost	House Connection, Sanitary pipe	Type-1	Difficulty: Low-1	615	pcs	20,000	12,300,000	13,327,050
		House Connection, Sanitary pipe	Type-2	Difficulty: Low-2	174	pcs	26,000	4,524,000	4,901,754
		House Connection, Sanitary pipe	Type-3	Difficulty: High	1,136	pcs	60,000	68,160,000	73,851,360
	TOTAL							84,984,000	92,080,164
6	East								
A	Direct Construction Cost	House Connection, Sanitary pipe	Type-1	Difficulty: Low-1	3,120	pcs	20,000	62,400,000	67,610,400
		House Connection, Sanitary pipe	Type-2	Difficulty: Low-2	390	pcs	26,000	10,140,000	10,986,690
		House Connection, Sanitary pipe	Type-3	Difficulty: High	4,814	pcs	60,000	288,840,000	312,958,140
	TOTAL							361,380,000	391,555,230

Source: JET

Table B4-13 Initial Capital Expenditure for House Connection, Sanitary Pipe within Plot

House Connection (Private) Standard Conversion Factor: 0.93 UNIT: Million NPR

Item	Direct Cost	Administration Cost (5%)	Engineering Cost (7%)	Physical Contingency (5%)	Sub total	Foreign Currency (FC)	Local Currency (LC)	Total	Remarks
West Phase-1	482	24	34	24	564	0	524	524	FC 0%, LC 100%
West Phase-2	1,162	58	81	58	1,360	0	1,265	1,265	FC 0%, LC 100%
Central Phase-1	440	22	31	22	515	0	479	479	FC 0%, LC 100%
Central Phase-2	367	18	26	18	429	0	399	399	FC 0%, LC 100%
Hemja	85	4	6	4	99	0	92	92	FC 0%, LC 100%
East	361	18	25	18	423	0	393	393	FC 0%, LC 100%

Source: JET

(2) Initial Capital Expenditure for On-Site Sanitation Facilities (Septic Tank)

There are two types of septic tanks (toilet, kitchen, and shower drain) for 3 households (15 people) and 1 household (5 people). The direct construction cost (excluding VAT) for each tank is 220,000 NPR for a 15-person tank and 170,000 NPR for a 5-person tank.

Initial Capital Expenditure for septic tank is as follows

Table B4-14 Construction Number of Septic Tank

Item	1. West 1	2. West 2	3. Central 1	4. Central 2	5. Hemja	6. East
Septic Tank for 15persons	857	3,198	2,123	2,389	609	3,094
Septic Tank for 5persons	0	9,339	0	4,144	1,445	10,902

Source: JET

Table B4-15 Construction Cost of Septic Tank

Standard Conversion Factor: 0.93 UNIT: Million NPR

Item	Direct Cost	Administration Cost (5%)	Engineering Cost (7%)	Physical Contingency (5%)	Sub total	Foreign Currency (FC)	Local Currency (LC)	Total	Remarks
Septic Tank for 15persons	220,000	11,000	15,400	11,000	257,400	0	257,400	257,400	FC 0% LC 100%
Septic Tank for 5persons	170,000	8,500	11,900	8,500	198,900	0	184,913	184,913	FC 0% LC 100%

Source: JET

(3) Initial Capital Expenditure for On-site Sanitation Facilities (Sludge Treatment Plant)

Initial Capital Expenditure for sludge treatment plant is as follows.

Table B4-16 Initial Capital Expenditure for On-site Sanitation Facilities (Sludge Treatment Plant)

Standard Conversion Factor: 0.93 UNIT: Million NPR

Item	Direct Cost	Administration Cost (20%)	Engineering Cost (15%)	Physical Contingency (5%)	Sub total	Foreign Currency (FC)	Local Currency (LC)	Total	Remarks
Sludge Treatment Plant	420.0	84.0	63.0	21.0	588.0	0.0	546.7	546.7	FC 0% LC 100%

Source: JET

B4.3.3 Operation and Maintenance Cost

(1) O&M Cost of Sewerage System for Off-Site

Annual O&M cost of sewerage system for Off-Site is calculated by multiplying the initial capital expenditures by the rate shown in Table B4-4.

Table B4-17 Annual O&M Cost of Sewerage System for Off-site

UNIT: Million NPR

Item	West		Central		Hemja		East		Remarks
	Direct Cost	O&M	Direct Cost	O&M	Direct Cost	O&M	Direct Cost	O&M	
Sewerage Pipeline	15,215	7.6	11,967	6.0	2,269	1.1	9,348	4.7	O&M: 0.05%
Pump Station	4,701	235.0	4,004	200.2	522	26.1	783	39.2	O&M: 5%
Treatment Plant	10,718	535.9	5,766	288.3	665	33.3	2,661	133.1	O&M: 5%
House Connection (Public)	15,790	7.9	8,385	4.2	880	0.4	3,803	1.9	O&M: 0.05%
House Connection (Private)	1,789	0.9	878	0.4	92	0.05	393	0.2	O&M: 0.05%

Source: JET

(2) O&M Cost of Sludge Treatment System for On-site (Septic Tank, Sludge Treatment Plant)

Annual O&M cost of sludge treatment system for On-Site (Septic tank, sludge treatment plant) is calculated by multiplying the initial capital expenditures by the rate shown in Table B4-8Table B4-4.

Annual O&M cost of septic tank is shown in Appendix-8.

Table B4-18 Annual O&M Cost of Sludge Treatment System for On-site (Sludge Treatment Plant)

Sludge Treatment Plant UNIT: Million NPR

Item	Direct Cost	O&M	Remarks
Sludge Treatment Plant	546.7	27.3	O&M: 5%

Source: JET

(3) O&M Cost of Sludge Treatment System for On-site (Vacuum Car)

Annual O&M cost of vacuum car is shown in Appendix-8.

B4.4 Capacity Enhancement Cost for Sewage Management

Capacity enhancement costs for sewage management are set as follows.

- Capacity Enhancement Cost for Sewerage and On-site Sanitation: 200 Million NPR
- Capacity Enhancement Cost for Water Environment Monitor: 200 Million NPR
- Capacity Enhancement Cost for Public Relation: 100 Million NPR

B5 Economic and Financial Analysis

B5.1 Economic Analysis

Economic analysis is carried out from the perspective of the national economy, and it assesses overall impact of a project on the welfare of peoples in the country. The purpose of project economic analysis is to assess whether a project is economically viable for view point of the national country.

All costs and benefits used for the analysis are expressed in the Nepal Rupee (NPR) in constant July 2022 values. Foreign currency-based costs and benefits were converted to NPR using the average exchange rate of NPR 1.0= Japanese Yen (JPY) 1.0835 and United State Dollar (USD) 1.0= NPR 150.899[15].

The cost and benefit streams to be generated by implementing master plan have been estimated from 2024 (commencement of construction activity of Phase I project for West Area) to 2090 (40 years[16] after the completion of project for East Area).

Service life of the assets constructed under the Project were assumed as 40 years. It was assumed that these project facilities could maintain its original function by appropriating rehabilitation costs at end of service life.

B5.1.1 Economic Cost

(1) Basic Assumptions

Financial analysis is based on market prices that are actually paid or received by a project, and it focuses on financial values of project costs and revenues. On the other hand, economic analysis uses economic prices, and it focuses on economic values of project costs and benefits.

Taxes and subsidies are regarded as transfer payments, which affect the distribution of financial costs and benefits between the project entity and other stakeholders, such as the federal government, local

15 Average exchange rate during the past three months (July – September 2022), Mitsubishi UFJ Bank
16 Evaluation period of 40 years was set with referring to JICA's guideline of economic analysis for sewerage project, published in 2002.

government, domestic contractors and citizens, but do not reduce or increase the amount of resources available for the country as a whole. For this reason, both tax and subsidy were eliminated from the analysis (e.g., fiscal support from the federal government to PMC regarding the Project was not regarded as cash inflow of PMC).

In addition, in order to converted from financial price of local currency-based costs to economic cost, standard conversion factor (SCF) was applied.

SCF in the country was calculated to be 0.93, based on following formula and foreign trade statistics of the country during the past 5 years.

$$\text{Standard Conversion Factor (SCF)} = \frac{M + X}{M + t_m + X - t_x + S}$$

Here

M: Imports of goods and services, X: exports of goods and services,
t_m: tax on import, t_x: tax on export, s: Export subsidy= 0

Table B5-1 Data Used for Calculating Standard Conversion Factor

(Unit: NPR billion, Current Price)

Year	2016	2017	2018	2019	2020
Taxes on Export	0.16	0.13	0.10	0.24	0.11
Taxes on Import	82.02	102.93	126.76	143.08	123.68
Imports of goods and services	885.11	1,133.32	1,404.21	1,600.28	1,326.58
Exports of goods and services	213.34	240.39	270.10	300.22	264.64

Source: International Financial Statistics 2022, IMF

Economic cost of the master plan project was calculated based on the cost written in the Chapter B4.1 and the above-mentioned SCF. Following basic principle of economic analysis, economic cost includes base cost, administration cost, physical contingency and consulting service fee, while excludes price contingency and taxes.

(2) Initial Capital Expenditures

1) Initial Capital Expenditure for Sewerage Projects

Disbursement schedule of initial capital expenditure for the sewerage projects was determined based on implementation schedule of the master projects mentioned in Chapter B3 and time required for construction of each facility.

Table B5-2 Initial Capital Expenditure for Sewerage Projects by Year (Economic Price)

	West			Central			Hemja		East		Total
	WWTP, MP, Sewer Pipes		House Connection Phase 1&2	WWTP, MP, Sewer Pipes		House Connection Phase 1&2	WWTP, MP, Sewer Pipes	House Connection	WWTP, MP, Sewer Pipes	House Connection	
	Phase 1	Phase 2		Phase 1	Phase 2						
2027	2,628.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,628.0
2028	2,628.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,628.0
2029	2,628.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,628.0
2030	3,378.8	4,518.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7,897.2
2031	0.0	4,518.3	94.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,612.8
2032	0.0	4,518.3	94.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,612.8
2033	0.0	5,809.3	94.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5,903.8
2034	0.0	0.0	325.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	325.7
2035	0.0	0.0	325.7	3,376.1	0.0	0.0	0.0	0.0	0.0	0.0	3,701.8
2036	0.0	0.0	234.7	3,938.8	0.0	0.0	0.0	0.0	0.0	0.0	4,173.5
2037	0.0	0.0	234.7	3,938.8	0.0	0.0	0.0	0.0	0.0	0.0	4,173.4
2038	0.0	0.0	234.7	0.0	3,143.5	101.2	0.0	0.0	0.0	0.0	3,479.3
2039	0.0	0.0	12.5	0.0	3,667.4	101.2	0.0	0.0	0.0	0.0	3,781.1
2040	0.0	0.0	12.6	0.0	3,667.4	101.2	0.0	0.0	0.0	0.0	3,781.1
2041	0.0	0.0	12.5	0.0	0.0	204.1	0.0	0.0	0.0	0.0	216.6

	West			Central			Hemja		East		Total
	WWTP, MP, Sewer Pipes		House Connection Phase 1&2	WWTP, MP, Sewer Pipes		House Connection Phase 1&2	WWTP, MP, Sewer Pipes	House Connection	WWTP, MP, Sewer Pipes	House Connection	
	Phase 1	Phase 2		Phase 1	Phase 2						
2042	0.0	0.0	12.6	0.0	0.0	94.8	1,036.8	0.0	0.0	0.0	1,144.1
2043	0.0	0.0	12.5	0.0	0.0	94.8	1,209.6	0.0	0.0	0.0	1,316.9
2044	0.0	0.0	12.6	0.0	0.0	94.8	1,209.6	0.0	0.0	0.0	1,316.9
2045	0.0	0.0	12.5	0.0	0.0	7.9	0.0	29.7	3,836.9	0.0	3,887.0
2046	0.0	0.0	12.5	0.0	0.0	7.9	0.0	29.7	4,476.4	0.0	4,526.5
2047	0.0	0.0	12.5	0.0	0.0	7.9	0.0	30.6	4,476.4	0.0	4,527.4
2048	0.0	0.0	12.5	0.0	0.0	7.9	0.0	0.8	0.0	129.8	151.1
2049	0.0	0.0	12.5	0.0	0.0	7.9	0.0	0.8	0.0	129.8	151.1
2050	0.0	0.0	12.5	0.0	0.0	7.9	0.0	0.8	0.0	133.6	154.9

Unit: NPR million
MP: Manhole Pump
Source: JET

2) Initial Capital Expenditure for On-site Sanitation Facilities

Initial capital expenditure of impermeable septic tanks by zone and by year were calculated by multiplying the economic cost of septic tank (for one household: up to 5 persons= NPR 184,913 or for three households: up to 15 persons= NPR 257,400) and number of incremental households with improved septic tank.

Table B5-3 Initial Capital Expenditure for On-site Sanitation Facilities by Year (Economic Price)

	Impermeable Septic Tank							Fecal Treatment Plant	Total
	West		Central		Hemja	East	Outside Sewer Area		
	Phase 1	Phase 2	Phase 1	Phase 2					
2024	31.7	146.4	39.1	64.5	17.3	101.5	60.8		647.3
2025	31.4	146.0	38.9	65.0	17.4	108.4	61.0		647.6
2026	31.7	146.2	39.1	64.1	17.4	108.0	60.8	273.3	920.1
2027	31.4	146.3	38.9	64.5	17.3	108.0	61.2	273.3	921.2
2028	31.4	146.3	39.1	64.5	17.3	108.4	60.5		647.3
2029	31.7	146.6	38.9	65.0	17.4	108.4	61.0		647.4
2030	31.4	146.2	39.1	64.1	17.3	108.4	61.0		647.6
2031	0.0	146.3	39.1	64.5	17.4	107.8	60.7		587.0
2032	0.0	145.9	38.9	64.5	17.4	108.2	60.8		587.5
2033	0.0	146.2	39.1	64.8	17.3	108.4	61.2		586.6
2034	0.0	64.2	39.1	64.8	17.3	108.0	60.8		375.4
2035	0.0	64.0	39.1	64.1	17.4	108.4	61.0		374.8
2036	0.0	63.8	39.1	64.8	17.3	108.0	61.0		375.1
2037	0.0	64.0	38.9	64.8	17.4	108.0	60.5		375.1
2038	0.0	63.8	0.0	64.5	17.3	108.4	61.0		300.2
2039	0.0	64.0	0.0	64.1	17.4	108.2	60.8		357.2
2040	0.0	64.0	0.0	64.8	17.3	108.5	61.0		356.8
2041	0.0	64.0	0.0	28.5	17.4	108.2	61.0		262.8
2042	0.0	63.8	0.0	28.5	17.3	107.8	60.8		262.4
2043	0.0	64.0	0.0	28.5	17.4	108.4	60.8		262.5
2044	0.0	64.2	0.0	28.1	17.3	108.2	61.0		262.8
2045	0.0	63.8	0.0	28.5	10.0	108.2	60.8		264.6
2046	0.0	64.0	0.0	28.5	9.8	107.8	60.7		264.6
2047	0.0	63.8	0.0	28.5	10.0	108.4	60.8		265.3
2048	0.0	64.0	0.0	28.1	9.8	74.5	61.4		143.7
2049	0.0	63.8	0.0	28.5	10.0	74.9	60.7		144.1
2050	0.0	64.7	0.0	28.1	10.0	73.6	59.0		141.8

Unit: NPR million
Source: JET

(3) Operation and Maintenance Cost

1) O&M Costs for Sewerage Projects

Annual O&M costs for WWTPs and for manhole pumps were assumed to be 5% of their initial capital expenditures. Of which, 50% was assumed as fixed cost, while rest of 50% was assumed as variable cost. It is assumed that fixed cost is required regardless of number of customers, while variable cost is

increased in accordance with number of customers.

Annual O&M costs for Sewer pipes and house connections were assumed as 0.05% of initial capital expenditure.

Table B5-4 O&M Costs for the Sewerage Projects (Economic Price)

	West		Central		Hemja		East		Total
	WWTP, MP	Sewer Pipes, HC	WWTP, MP	Sewer Pipes, HC	WWTP, MP	Sewer Pipes, HC	WWTP, MP	Sewer Pipes, HC	
2031	210.9	2.2	0.0	0.0	0.0	0.0	0.0	0.0	213.1
2032	229.1	2.2	0.0	0.0	0.0	0.0	0.0	0.0	231.3
2033	247.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	249.6
2034	311.7	2.4	0.0	0.0	0.0	0.0	0.0	0.0	314.2
2035	376.2	8.1	0.0	0.0	0.0	0.0	0.0	0.0	384.3
2036	616.5	8.2	0.0	0.0	0.0	0.0	0.0	0.0	624.7
2037	664.2	8.3	0.0	0.0	0.0	0.0	0.0	0.0	672.5
2038	711.8	8.4	211.4	2.4	0.0	0.0	0.0	0.0	934.1
2039	716.7	8.4	239.8	2.5	0.0	0.0	0.0	0.0	967.4
2040	721.6	8.4	268.2	2.5	0.0	0.0	0.0	0.0	1,000.8
2041	726.6	8.4	387.0	6.2	0.0	0.0	0.0	0.0	1,128.2
2042	731.5	8.5	413.0	6.3	0.0	0.0	0.0	0.0	1,159.2
2043	736.4	8.5	439.0	6.3	0.0	0.0	0.0	0.0	1,190.2
2044	741.3	8.5	465.0	6.4	0.0	0.0	0.0	0.0	1,221.2
2045	746.3	8.5	468.9	6.4	39.0	1.1	0.0	0.0	1,270.2
2046	751.2	8.5	472.8	6.4	48.4	1.2	0.0	0.0	1,288.4
2047	756.1	8.5	476.7	6.4	58.0	1.2	0.0	0.0	1,306.9
2048	761.0	8.5	480.6	6.4	58.5	1.2	114.5	4.7	1,435.4
2049	766.0	8.5	484.5	6.4	58.9	1.2	143.0	4.8	1,473.2
2050	770.8	8.5	488.4	6.4	59.4	1.2	172.2	4.9	1,511.7
:	:	:	:	:	:	:	:	:	:

Unit: NPR million
MP: Manhole Pump, HC: House Connection
Source: JET

2) O&M Costs for On-site Sanitation Facilities

Annual O&M costs for impermeable septic tanks and fecal treatment plant were assumed to be 0.05% and 5% of their initial capital expenditures, respectively. Cost of transport and collection of sludge were estimated based on procurement cost of vacuum cars, fuel cost, personal expense, insurance expense and cost of car scrup (please refer to Chapter B3.3 for more detail). O&M costs for on-site sanitation facilities and its related facilities by zone and by years are shown in the following table.

Table B5-5 O&M Costs for On-Site Sanitation Facilities (Economic Price)

	Impermeable Septic Tank						Transport/ Collection of Sludge	Fecal Treatment Plant	Total
	West	Central	Hemja	East	Others	Sub-total			
2024	0.1	0.1	0.0	0.1	0.0	0.2	0.0	0.0	0.2
2025	0.2	0.1	0.0	0.1	0.1	0.5	0.0	0.0	0.5
2026	0.3	0.2	0.0	0.2	0.1	0.7	68.3	0.0	69.0
2027	0.4	0.2	0.0	0.2	0.1	0.9	44.6	0.0	45.6
2028	0.4	0.3	0.0	0.3	0.2	1.2	50.7	19.5	71.4
2029	0.5	0.3	0.1	0.3	0.2	1.4	64.2	19.5	85.1
2030	0.6	0.4	0.1	0.4	0.2	1.6	63.7	19.5	84.9
2031	0.6	0.4	0.1	0.4	0.2	1.7	111.8	19.5	133.1
2032	0.7	0.5	0.1	0.5	0.3	2.0	78.3	19.5	99.8
2033	0.7	0.5	0.1	0.5	0.3	2.2	83.9	19.5	105.7
2034	1.1	0.6	0.1	0.6	0.3	2.7	74.7	19.5	96.9
2035	0.9	0.6	0.1	0.6	0.4	2.7	78.5	19.5	100.6
2036	0.8	0.7	0.1	0.7	0.4	2.7	73.3	19.5	95.5
2037	0.6	0.7	0.1	0.8	0.4	2.7	67.2	19.5	89.3
2038	0.5	0.5	0.1	0.8	0.5	2.4	67.8	19.5	89.7
2039	0.5	0.5	0.1	0.9	0.5	2.5	68.5	19.5	90.5
2040	0.5	0.6	0.1	0.9	0.5	2.7	68.5	19.5	90.7
2041	0.6	0.7	0.2	1.0	0.5	2.9	87.7	19.5	110.1
2042	0.6	0.5	0.2	1.0	0.6	2.9	95.1	19.5	117.6
2043	0.6	0.4	0.2	1.1	0.6	2.9	72.5	19.5	95.0
2044	0.7	0.3	0.2	1.1	0.6	2.9	99.4	19.5	121.9
2045	0.7	0.3	0.2	1.2	0.7	3.1	93.5	19.5	116.2

	Impermeable Septic Tank						Transport/ Collection of Sludge	Fecal Treatment Plant	Total
	West	Central	Hemja	East	Others	Sub-total			
2046	0.7	0.3	0.2	1.2	0.7	3.2	131.3	19.5	154.0
2047	0.8	0.3	0.1	1.3	0.7	3.3	107.3	19.5	130.1
2048	0.8	0.4	0.1	1.5	0.8	3.6	102.5	19.5	125.6
2049	0.8	0.4	0.1	1.3	0.8	3.4	91.0	19.5	113.9
2050	0.9	0.4	0.1	1.0	0.8	3.2	68.6	19.5	91.3
:	:	:	:	:	:	:	:	:	:

Unit: NPR million
Source: JET

(4) Rehabilitation Cost of Sewage/Fecal Treatment Plants and Impermeable Septic Tanks

Rehabilitation costs of sewerage/fecal treatment plants and impermeable septic tanks after 40 years of construction were assumed to be 20% of their initial capital expenditures.

(5) Residual Value

The residual value of project facilities at the end of cashflow, year 2090, was calculated based on 40 years depreciation period with straight line method.

B5.1.2 Economic Benefits

Economic benefits generated through implementation of the MP projects could be broadly divided into following three benefits. In this MP, economic analysis aims to quantify “reduction in health damage” and “increase in value added of tourism industry”.

Table B5-6 Economic Benefits Used for the Economic Analysis

Type of Benefit	Note	Target
Reduction in Health Damage	Currently, permeable septic tanks are widely used in PMC and there is no sewerage network system in the area. However, permeable septic tanks involve risk of fecal-oral pathogen transmission through polluted underground water, which could be regarded as major causes of health problem such as diarrheal diseases. Development of sewerage system and/or installation of impermeable septic tanks through this master plan projects could contribute to reduce health damages.	○
Increase in Value Added of Tourism Industry	This master plan projects could contribute to reduce polluted water to inflow to Phewa Lake and other lakes in the study area, and then contribute to improve water quality of these lakes and to prevent environmental degradation. This could contribute to attract more tourists and then generate value added effects to local industries.	○
Reduction in Greenhouse Gas Emission	Currently the sludge from septic tanks is transported to disposal sites, and then landfilled after dewatering and solar drying. Methane gas are generated through these processes. This master plan will consider measures to reduce such greenhouse gas emission through introduction of methods to recover methane gas and/or methods for compositing sludge. However, currently, since treatment methods and its specifications have not determined yet, greenhouse gas emission reduction effects are not included in the analysis at this stage.	×

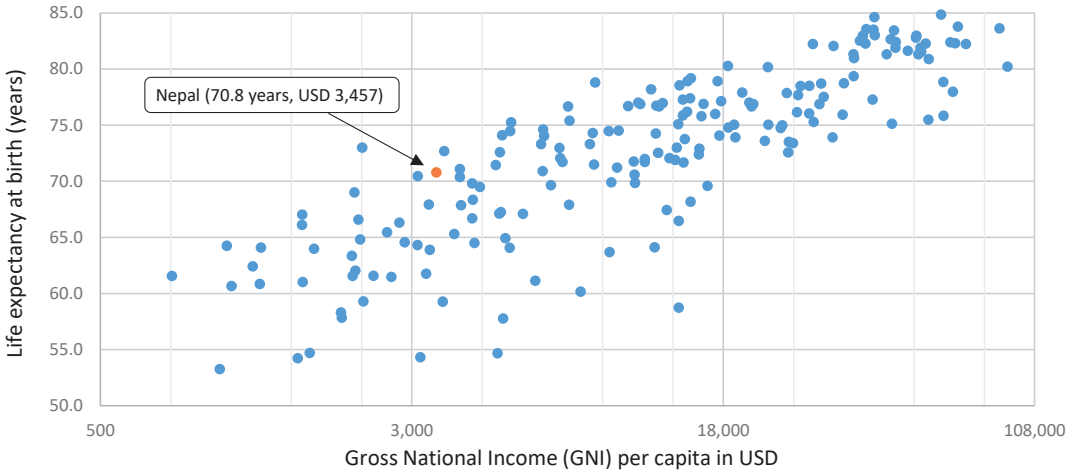
Source: JET

(1) Reduction in Health Damage

1) Relationship between Sanitation Infrastructure and Health Damages

The following figure illustrates relationship between the life expectancy at birth and the gross national income (GNI) per capita of counties around the world in 2019. Horizontal axis is shown in logarithmic scale. As the graph indicates that the life expectancy at birth become higher as the gross national income (GNP) per capita is increase.

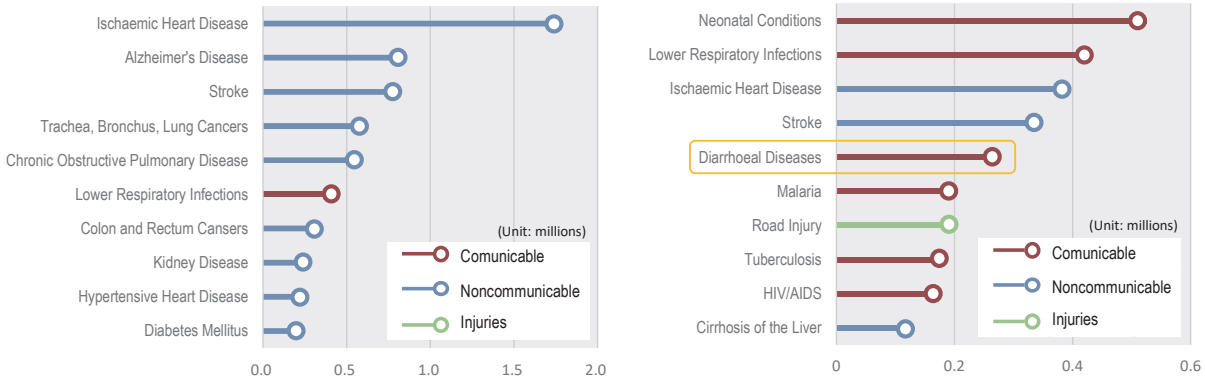
Life expectancies at birth of Nepal are about 10 -15 years lower than some of the high-income countries.



Source: Prepared by JET based on World Development Indicators, World Bank

Figure B5-1 Relationship between Life Expectancy at Birth and Per Capita GNI in 2019

The following graph indicates top ten causes of death in low-income and high-income countries in 2019. In case of high-income countries, only one communicable disease was ranked within top 10 causes of death. While six communicable diseases were ranked within top 10 causes in low-income countries. Diarrheal disease was ranked 5th in low-income countries.



Source: Prepared by JET based on data quoted from World Health Organization, 2019

Figure B5-2 Leading Causes of Death in High Income (Left) and Low Income (Right) Countries

It is well known that communicable diseases, particularly diarrhea disease, spread are significantly affected by water environment. Improvement of water supply and sanitation could contribute to reduce diarrheal diseases.

Most of households in the study area have permeable septic tanks. However, since such type of septic tanks could not prevent contaminated water to sink into ground and ground water, risks of diarrheal diseases still exist.

The routes by which pathogens infect individuals and affect population health via sanitation and hygiene are many and diverse. They could be broadly categorized as below;

- Water-borne diseases (e.g. cholera, typhoid, salmonellosis and dysentery)
- Water-washed diseases (e.g. trachoma)
- Water-based diseases (e.g. schistosomiasis)
- Water-related vector-borne diseases (e.g. malaria, filariasis and dengue)

While a full analysis of improved sanitation services would consider pathogens passed via all these routes, this economic analysis focuses on fecal-oral disease transmission which dominates the burden of disease associated with the water-borne routes. According to the WHO's report[17], this is partly because, at the household level, it is the transmission of fecal-oral diseases that is most closely associated with sanitation projects. In terms of burden of disease, water-borne diseases comprise mainly infectious diarrhea. Infectious diarrhea includes cholera, salmonellosis, shigellosis, amoebiasis, and other protozoal and viral intestinal infections. These are transmitted by water, person-to-person contact, animal-to-human contact, and foodborne, droplet and aerosol routes. Infectious diarrhea causes the main burden resulting from poor access to sanitation.

In 2020, 8,889 peoples were killed by the infectious diarrhea in Nepal, and was ranked 7th among causes of deaths[18]. Incidence rate and mortality rate of diarrhea in Nepal are well higher than the world average. Globally, children below 5 years typically severely affected by diarrhea, while in Napal and in South Asia, incidence rate and mortality rate of people above 70 years are quite high.

Table B5-7 Incidence Rate and Mortality Rate of Diarrheal Disease in 2016

	Incidence Rate of Diarrhea /person/ year			Mortality Rate (Death per 100,000)		
	All	Below 5 years old	Above 70 years old	All	Below 5 Years Old	Above 70 Years Old
World Average	0.61	1.75	0.90	22.4	70.6	171.7
High-Income Countries	0.13	0.58	0.17	2.9	1.3	20.1
South Asia	0.88	1.49	3.00	51.4	66.4	877.4
Nepal	1.08	2.24	3.24	29.6	22.9	548.2

Source: The Global Burden of Diseases, Injuries, and Risk Factors Study in 195 countries, 2016

High incidence/ mortality rate in the country could be resulting from inadequate water supply, lack of proper medical system and "insufficient sanitation facilities".

2) Relationship between Diarrheal Diseases and Sanitation Infrastructure Development

Table B5-8 indicates relative risks of diarrheal diseases for different status of water and sanitation infrastructure development scenarios, which were used by the World Health Organization (WHO)[19].

Table B5-8 Relative Risks of Diarrheal Disease for Different Status of Water and Sanitation Infrastructure Development Scenarios

Level	Note	Risk of Diarrhea
VI	No improved water supply and no basic sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled	11.0
Vb	Improved water supply and no basic sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled	8.7
Va	Improved sanitation but no improved water supply in a country which is not extensively covered by those services, and where water supply is not routinely controlled	6.9*
IV	Improved water supply and improved sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled	6.9*

[17] "Economic and health effects of Increasing coverage of low-cost household drinking-water supply and sanitation interventions to countries off-track to meet MDG target 10", 2007, WHO
[18] Department of Health Services, Ministry of Health and Population
[19] Estimating the Burden of Disease from Water, Sanitation, and Hygiene at a Global Level Annette Prüss, David Kay, Lorna Fewtrell, and Jamie Bartram, 2002

Level	Note	Risk of Diarrhea
III	Improved water supply and improved sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled, plus household water treatment	4.5
II	Regulated water supply and full sanitation coverage, with partial treatment for sewage, corresponding to a situation typically occurring in developed countries	2.5
I	Ideal situation, corresponding to the absence of transmission of diarrhoeal disease through water, sanitation and hygiene	1.0

Source: WHO Annette Prüss, David Kay, Lorna Fewtrell and Jamie Bartram
Note: According the original thesis, status of sanitation and water supply infrastructure of Level IV and Va are different, while risk of diarrheal diseases remain the same 6.9

Nepal water supply corporation (NWSC) and several Water Users and Sanitation Committees (WUSCs) are supplying water in the study area. 93% of households in the study area receive water from them. Since water supply in the study area is not 24 hours supply, water supply in the area could be regarded as "improved water supply, while it is not routinely controlled".

"Improved sanitation" mentioned in above table involves better access and safer disposal of human excreta using sanitation facilities including septic tank and sewage. In the study area, most of all households treats their excreta on site using permeable septic tanks, while all of them could not prevent contaminated water to sink into ground and groundwater. Thus, infection route of diarrheal diseases still exists, and thereby, the existing sanitation facilities in the study area could not necessarily be regarded as "improved sanitation".

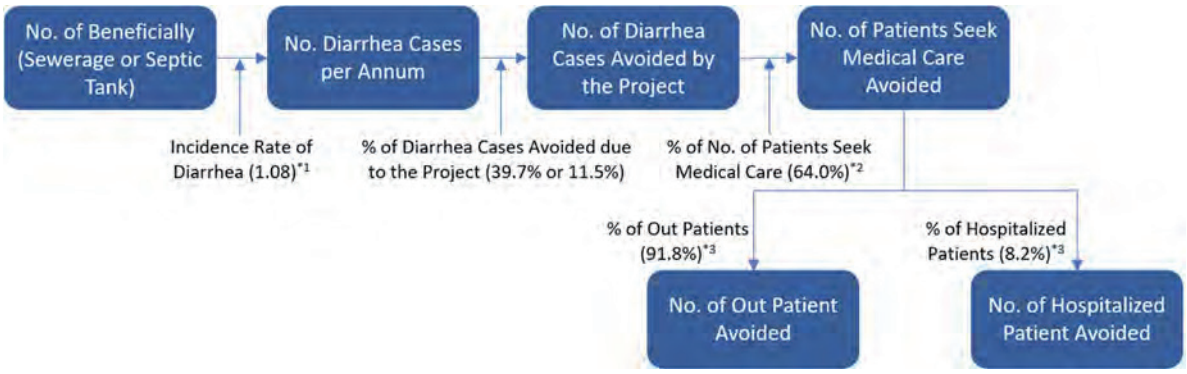
For these reasons, level of water and sanitation facilities in the study area without MP projects was judged to be between Vb and IV. Risk of diarrheal diseases without MP projects was assumed as 7.8 (median value of Vb: 8.7 and IV: 6.9).

It is assumed that the risk of diarrheal diseases with MP projects will become 6.9 (level IV) at on-site area and 4.7 at sewer area (median value of level IV: 6.9 and level II: 2.5).

Based on these assumptions, it was assumed that the MP project could contribute to reduce the risk of diarrheal diseases by 11.5% (7.8 → 6.9) at on-site area, and by 39.7% (7.8 → 4.7) at sewer area.

3) Economic Benefits resulting from Reduction in Diarrheal Disease

Decrease in number of diarrhea cases and its patients in the study area resulting from the MP projects implementation were estimated based on the following methodology.



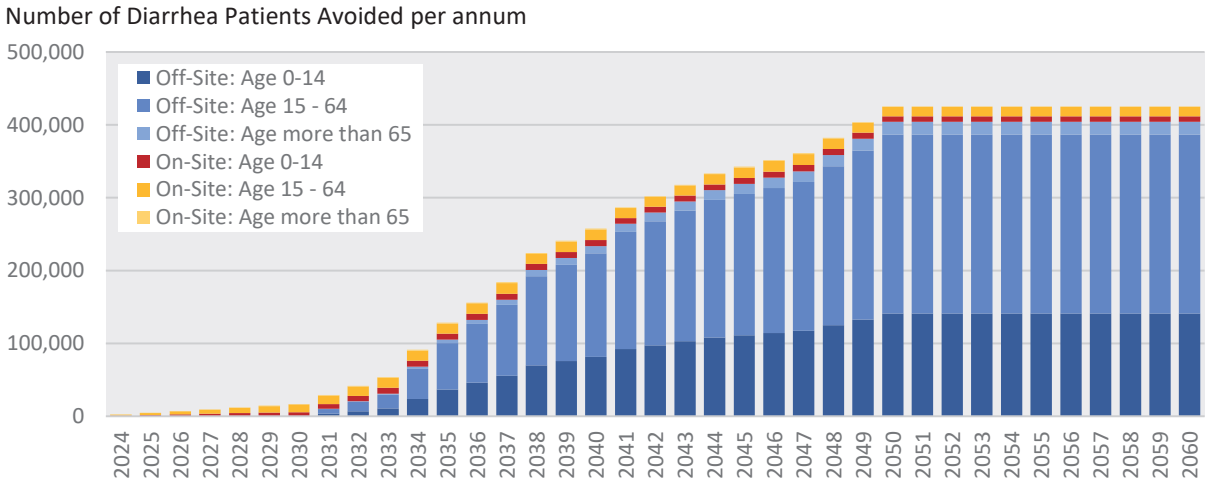
*1: Incidence rate of Diarrhea in Nepal, the Global Burden of Diseases, Injuries, and Risk Factors Study in 195 countries
*2: Percentage of Diarrhea Cases seek care, Demographic and Health Survey Nepal 2016
*3: Percentage of In/Outpatients: Diarrhea, World Health Organization
Source: JET

Figure B5-3 Flow to Estimate Number of Diarrhea Patient Avoided

Figure B5-4 illustrates estimated diarrhea patients' reduction effects of by off-site (sewerage area)/ on-site and by age category. As shown in the graph, it was estimated that most of diarrhea patients' reduction

effects could be seen in off-site area, where sewerage network will be developed.

Population households in the study area will be increased after MP projects completion in 2050. However, since additional capital expenditure and O&M costs to accommodate such population increase were not considered this analysis, benefits resulting from population increase after 2050 were not regarded as benefit of the MP projects.



Source: JET

Figure B5-4 Diarrhea Patients Reduction Effects by Age-group and by Off-site/ On-site

With referring to the WHO report in 2007[20], direct and in-direct economic benefits resulting from reduction in diarrhea patients were determined as follows;

Table B5-9 Types of Health Damage Reduction Benefits and its Target Age Groups

Direct Benefit	1) Reduction in Expenditure on Treatment of Diarrhoeal Disease (Target Age Group: All)
In-direct Benefit	2) Income Gained due to Days Lost from Work Avoided (Target Age Group: 15 – 64) 3) Days of School Absenteeism Avoided (Target Age Group: 5 – 14) 4) Productive Parent Days Lost Avoided due to Less Child Illness (Target Age Group: 15 – 64) 5) GDP Lost Avoided due to Less Mortality (Target Age Group: below 65)

Source: JET

(a) Reduction in Expenditure on Treatment of Diarrhoeal Disease

Reduction in expenditure on treatment of diarrhoeal disease was estimated by multiplying patients' reduction effects as shown in Figure B5-4 and average medical and non-medical expenditures of diarrhoeal diseases.

Average medical and non-medical expenditure in used in diarrhea treatment were assumed as the following table.

Table B5-10 Average Medical and Non-medical Expenditures used in Diarrhea Treatment

		in 2015 USD[1]	in 2022 USD[*2]	in 2022 NPR[*3]
Average Expenditure of Diarrheal disease (Out Patient)	Medical	4.80 USD/day	5.96 USD/day	899.2 NPR/day
	Non-medical	1.65 USD/day	2.09 USD/day	309.1 NPR/day
Average Expenditure of Diarrheal	Medical	25.67 USD/day	31.87 USD/day	4,808.8 NPR/day

[20] Economic and health effects of Increasing coverage of low-cost household drinking-water supply and sanitation interventions to countries off-track to meet MDG target 10, Public Health and the Environment World Health Organization, 2007

		in 2015 USD[1]	in 2022 USD[*2]	in 2022 NPR[*3]
disease (Hospitalized Patient)	Non-medical	5.29 USD/day	6.57 USD/day	991.0 NPR/day

Source: *1 Cost of illness for childhood diarrhea in low- and middle-income countries: a systematic review of evidence and modelled estimates, median of low-income countries, Annette Prüss, David Kay, 2020
*2 Adjusted to 2022 price using consumer price index of United States during the period from July 2015 to July 2022
*3 Exchange rate used 1.0 USD= 150.899 NPR

Based on the above-mentioned assumptions, economic benefit of reduction in expenditure on treatment of diarrhoeal disease was calculated as follows;

Table B5-11 Economic Benefits of Reduction in Expenditure on Treatment of Diarrhoeal Disease

2024-30	2031-40	2041-50	2051-60	2061-70	2071-80	2081-90	Total
69.8	1,429.0	3,558.5	4,318.0	4,318.0	4,318.0	4,318.0	22,329.2

Unit: NPR million
Source: JET

(b) Income Gained due to Days Lost from Work Avoided

Income gained due to days lost from work avoided is productivity effect of reduction in diarrhea disease. This economic benefit could be valued by taking the opportunity cost of workers. Opportunity cost is the amount in monetary terms that the working-age person (age 15- 64) would earn over the sickness period if he/she were working. The Gross National Income (GNI) per capita was taken as a value for what people's working time is worth (USD 1,372 per annum[21]= USD 3.76 per day in 2022). Average days lost due to diarrhea disease was assumed as 2.74 days[22] per case.

Since, GNI per capita will be increase as growth of national economy, opportunity cost of working time will be increased as well. Economic evaluation uses fixed price without taking inflation into consideration, thereby this analysis employed IMF's real GNI growth forecast of Nepal up to 2030 (5.02% on an average). It was assumed that the real GNI growth ratio after 2030 will be gradually slow down (reduced by 0.5% point for every five years)

Based on the above-mentioned assumptions, economic benefit of income gained due to days lost from work avoided was calculated as Table B5-12;

Table B5-12 Income Gained due to Days Lost from Work Avoided

2024-30	2031-40	2041-50	2051-60	2061-70	2071-80	2081-90	Total
109.6	3,431.8	11,824.8	18,872.4	22,784.3	24,087.7	24,087.7	105,198.4

Unit: NPR million
Source: JET

(c) Days of School Absenteeism Avoided

Impact of diarrhea disease of children of school age (5-14 years old) is school absenteeism. Opportunity cost of children of school age was assumed as same as GNI per capita (USD 3.76 per day in 2022). Average duration of school absenteeism per diarrhea case was assumed to be 2.7 days[23]. Economic benefit of days of school absenteeism avoided was calculated as Table B5-13;

21: Central Bureau of Statistics, 2022 July
22: Systematic review of diarrhea duration and severity in children and adults in low- and middle-income countries, BMC Public Health 2012 (from here on mentioned as "BMC Public Health 2021"), Average recovery period of diarrheal diseases of patients above 16 years old in low-income countries
23: BMC Public Health 2012, average period of recovery from diarrhea disease in low-income countries (age 5- 14).

Table B5-13 Days of School Absenteeism Avoided

2024-30	2031-40	2041-50	2051-60	2061-70	2071-80	2081-90	Total
44.7	1,401.2	4,828.0	7,705.5	9,302.7	9,834.9	9,834.9	42,952.0

Unit: NPR million
Source: JET

(d) Productive Parent Days Lost Avoided due to Less Child Illness

For children under five, the assumption is made that a parent or caretaker has to spend more time with a sick child than a healthy one, valued at 50% of the GNI per capita. Average duration of recovery for children under five was assumed to be 9.09 days[24]. Economic benefit of productive parent days lost avoided due to less child Illness was calculated as Table B5-14;

Table B5-14 Productive Parent Days Lost Avoided due to Less Child Illness

2024-30	2031-40	2041-50	2051-60	2061-70	2071-80	2081-90	Total
29.0	907.1	3,125.4	4,988.2	6,022.1	6,366.6	6,366.6	27,804.9

Unit: NPR million
Source: JET

(e) GNI Lost Avoided due to Less Mortality

In terms of deaths averted from the MP project implementation, economic benefit of saved lives at the discounted income stream of the individual whose death is avoided, thus representing the net present value of their economic contribution to the country. Therefore, the number of productive years ahead of the individual who would have died needs to be estimated (depending on the age of the person whose life is saved) and the economic value per year of healthy life saved.

The burden of disease is calculated by multiplying the disability-adjusted life year (DALY) and opportunity cost of working age population (15-64 years old). One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of years of life lost due to premature mortality (YLLs) and years of healthy life lost due to disability (YLDs) due to prevalent cases of the disease or health condition in a population. Since diarrhea disease rarely led to disability, YLDs were assumed to be zero. On the other hand, YLLs were estimated by deducting age of death from the life expectancy.

The GNI per capita (USD 1,372 per annum in 2022) is used to reflect the annual opportunity cost of a working age population.

Number of deaths averted were estimated by multiplying number of diarrhea patients averted and case fatality rate of diarrhea disease in Nepal (0.0274%)[25.]

With referring to the WHO report, it was assumed that future benefits are discounted at 3% per year. For those not yet in the working age (0- 15 years old) the current value for the future income stream was further discounted to take account of the time period before they become income earners. Present value of GNI lost avoided per deceased person was estimated to be (0-5 years old: USD 82,036, 6-15 years old: USD 89,531, 15- 64 years old: USD 55,676 and 65years old and above: 0).

Economic benefit of GNI Lost Avoided due to Less Mortality was calculated as Table B5-15;

Table B5-15 GNI Lost Avoided due to Less Mortality

2024-30	2031-40	2041-50	2051-60	2061-70	2071-80	2081-90	Total
295.8	9,267.1	31,931.1	50,962.0	61,525.6	65,045.3	65,045.3	284,072.2

Unit: NPR million
Source: JET

24: BMC Public Health 2012, average recovery period from diarrheal disease of children under five in low-income countries
25 GBD Study 2016, WHO

(2) Economic Benefits on Tourism Industries

Tourism industry plays vital role in the country, which accounted for 10.3% of gross domestic products (GDP) of the country in 2019. The industry contributes to earn foreign exchange of USD 860 million (30% of foreign exchange earnings of Nepal) and to create 1.16 million jobs (7.8% of total labor force in the country)[26].

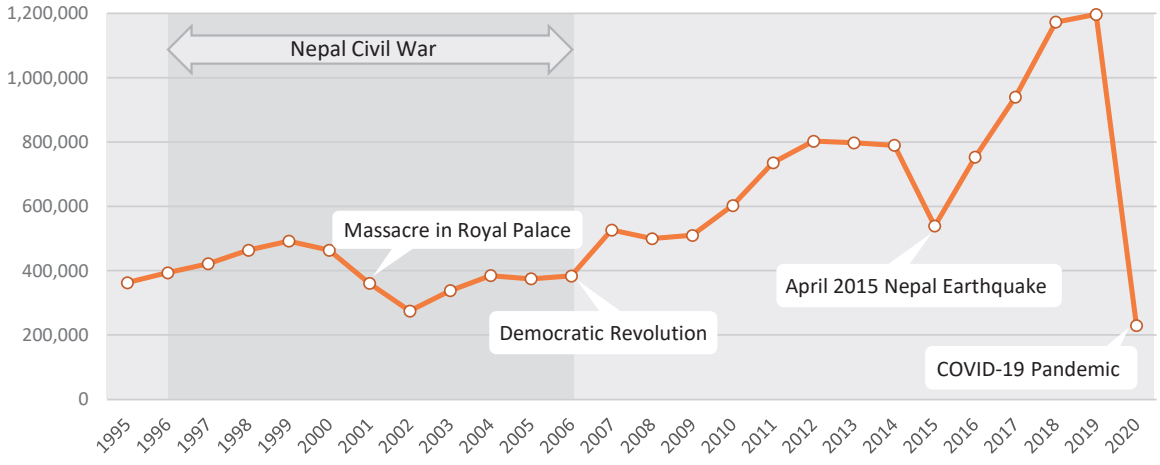
Pokhara is one of the most popular tourist destinations in the country, and is well-known as gateway for Annapurna region. Pokhara owes much its popularity to the enchanting fresh-water cluster of 9 Lakes which include the popular Phewa, Begnas, Rupa, Khaste, Dipang, Maidi, Gunde, Neurani, Kamalpokhari and Pokhara Seti Catchment, lakes. The lakes play a vital role in sustaining the tourism industry, biodiversity, ecosystem and the local livelihood. The Pokhara Valley Lake Cluster was listed as Ramsar Site in 2021.

Phewa lake is situated at the southern side of Pokhara city. There are many hotels, restaurants, shops and other tourist attractions for tourists at its lakeside.

Since tourists visiting Pokhara and lakeside area typically natural lovers, who aims to enjoy activities in lakes and mountains, deterioration of water quality of lakes and its surrounding area due to insufficient sanitation infrastructure will have negative impacts on tourism industry in the country.

1) Changes in Foreign Tourists visiting Nepal and Pokhara

Foreign tourists' arrivals in the country vary from year to year but are in a long-term growth trend (please refer to Table B5-5). The tourism industry is one of the most affected industries by the COVID-19 pandemic. While number of foreign tourists was sharply reduced in 2020 due to travel restrictions resulting from the pandemic, foreign tourists are returning to Nepal after steady drop in coronavirus cases.



Source: Prepared by JET based on Nepal Tourism Statistics

Figure B5-5 Changes in Foreign Tourists Arrival in Nepal from 1995 to 2020

Tourism statistics data collection in Pokhara has started since July 2018. During the period from July 2018 to August 2019, number of foreign tourists visiting Pokhara (298,975) accounted for 24.3% of tourists arrival in the country (1,230,451).

As same as national trend, number of tourists visiting Pokhara had decreased due to the pandemic. It is assumed that the number of foreign tourists will become same level as just before the pandemic (2018/19) by 2023. It is also assumed that number of tourists will be increased by 7.10% per annum (same growth rate during the decade before the pandemic: 2010 - 2019) up to 2025, and then the growth rate will become half by every 10 years.

26: Quoted from World Travel and Tourism Council (2019)

2) Possible Positive Impacts on Tourism Industry due to the Sanitation Projects

Commercial area, hotels, restaurants, travel agent's offices and other tourists attractions are densely located in lakeside area, east coast of the Phewa lake. The lake is a great place to relax with various leisure and water activities. In addition, number of tourists visiting Begnas and Rupa lakes has been increasing sharply.

As written in chapter A5.5 of this report, it is estimated that water quality of the Phewa lake will be deteriorating without this MP projects implementation. JET estimated that COD (chemical oxygen demand) of the lake will be increased from 6.4mg/L (present status) to 8.3mg/L by 2050 under without the MP projects scenario. According to Environmental quality standards issued by the Ministry of Environment, Japan, when COD of a lake exceeding 8.0 mg/L, it will disrupt day to day lives of population (including things like walks along the lake).

Since Pokhara and its surrounding area is well-known for its natural beauty, deterioration of water quality of Phewa lake and other lakes will result in reduction of tourists in the area.

On the other hand, the MP projects implementation could significantly contribute to prevent contaminated water to flow into the rivers and lakes. JET estimated that COD of Phewa lake will be reduced to 4.3 mg/L under with the MP projects scenarios.

Although there are no empirical research analyzing relationship between water quality and tourism, it is assumed that number of tourists will be decreased by 5% under without MP projects scenario. Also, number of tourists will not be reduced under with the MP projects implementation scenario.

3) Direct and In-direct Value-Added Effects on Tourism Related Industries

Increase in tourism spendings due to MP projects were estimated by multiplying number of foreign tourists' reduction avoided, average duration of stay in Pokhara (9 days)[27] and average tourist spending per day (USD 65)[28].

Out of such tourism spending, only value-added portion could be regarded as economic benefit. Value added could be defined as the sum of an industry's compensation of employees, taxes on production and imports and gross operating surplus. Value added ratio of tourism industry was assumed as 56% with referring to the OECD's report[29].

Tourism spendings are economically important, as they generate not only direct value-added effects but also in-direct value-added effects in the economy. For example, tourists spending at restaurant will not generate value added effects not only on restaurant, but also will generate in-direct value-added effects on ingredients producers (e.g., agricultural, livestock, fishery industries), logistics providers (e.g., logistics industries transporting ingredients), and etc. The above-mentioned OCED report estimated that such in-direct value-added effects accounted for 34% of tourism spending.

Based on these assumptions, direct and in-direct value-added effects on tourism industry generated from the master plan projects were calculated as follows.

Table B5-16 Direct and In-direct Value Added Effects on Tourism Related Industries

	2024-30	2031-40	2041-50	2051-60	2061-70	2071-80	2081-90	Total
Direct Value-Added Effects	7,529.2	17,566.7	25,090.9	31,936.3	35,639.5	36,457.2	36,873.7	191,093.6
In-direct Value-Added Effects	4,677.0	10,912.2	15,586.1	19,838.3	22,138.7	22,646.7	22,905.4	118,704.4

Unit: NPR million
Source: JET

27: Analysis of Tourists' Length of Stay in Pokhara, Nepal, Nirajan BAM, 2022 October
28: Nepal Tourist Statistics 2020, Government of Nepal Ministry of Culture, Tourism & Civil Aviation
29: OECT Tourism Trend and Policies 2020

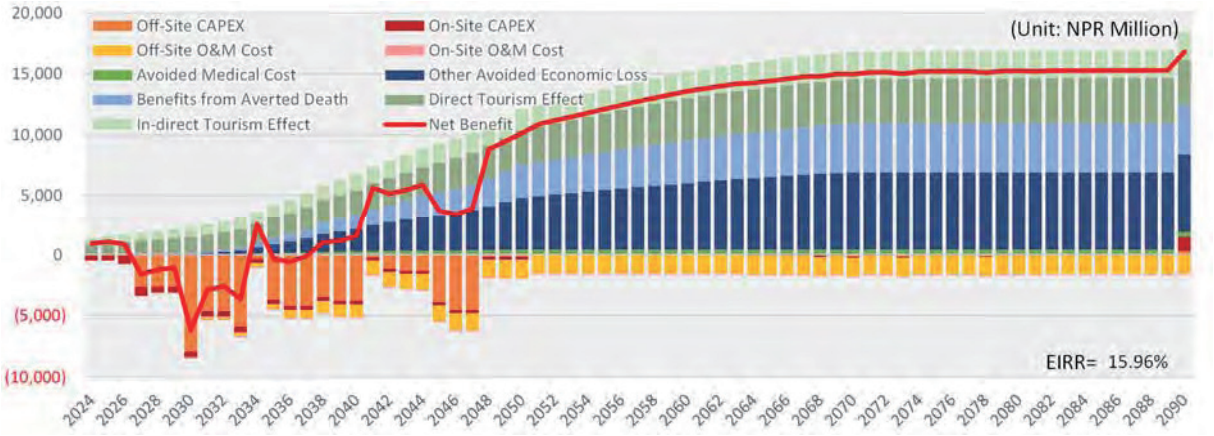
B5.1.3 Calculation of Economic Internal Rate of Return

The annual cost-benefit stream for the MP projects, provides an EIRR of 15.96%. Economic Net Present Value (ENPV) and Benefit to Cost Ratio (B/C Ratio) of the projects at 12% discount rate were calculated to be NPR 4,780.5 million and 1.179, respectively (please refer to Figure B5-6 and Table B5-17 for cashflow of economic analysis).

Table B5-17 Results of Economic Analysis

EIRR: Economic Internal Rate of Return	ENPV: Economic Net Present Value	B/C Ratio: Benefit to Cost Ratio
15.96%	NPR 4,780.5 million	1.179

Source: JET



Source： JET

Figure B5-6 Cashflow for Economic Internal Rate of Return

These results demonstrate that the master plan projects are economically feasible for implementation as each indicator is above the threshold value; EIRR>12%[30], ENPV>0 and B/C Ratio.

Table B5-18 Cashflow of Economic Internal Rate of Return (EIRR)

	Capital Expenditure		O&M Cost		Health Improvement Effects			Tourism Value Added Effects		Net Economic Benefits
	Off-Site	On-Site	Off-Site	On-Site	Medical Cost Avoided	Avoided GNI Lost	Other In-direct Benefits	Direct Effects	In-direct Effects	
2024	0.0	-461.3	0.0	-0.2	2.5	8.2	5.1	841.5	522.7	918.4
2025	0.0	-468.1	0.0	-0.5	5.0	17.5	10.9	932.3	579.1	1,076.1
2026	0.0	-740.7	0.0	-69.0	7.5	28.2	17.5	998.6	620.3	862.3
2027	-2,628.0	-740.9	0.0	-45.6	10.0	40.4	25.0	1,069.6	664.4	-1,605.1
2028	-2,628.0	-467.5	0.0	-71.4	12.5	53.0	32.8	1,145.7	711.7	-1,211.2
2029	-2,628.0	-469.0	0.0	-85.1	15.0	66.8	41.4	1,227.2	762.3	-1,069.5
2030	-7,897.2	-467.5	0.0	-84.9	17.5	81.8	50.7	1,314.5	816.5	-6,168.6
2031	-4,612.8	-435.8	-213.1	-133.1	30.0	147.5	91.4	1,390.0	863.4	-2,872.5
2032	-4,612.8	-435.7	-231.3	-99.8	42.5	219.8	136.1	1,469.8	913.0	-2,598.4
2033	-5,903.8	-436.9	-249.6	-105.7	55.0	297.3	184.2	1,554.3	965.5	-3,639.5
2034	-325.7	-354.1	-314.2	-96.9	92.7	523.4	324.2	1,643.6	1,021.0	2,514.1
2035	-3,701.8	-354.1	-384.3	-100.6	130.3	769.3	476.5	1,738.0	1,079.6	-347.0
2036	-4,173.5	-354.0	-624.7	-95.5	158.5	977.9	605.7	1,806.4	1,122.1	-576.9
2037	-4,173.4	-353.5	-672.5	-89.3	186.7	1,203.8	745.7	1,877.4	1,166.2	-108.9
2038	-3,479.3	-314.9	-934.1	-89.7	227.4	1,525.1	944.7	1,951.3	1,212.1	1,042.5
2039	-3,781.1	-314.6	-967.4	-90.5	244.4	1,705.4	1,056.3	2,028.0	1,259.8	1,140.3
2040	-3,781.1	-315.6	-1,000.8	-90.7	261.5	1,897.5	1,175.3	2,107.8	1,309.3	1,563.2
2041	-216.6	-279.1	-1,128.2	-110.1	291.0	2,196.4	1,360.4	2,179.5	1,353.9	5,647.2
2042	-1,144.1	-278.2	-1,159.2	-117.6	306.7	2,408.1	1,491.6	2,253.7	1,400.0	5,161.0
2043	-1,316.9	-279.1	-1,190.2	-95.0	322.4	2,620.7	1,623.2	2,330.4	1,447.6	5,463.2
2044	-1,316.9	-278.7	-1,221.2	-121.9	338.1	2,845.2	1,762.3	2,409.7	1,496.9	5,913.5
2045	-3,887.0	-271.3	-1,270.2	-116.2	347.5	3,027.0	1,874.9	2,491.8	1,547.8	3,744.4

30: Social Discount Rate of Nepal quoted from Kathmandu Valley Wastewater Management Project (RRP NEP 43524), ADB

	Capital Expenditure		O&M Cost		Health Improvement Effects			Tourism Value Added Effects		Net Economic Benefits
	Off-Site	On-Site	Off-Site	On-Site	Medical Cost Avoided	Avoided GNI Lost	Other In-direct Benefits	Direct Effects	In-direct Effects	
2046	-4,526.5	-270.7	-1,288.4	-154.0	356.9	3,218.0	1,993.2	2,554.1	1,586.6	3,469.2
2047	-4,527.4	-271.4	-1,306.9	-130.1	366.4	3,419.7	2,118.2	2,618.0	1,626.3	3,912.8
2048	-151.1	-237.8	-1,435.4	-125.6	388.0	3,731.2	2,311.1	2,683.5	1,667.0	8,830.9
2049	-151.1	-237.8	-1,473.2	-113.9	409.7	4,058.5	2,513.9	2,750.6	1,708.7	9,465.4
2050	-154.9	-235.4	-1,511.7	-91.3	431.8	4,406.5	2,729.4	2,819.5	1,751.4	10,145.3
2051	0.0	0.0	-1,511.7	-91.3	431.8	4,539.5	2,811.8	2,886.6	1,793.1	10,859.7
2052	0.0	0.0	-1,511.7	-91.3	431.8	4,676.5	2,896.6	2,955.3	1,835.8	11,193.0
2053	0.0	0.0	-1,511.7	-91.3	431.8	4,794.2	2,969.6	3,025.7	1,879.5	11,497.8
2054	0.0	0.0	-1,511.7	-91.3	431.8	4,915.0	3,044.3	3,097.7	1,924.2	11,810.1
2055	0.0	0.0	-1,511.7	-91.3	431.8	5,038.7	3,121.0	3,171.5	1,970.1	12,130.0
2056	0.0	0.0	-1,511.7	-91.3	431.8	5,165.6	3,199.6	3,232.7	2,008.1	12,434.7
2057	0.0	0.0	-1,511.7	-91.3	431.8	5,295.7	3,280.2	3,295.1	2,046.9	12,746.5
2058	0.0	0.0	-1,511.7	-91.3	431.8	5,402.5	3,346.3	3,358.7	2,086.4	13,022.7
2059	0.0	0.0	-1,511.7	-91.3	431.8	5,511.6	3,413.9	3,423.5	2,126.6	13,304.4
2060	0.0	0.0	-1,511.7	-91.3	431.8	5,622.8	3,482.8	3,489.6	2,167.7	13,591.6
2061	0.0	0.0	-1,511.7	-91.3	431.8	5,736.2	3,553.1	3,505.1	2,177.3	13,800.5
2062	0.0	0.0	-1,511.7	-91.3	431.8	5,852.0	3,624.8	3,520.7	2,187.0	14,013.2
2063	0.0	0.0	-1,511.7	-91.3	431.8	5,940.8	3,679.8	3,536.3	2,196.7	14,182.4
2064	0.0	-92.3	-1,511.7	-91.3	431.8	6,031.0	3,735.6	3,552.0	2,206.4	14,261.6
2065	0.0	-93.6	-1,511.7	-91.3	431.8	6,122.6	3,792.3	3,567.7	2,216.2	14,434.0
2066	0.0	-93.5	-1,511.7	-91.3	431.8	6,215.5	3,849.9	3,575.7	2,221.1	14,597.5
2067	0.0	-93.5	-1,511.7	-91.3	431.8	6,309.9	3,908.3	3,583.6	2,226.1	14,763.1
2068	0.0	-184.9	-1,511.7	-91.3	431.8	6,374.1	3,948.1	3,591.5	2,231.0	14,788.7
2069	0.0	-93.8	-1,511.7	-91.3	431.8	6,439.0	3,988.3	3,599.5	2,236.0	14,997.8
2070	-155.7	-93.5	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,607.5	2,240.9	14,961.5
2071	0.0	-87.2	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,615.5	2,245.9	15,136.5
2072	0.0	-87.1	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,623.5	2,250.9	15,149.5
2073	-155.7	-87.4	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,631.6	2,255.9	15,006.6
2074	0.0	-70.8	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,639.6	2,260.9	15,191.9
2075	0.0	-70.8	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,647.7	2,265.9	15,205.0
2076	0.0	-70.8	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,651.8	2,268.4	15,211.6
2077	0.0	-70.7	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,655.8	2,270.9	15,218.3
2078	-125.6	-63.0	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,659.9	2,273.4	15,106.9
2079	0.0	-62.9	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,663.9	2,276.0	15,239.2
2080	0.0	-63.1	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,668.0	2,278.5	15,245.6
2081	-41.9	-55.8	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,672.1	2,281.0	15,217.6
2082	0.0	-55.6	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,676.1	2,283.6	15,266.3
2083	0.0	-55.8	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,680.2	2,286.1	15,272.7
2084	0.0	-55.7	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,684.3	2,288.6	15,279.4
2085	0.0	-54.3	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,688.4	2,291.2	15,287.5
2086	0.0	-54.1	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,690.4	2,292.4	15,291.0
2087	0.0	-54.3	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,692.5	2,293.7	15,294.1
2088	-19.3	-47.6	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,694.5	2,295.0	15,284.9
2089	0.0	-47.6	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,696.6	2,296.3	15,307.5
2090	305.7	1,158.5	-1,511.7	-91.3	431.8	6,504.5	4,028.9	3,698.6	2,297.5	16,822.6
(Unit: NPR Million)									EIRR=	15.96%

Source: JST

B5.2 Financial Analysis

Financial analysis was carried out from the perspective of the project, and considers incremental revenues and costs generated by the project. The purpose of financial analysis is to assess the ability of the project to generate adequate incremental cash flows to recover its financial costs without external support.

As same as economic analysis, all costs and benefits used for the analysis are expressed in the Nepal Rupee (NPR) in constant July 2022 values. Foreign currency-based costs and benefits were converted to NPR using the average exchange rate of NPR 1.0= Japanese Yen (JPY) 1.0835 and United State Dollar (USD) 1.0= NPR 150.899[31].

The cost and benefit streams to be generated by implementing master plan have been estimated from 2024 (commencement of construction activity of Phase I project for West Area) to 2090 (40 years[32] after

[31] Average exchange rate during the past three months (July – September 2022), Mitsubishi UFJ Bank

[32] Evaluation period of 40 years was set with referring to JICA's guideline of economic analysis for sewerage project, published in 2002.

the completion of project for East Area).

Service life of the assets constructed under the Project were assumed as 40 years. It was assumed that these project facilities could maintain its original function by appropriating rehabilitation costs at end of service life.

B5.2.1 Project Cost

(1) Basic Assumptions

Financial analysis is based on market prices that are actually paid or received by a project, and it focuses on financial values of project costs and revenues. Project cost is including base cost, administration cost, physical contingency, consulting fee and taxes. Since price used for this analysis is expressed in fixed price, without taking price inflation into consideration, price contingencies are not regarded as cost.

(2) Initial Capital Expenditures

In case of the sewerage projects, it was assumed that initial capital expenditure of WWTPs, manhole pumps, sewer pipes will be borne by the governments (federal government and/or PMC), while that of house connection will be borne by each household. Since this financial analysis is executed from view point of governments (federal government and PMC), capital expenditure of house connection was excluded from this analysis.

As same as economic analysis, disbursement schedule of initial capital expenditures was determined based on implementation schedule of the master projects mentioned in Chapter B3 and time required for construction of each facility.

Table B5-19 Initial Capital Expenditure for the Sewerage Projects (Financial Cost)

	West		East		Hemja	East	Total
	Phase 1	Phase 2	Phase 1	Phase 2			
2027	3,110.2	0.0	0.0	0.0	0.0	0.0	3,110.2
2028	3,110.2	0.0	0.0	0.0	0.0	0.0	3,110.2
2029	3,110.2	0.0	0.0	0.0	0.0	0.0	3,110.2
2030	3,998.8	5,379.7	0.0	0.0	0.0	0.0	9,378.5
2031	0.0	5,379.7	0.0	0.0	0.0	0.0	5,379.7
2032	0.0	5,379.7	0.0	0.0	0.0	0.0	5,379.7
2033	0.0	6,916.7	0.0	0.0	0.0	0.0	6,916.7
2034	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2035	0.0	0.0	4,009.4	0.0	0.0	0.0	4,009.4
2036	0.0	0.0	4,677.6	0.0	0.0	0.0	4,677.6
2037	0.0	0.0	4,677.6	0.0	0.0	0.0	4,677.6
2038	0.0	0.0	0.0	3,758.7	0.0	0.0	3,758.7
2039	0.0	0.0	0.0	4,385.1	0.0	0.0	4,385.1
2040	0.0	0.0	0.0	4,385.1	0.0	0.0	4,385.1
2041	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2042	0.0	0.0	0.0	0.0	1,237.3	0.0	1,237.3
2043	0.0	0.0	0.0	0.0	1,443.6	0.0	1,443.6
2044	0.0	0.0	0.0	0.0	1,443.6	0.0	1,443.6
2045	0.0	0.0	0.0	0.0	0.0	4,570.7	4,570.7
2046	0.0	0.0	0.0	0.0	0.0	5,332.5	5,332.5
2047	0.0	0.0	0.0	0.0	0.0	5,332.5	5,332.5
2048	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2049	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Unit: NPR million
Source: JET

In case of on-site sanitation project, it was assumed that installation cost of impermeable septic tanks will be borne by each household, and initial capital expenditure for fecal treatment plants and vacuum cars for fecal sludge collection and transportation will be covered by grant assistance from international donor agency. Since these initial capital expenditures will not be borne by the governments, they were excluded from the analysis.

(3) Operation and Maintenance Cost

In case of sewerage projects, government needs to bone O&M costs of WWTPs, manhole pumps and sewer pipes. Since O&M costs of house connections will be borne by each customer, it was excluded from the analysis.

O&M costs of sewerage projects to be borne by the governments were summarized as Table B5-20.

Table B5-20 Operation and Maintenance Cost of Sewerage Projects

	West		Central		Hemja		East		Total
	WWTP, MP	Sewer Pipes	WWTP, MP	Sewer Pipes	WWTP, MP	Sewer Pipes	WWTP, MP	Sewer Pipes	
2031	209.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	210.8
2032	227.6	1.3	0.0	0.0	0.0	0.0	0.0	0.0	228.9
2033	245.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0	247.0
2034	309.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0	311.0
2035	373.8	2.6	0.0	0.0	0.0	0.0	0.0	0.0	376.3
2036	612.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	615.1
2037	659.9	2.6	0.0	0.0	0.0	0.0	0.0	0.0	662.4
2038	707.2	2.6	250.4	1.4	0.0	0.0	0.0	0.0	961.6
2039	712.1	2.6	283.9	1.4	0.0	0.0	0.0	0.0	1,000.0
2040	717.0	2.6	317.6	1.4	0.0	0.0	0.0	0.0	1,038.6
2041	721.9	2.6	458.3	2.8	0.0	0.0	0.0	0.0	1,185.6
2042	726.8	2.6	489.1	2.8	0.0	0.0	0.0	0.0	1,221.3
2043	731.7	2.6	519.9	2.8	0.0	0.0	0.0	0.0	1,257.0
2044	736.6	2.6	550.7	2.8	0.0	0.0	0.0	0.0	1,292.6
2045	741.4	2.6	555.3	2.8	46.3	1.4	0.0	0.0	1,349.8
2046	746.3	2.6	559.9	2.8	57.4	1.4	0.0	0.0	1,370.4
2047	751.2	2.6	564.6	2.8	68.8	1.4	0.0	0.0	1,391.3
2048	756.1	2.6	569.2	2.8	69.3	1.4	134.6	5.6	1,541.5
2049	761.0	2.6	573.8	2.8	69.9	1.4	168.0	5.6	1,585.0
2050	765.8	2.6	578.4	2.8	70.4	1.4	202.3	5.6	1,629.3
:	:	:	:	:	:	:	:	:	:

Unit: NPR million
MP: Manhole Pump
Source: JET

In case of on-site sanitation projects, government needs to bone O&M costs of impermeable septic tanks and fecal treatment plants as well as costs of fecal sludge collection and transportation.

Table B5-21 Operation and Maintenance Cost of On-site Sanitation Facilities

Year	IST	C&T	FTP	Total	Year	IST	C&T	FTP	Total	Year	IST	C&T	FTP	Total
2024	0.3			0.3	2047	3.9	115.4	21.0	140.3	2070	3.9	73.5	21.0	98.4
2025	0.5			0.5	2048	4.3	110.2	21.0	135.5	2071	3.9	94.8	21.0	119.7
2026	0.8	73.5		74.3	2049	4.1	97.8	21.0	123.0	2072	3.9	101.9	21.0	126.8
2027	1.1	48.0		49.1	2050	3.9	73.7	21.0	98.6	2073	3.9	80.6	21.0	105.5
2028	1.4	54.5	21.0	76.9	2051	3.9	80.6	21.0	105.5	2074	3.9	109.0	21.0	133.9
2029	1.6	69.0	21.0	91.7	2052	3.9	73.5	21.0	98.4	2075	3.9	101.9	21.0	126.8
2030	1.9	68.5	21.0	91.4	2053	3.9	73.5	21.0	98.4	2076	3.9	144.5	21.0	169.4
2031	2.1	120.3	21.0	143.3	2054	3.9	73.5	21.0	98.4	2077	3.9	116.1	21.0	141.0
2032	2.3	84.3	21.0	107.6	2055	3.9	73.5	21.0	98.4	2078	3.9	109.0	21.0	133.9
2033	2.6	90.3	21.0	113.9	2056	3.9	94.8	21.0	119.7	2079	3.9	94.8	21.0	119.7
2034	3.2	80.3	21.0	104.5	2057	3.9	101.9	21.0	126.8	2080	3.9	73.5	21.0	98.4
2035	3.2	84.4	21.0	108.6	2058	3.9	80.6	21.0	105.5	2081	3.9	80.6	21.0	105.5
2036	3.2	78.8	21.0	103.0	2059	3.9	109.0	21.0	133.9	2082	3.9	73.5	21.0	98.4
2037	3.2	72.2	21.0	96.4	2060	3.9	101.9	21.0	126.8	2083	3.9	73.5	21.0	98.4
2038	2.8	72.9	21.0	96.8	2061	3.9	144.5	21.0	169.4	2084	3.9	73.5	21.0	98.4
2039	3.0	73.6	21.0	97.7	2062	3.9	116.1	21.0	141.0	2085	3.9	73.5	21.0	98.4
2040	3.2	73.7	21.0	97.9	2063	3.9	109.0	21.0	133.9	2086	3.9	94.8	21.0	119.7
2041	3.5	94.3	21.0	118.8	2064	3.9	94.8	21.0	119.7	2087	3.9	101.9	21.0	126.8
2042	3.5	102.3	21.0	126.8	2065	3.9	73.5	21.0	98.4	2088	3.9	80.6	21.0	105.5
2043	3.5	78.0	21.0	102.6	2066	3.9	80.6	21.0	105.5	2089	3.9	109.0	21.0	133.9
2044	3.5	106.9	21.0	131.4	2067	3.9	73.5	21.0	98.4	2090	3.9	101.9	21.0	126.8
2045	3.7	100.6	21.0	125.3	2068	3.9	73.5	21.0	98.4					
2046	3.8	141.2	21.0	166.0	2069	3.9	73.5	21.0	98.4					

Unit: NPR million
IST: Impermeable Septic Tank, C&T: Collection and Transportation of Fecal Sludge, FTP: Fecal Treatment Plant
Source: JET

(4) Rehabilitation Cost of Sewage/Fecal Treatment Plants

Rehabilitation costs of sewerage/fecal treatment plants after 40 years of construction were assumed to be 20% of their initial capital expenditures.

B5.2.2 Financial Benefits

Financial benefits of the MP projects consist of incremental revenue from connection fee and from wastewater tariff.

Of which, wastewater tariff could be charged by linked with water tariff or linked with property tax. Water tariff linked method was already adopted in Kathmandu. KUKL collected 50% of water tariff as wastewater tariff. In case of Pokhara, PMC could ask NWSC to collect wastewater tariff together with water tariff collection. It is said that the collection ratio of property tax is relatively low in Pokhara, while NWSC Pokhara has been achieving almost 100% tariff collection. For this reason, this analysis tentatively adopted water tariff linked method for wastewater tariff.

Customers who wish to connect sewerage network needs to pay around NPR 20,000 – 26,000 to contractor for house connection, while customers who wish to install impermeable septic tank needs to born NPR 97,000 to 225,000. If PMC charge connection fee on top of these costs, it might discourage peoples from connecting sewerage network or from installing impermeable septic tank. Thereby, it is assumed that PCM will not charge connection fee to customers.

Table B5-22 shows NWSC's actual and planned revenue from water supply service in Pokhara. As shown in the table, the average water tariff collected from private customers was NPR 443.6 per connection in 2021. It is forecasted to be increase around NPR 470 per connection in 2022 and 2023. On the other hand, revenue from water tariff collected from governmental organizations accounted for around 5% of revenue from private consumers.

Table B5-22 NWSC's Revenue from Water Supply Service in Pokhara between 2021 - 2023

	2021 (Actual)			2022 (Planned)			2023 (Planned)		
	No. of Connection	Average Monthly Tariff (NPR)	Annual Revenue (NPR 1,000)	No. of Connection	Average Monthly Tariff (NPR)	Annual Revenue (NPR 1,000)	No. of Connection	Average Monthly Tariff (NPR)	Annual Revenue (NPR 1,000)
Private w/h Meter	44,029	442.4	233,741	45,902	468.0	257,786	47,902	472.0	271,317
Private w/o Meter	345	598.1	2,476	300	660.0	2,376	200	650.0	1,560
Sub Total	44,374	443.6	236,217	46,202	469.2	260,162	48,102	472.7	272,877
Govt. w/h Meter	397	1,876.6	8,940	402	2,050.0	9,889	402	2,050.0	9,889
Govt. w/o Meter	127	2,110.2	3,216	127	2,112.0	3,219	127	2,113.0	3,220
Sub Total	524	1,933.21	12,156	529	2,064.9	13,108	529	2,065.1	13,109
Total	44,898	461.00	248,373	46,731	487.3	273,270	48,631	490.1	285,986

Source: NWSC Pokhara

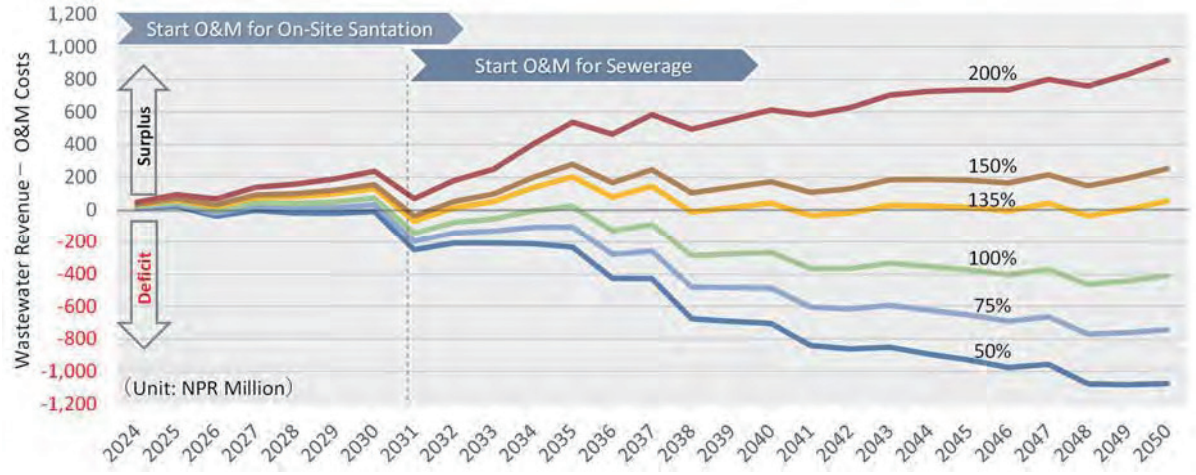
Figure B5-7 illustrates the gap between PMC's revenue from wastewater tariff[33] and O&M cost to be borne by PMC (revenue minus O&M cost). Wastewater tariff is assumed as 50 – 200% of water tariff[34].

If wastewater tariff is assumed as 50% of water tariff, wastewater revenue could not cover O&M cost (deficit of NPR 200 – 1,100 million per year).

In order to cover O&M cost from wastewater tariff revenue, it needs to set 135% of water tariff.

[33] As same as water tariff revenue, wastewater tariff revenue from government organization account for 5% of revenue from private consumers.

[34] Water tariff is assumed as NPR 470 per connection per month.



Source: JST

Figure B5-7 Gap between Wastewater Tariff Revenue and O&M Costs under Various Cases

However, if wastewater tariff will be set higher than the water tariff, there will be less consumers willing to connect the sewerage network or install impermeable septic tank. For this reason, wastewater tariff is assumed as same as water tariff (100% of water tariff), and then the gap will be filled by newly introduced tourism tax.

It is assumed that tourism tax will be imposed to foreign tourists stay hotels in Pokhara. Number of tourists and average length of stay are assumed as same assumptions as "B5.1.2(2) Economic Benefits on Tourism Industries". In this case, it is found that tourism tax of NPR 90 per night per tourist is good enough to fill the gap.

Based on the above assumptions, revenue from wastewater tariff and tourism tax were calculated as the Table B5-23

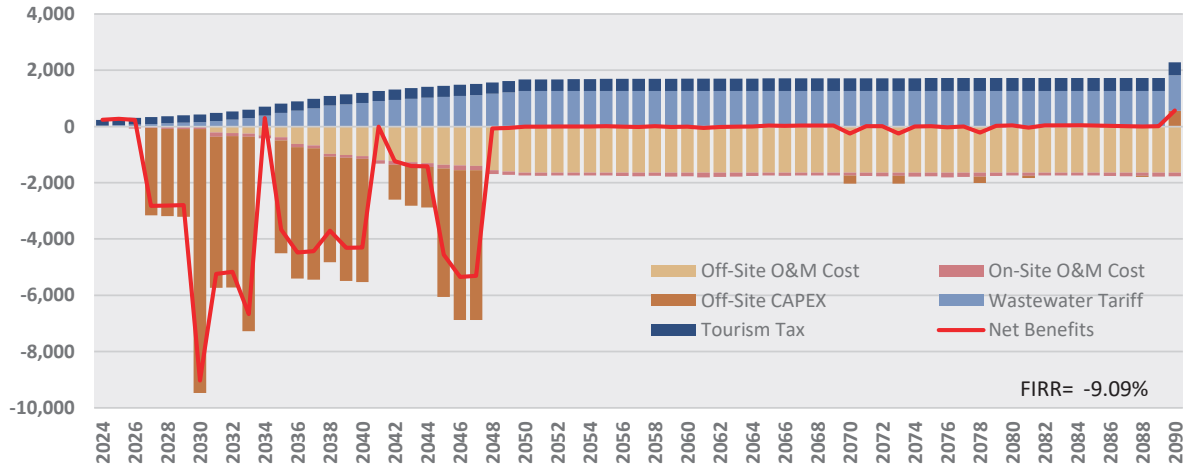
Table B5-23 Revenue from Wastewater Tariff and Tourism Tax

	2024-30	2031-40	2041-50	2051-60	2061-70	2071-80	2081-90	Total
Revenue from Wastewater Tariff	657.9	5,457.5	11,307.8	13,273.9	13,273.9	13,273.9	13,273.9	70,518.6
Revenue from Tourism Tax	1,727.3	3,248.9	3,882.5	4,248.3	4,444.9	4,546.9	4,598.8	26,697.6

Unit: NPR million
Source: JET

B5.2.3 Calculation of Financial Internal Rate of Return (FIRR)

Revenue collected from beneficially is not enough to cover capital expenditure and O&M cost, thereby financial internal rate of return (FIRR) of the master plan projects shows negative value (FIRR= -9.09%). Please refer to Figure B5-8 and Table B5-24. Which indicated that the MP projects are financially not feasible (not profitable), while the projects already proven to be economically feasible (please refer to Chapter B5.1) and worthwhile implementation from national economic point of view.



Source: JET

Figure B5-8 Cashflow of Financial Internal Rate of Return of the Master Plan Project

It is generally known that the financial feasibility of sanitation project is scarcely variable without fiscal support from the central government and/or donor agencies.

The following section examines profitability and fiscal sustainability of the MP projects taking fiscal support from the Central Government and PMC into consideration.

Table B5-24 Cashflow of the Financial Internal Rate of Return (FIRR)

Year	Capital Expenditure	O&M Cost		Wastewater Tariff		Travel Tax	Net Financial Benefit
		Sewerage	On-site	Sewerage	On-site		
2024	0.0	0.0	-0.6	0.0	23.5	215.3	238.2
2025	0.0	0.0	-1.1	0.0	47.0	230.5	276.4
2026	0.0	0.0	-75.2	0.0	70.5	238.7	234.1
2027	-3,110.2	0.0	-50.2	0.0	94.0	247.2	-2,819.2
2028	-3,110.2	0.0	-78.3	0.0	117.5	256.0	-2,815.0
2029	-3,110.2	0.0	-93.3	0.0	141.0	265.1	-2,797.5
2030	-9,378.5	0.0	-93.4	0.0	164.5	274.5	-9,032.9
2031	-5,379.7	-212.1	-145.4	29.0	182.7	284.2	-5,241.2
2032	-5,379.7	-230.2	-109.9	57.9	201.0	294.3	-5,166.5
2033	-6,916.7	-248.2	-116.4	86.9	219.2	304.8	-6,670.5
2034	0.0	-312.3	-107.7	189.6	220.5	315.6	305.7
2035	-4,009.4	-382.9	-111.7	292.2	221.8	326.8	-3,663.1
2036	-4,677.6	-621.7	-106.1	368.1	226.2	332.6	-4,478.6
2037	-4,677.6	-669.0	-99.6	443.9	230.5	338.5	-4,433.2
2038	-3,758.7	-969.6	-99.6	557.5	222.7	344.5	-3,703.1
2039	-4,385.1	-1,008.0	-100.7	603.1	226.2	350.6	-4,313.8
2040	-4,385.1	-1,046.6	-101.1	648.7	229.7	356.9	-4,297.5
2041	0.0	-1,196.5	-122.3	733.9	214.4	363.2	-7.4
2042	-1,237.3	-1,232.2	-130.4	776.4	216.0	369.6	-1,237.7
2043	-1,443.6	-1,267.8	-106.1	819.0	217.7	376.2	-1,404.6
2044	-1,443.6	-1,303.5	-135.0	861.5	219.4	382.9	-1,418.2
2045	-4,570.7	-1,360.7	-129.1	885.3	225.7	389.7	-4,559.7
2046	-5,332.5	-1,381.3	-169.8	909.2	232.0	393.1	-5,349.3
2047	-5,332.5	-1,402.2	-144.2	933.3	238.3	396.6	-5,310.7
2048	0.0	-1,552.4	-139.9	995.7	227.6	400.2	-68.9
2049	0.0	-1,595.9	-127.1	1,058.1	216.9	403.7	-44.3
2050	0.0	-1,640.2	-102.5	1,121.8	205.5	407.3	-8.0
2051	0.0	-1,640.2	-109.4	1,121.8	205.5	410.9	-11.3
2052	0.0	-1,640.2	-102.3	1,121.8	205.5	414.5	-0.6
2053	0.0	-1,640.2	-102.3	1,121.8	205.5	418.2	3.1
2054	0.0	-1,640.2	-102.3	1,121.8	205.5	421.9	6.8
2055	0.0	-1,640.2	-102.3	1,121.8	205.5	425.7	10.6
2056	0.0	-1,640.2	-123.6	1,121.8	205.5	427.6	-8.8
2057	0.0	-1,640.2	-130.7	1,121.8	205.5	429.5	-14.0
2058	0.0	-1,640.2	-109.4	1,121.8	205.5	431.4	9.2
2059	0.0	-1,640.2	-137.8	1,121.8	205.5	433.3	-17.3
2060	0.0	-1,640.2	-130.7	1,121.8	205.5	435.2	-8.3

Year	Capital Expenditure	O&M Cost		Wastewater Tariff		Travel Tax	Net Financial Benefit
		Sewerage	On-site	Sewerage	On-site		
2061	0.0	-1,640.2	-173.3	1,121.8	205.5	437.1	-49.0
2062	0.0	-1,640.2	-144.9	1,121.8	205.5	439.1	-18.6
2063	0.0	-1,640.2	-137.8	1,121.8	205.5	441.0	-9.6
2064	0.0	-1,640.2	-123.6	1,121.8	205.5	443.0	6.6
2065	0.0	-1,640.2	-102.3	1,121.8	205.5	445.0	29.9
2066	0.0	-1,640.2	-109.4	1,121.8	205.5	445.9	23.7
2067	0.0	-1,640.2	-102.3	1,121.8	205.5	446.9	31.8
2068	0.0	-1,640.2	-102.3	1,121.8	205.5	447.9	32.8
2069	0.0	-1,640.2	-102.3	1,121.8	205.5	448.9	33.8
2070	-282.8	-1,640.2	-102.3	1,121.8	205.5	449.9	-247.9
2071	0.0	-1,640.2	-123.6	1,121.8	205.5	450.9	14.5
2072	0.0	-1,640.2	-130.7	1,121.8	205.5	451.9	8.4
2073	-282.8	-1,640.2	-109.4	1,121.8	205.5	452.9	-252.0
2074	0.0	-1,640.2	-137.8	1,121.8	205.5	453.9	3.3
2075	0.0	-1,640.2	-130.7	1,121.8	205.5	454.9	11.4
2076	0.0	-1,640.2	-173.3	1,121.8	205.5	455.4	-30.7
2077	0.0	-1,640.2	-144.9	1,121.8	205.5	455.9	-1.8
2078	-228.2	-1,640.2	-137.8	1,121.8	205.5	456.5	-222.3
2079	0.0	-1,640.2	-123.6	1,121.8	205.5	457.0	20.5
2080	0.0	-1,640.2	-102.3	1,121.8	205.5	457.5	42.4
2081	-76.1	-1,640.2	-109.4	1,121.8	205.5	458.0	-40.3
2082	0.0	-1,640.2	-102.3	1,121.8	205.5	458.5	43.4
2083	0.0	-1,640.2	-102.3	1,121.8	205.5	459.0	43.9
2084	0.0	-1,640.2	-102.3	1,121.8	205.5	459.5	44.4
2085	0.0	-1,640.2	-102.3	1,121.8	205.5	460.0	44.9
2086	0.0	-1,640.2	-123.6	1,121.8	205.5	460.3	23.9
2087	0.0	-1,640.2	-130.7	1,121.8	205.5	460.5	17.0
2088	-35.1	-1,640.2	-109.4	1,121.8	205.5	460.8	3.5
2089	0.0	-1,640.2	-137.8	1,121.8	205.5	461.0	10.4
2090	555.9	-1,640.2	-130.7	1,121.8	205.5	461.3	573.7
						FIRR=	-9.09%

(Unit: NPR million)
Source: JST

Column: Sewerage Network Development could Contribute to Reduce Initial Capital Investment Cost to be Born by Citizens

Citizens who wish to connect to sewerage network needs to born cost of house connection pipe from main public sewer pipe to their property. Typically, a household has to pay around NPR 20,000 to a construction contractor for house connection.

On the other hand, if sewer network will not be developed, they have to install impermeable septic tank at their own cost (roughly NPR 225,000 per household).

As example described above, sewerage network development could contribute to reduce initial capital investment of citizens by NPR 205,000 per household (NPR 225,000 – NPR 20,000). Such citizens fiscal burden reduction throughout master plan implementation period was calculated to be NPR 31,354 million.

Table B5-25 Reduction in Initial Capital Investment Costs to be Born by Citizens

Year	Number of Households benefited by Sewerage Network Development							Cost Reduction (NPR mil.)
	West-1	West-2	Central-1	Central-2	Hemja	East	Total	
2024	0	0	0	0	0	0	0	0.0
2025	0	0	0	0	0	0	0	0.0
2026	0	0	0	0	0	0	0	0.0
2027	0	0	0	0	0	0	0	0.0
2028	0	0	0	0	0	0	0	0.0
2029	0	0	0	0	0	0	0	0.0
2030	0	0	0	0	0	0	0	0.0
2031	4,378	0	0	0	0	0	4,378	897.5

2032	4,377	0	0	0	0	0	4,377	897.3
2033	4,378	0	0	0	0	0	4,378	897.5
2034	4,377	10,528	0	0	0	0	14,905	3,055.5
2035	4,378	10,529	0	0	0	0	14,907	3,055.9
2036	368	10,531	0	0	0	0	10,899	2,234.3
2037	368	10,529	0	0	0	0	10,897	2,233.9
2038	369	10,528	4,785	0	0	0	15,682	3,214.8
2039	368	957	4,785	0	0	0	6,110	1,252.6
2040	369	957	4,785	0	0	0	6,111	1,252.8
2041	368	956	4,785	5,191	0	0	11,300	2,316.5
2042	369	956	457	3,920	0	0	5,702	1,168.9
2043	368	957	457	3,921	0	0	5,703	1,169.1
2044	369	957	457	3,920	0	0	5,703	1,169.1
2045	368	955	457	423	1,212	0	3,415	700.1
2046	368	958	457	422	1,212	0	3,417	700.5
2047	369	956	457	423	1,246	0	3,451	707.5
2048	368	957	457	422	88	5,157	7,449	1,527.0
2049	369	955	457	423	88	5,158	7,450	1,527.3
2050	368	957	457	422	88	5,302	7,594	1,556.8
Source: JST						Cost Reduction Total		31,354.7

Note should be taken that financial and economic analysis in this chapter try to measure incremental cost and benefit under with and without (both of them will not be developed) the MP project. Under the with the MP project case, sewerage network and impermeable septic tanks will be developed, while both of them will not be developed under without the MP project.

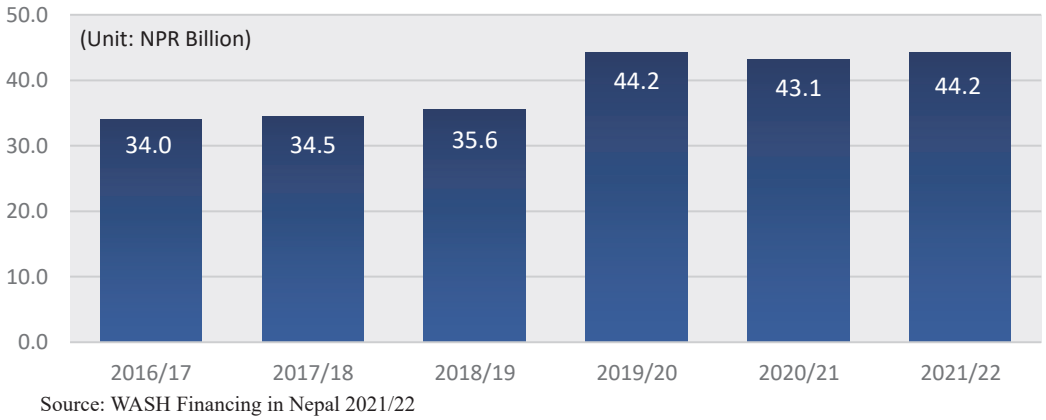
For this reason, the case mentioned above (impermeable septic tank will be developed when sewerage network will not be realized), could not be regarded as financial nor economic benefit of the MP project.

B5.3 Financing Plan

B5.3.1 WASH Budgets of Federal Government and PMC

(1) WASH Budget of Federal Government

Figure B5-9 illustrates budget for water, sanitation and hygiene (WASH) during the past five years. WASH budget is generally in increasing trend, while it remains to be almost stagnant in the last three consecutive years due to pandemic of COVID-19 and economic recession.

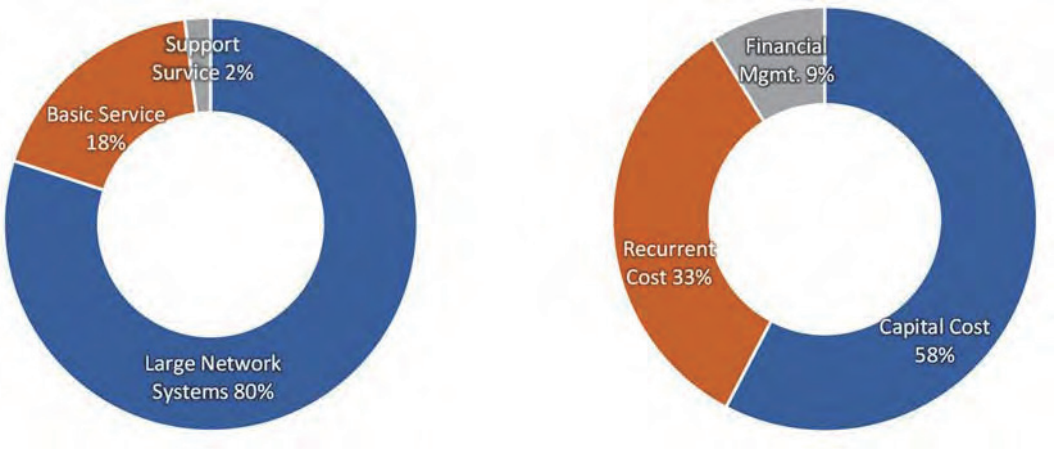


Source: WASH Financing in Nepal 2021/22

Figure B5-9 Changes in WASH Budget (2016/17 - 2021/22)

WASH budget in 2021/22 is NPR 44.2 billion, which is 2.64% of the overall federal budget and 1.2%

of GDP. Out of the budget allocated to WASH services, 80% (or NPR 35.4 billion) for programs related to large network systems. In addition, 58% of the budget allocated to WASH is for capital cost[35] (NPR 25.5 billion).



Source: WASH Financing in Nepal 2021/22

Figure B5-10 WASH Budget in 2021/22 by Purpose (Left) and by Budget Type (Right)

Based on this information, it is estimated that capital cost for large network systems to be NPR 20.5 billion (=NPR 44.2 billion * 80% * 58%).

(2) PMC's Budget for Capital Expenditure for Infrastructure Development

PMC's annual budgets during the past three fiscal years (2019/20 - 2021/22) were ranged between NPR 3.26 billion and NPR 6.28 billion. Of which, capital expenditure for infrastructure development (NPR 1.95 – 2.88 billion) occupied 44.7% and 59.8% to total budget.

Capital expenditure for water and sanitation projects during the three fiscal years was recorded NPR 33.6 – 163.2 million, which accounted for 2.6 – 4.8% of capital expenditure for infrastructure development.

B5.3.2 Fiscal Burden of Master Plan Implementation to be Born by the Governments

(1) Cost Share between the Federal Government and PMC (Base Case Scenario)

Under this MP, it is proposed that sanitation facilities will be developed from 2027 to 2050 (24 years). It was assumed that initial capital expenditure of WWTP, manhole pumps and sewer pipes will be borne by the governments (federal government and/or PMC)[36].

This section aims to clarify whether federal government and/or PMC could bone such fiscal burden taking their affordability into consideration.

Since MP projects require large initial capital expenditures, it was assumed that federal government will utilize concessional loan from donor agency to cover such expenditures. This analysis tentatively employ scenario that Japanese government will provide ODA loan through JICA. It was assumed that ODA loan will be provided in three tranche having 8 years disbursement period each. Principe repayment, interest payment of ODA loans and Nepal government's own costs were estimated based on the assumptions summarized in Table B5-26. Terms and conditions of ODA loan was tentatively set based on assumptions that this master plan projects are eligible for preferential terms, and Nepal is

[35] Capital cost is mostly investment in assets that are used over time in the provision of goods or services. Examples of capital costs include the amounts spent for WWTPs, sewer pipes and etc. On the other hand, recurrent cost means expenditures that are recurring in nature, i.e., spending that is consumed, whose benefits last for only a limited period. Examples of recurrent cost include salaries and wages, employee allowances, O&M costs and etc.

[36] It was assumed that initial capital expenditure of house connection and septic tanks will be borne by each household, and that of fecal treatment plants and vacuum cars will be covered by grant assistance from international donor agency.

categorized as low-income countries.

Table B5-26 ODA Loan Assumptions

	Phase 1	Phase 2	Phase 3
Implementation Period	2027 ~ 35	2036 ~ 42	2043 ~ 50
Project Cost*	NPR 41,765 million	NPR 32,810 million	NPR 16,679 million
Loan Amount	NPR 35,500 million	NPR 27,880 million	NPR 14,177 million
Interest Rate	0.65% /year		
Repayment Period	40 years		
Grace Period	10 years		
Loan Coverage	85%		

Source: JET and Terms and Conditions of Japanese ODA Loans for Low-Income Countries, April 2022

As mentioned in Table B5-26, it was assumed that 15% of project cost will be covered by Nepal government's own funds. Of which, it was assumed that Federal government and PMC will bear 66.7% and 33.3% of own funds, respectively (same arrangement as ADB's Sewerage Project in Biratnagar).

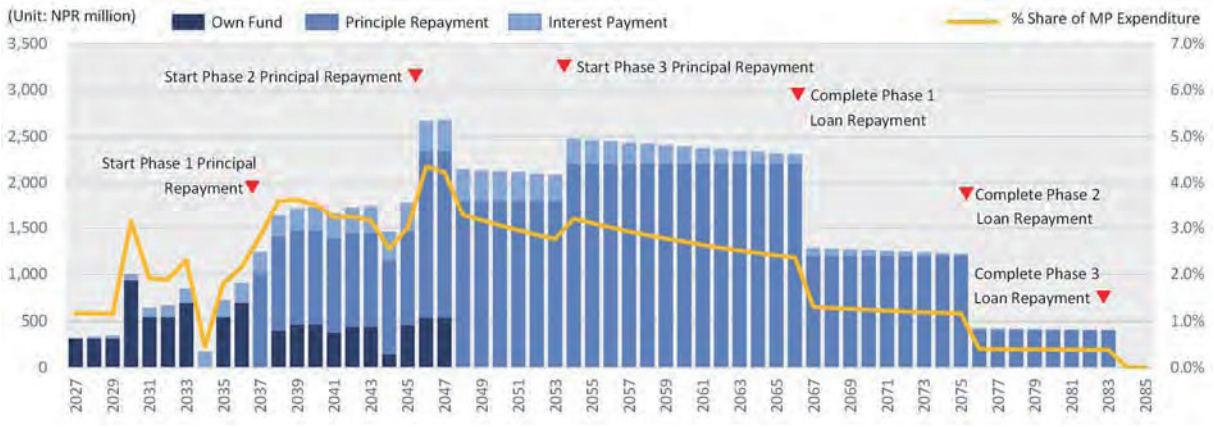
With referring to the above-mentioned ADB project, it was assumed that the loan repayment obligation will be share between the Federal Government (85.5%) and PMC (14.5%[37]).

(2) Fiscal Burden of the Federal Government

Figure B5-11 illustrates annual disbursement schedule of Federal Government's master plan expenditures, which consists of own fund, principal repayment and interest payment of the loan. Yellow line in the graph shows the percentage share of the Federal Government's master plan expenditures to its WASH budget for capital cost of large network system.

Federal government's fiscal burden will be increased particularly after commencement of principal repayment of the phase 2 project in 2046, and will be eased after completion of loan repayment of phase 1 project in 2075. During the period, the Federal Government needs to borne around NPR 2,100 – 2,700 million per annum.

It was estimated that the percentage share of the Federal Government's master plan expenditures to its WASH budget for capital cost of large network system will be 2.14% on an average during the evaluation period, and will become highest in 2046 (4.35%). Since Pokhara is the second largest metropolitan city in the country, such fiscal burden is not seen as significant.



Source: JET

Figure B5-11 Fiscal Burden of Master Plan Implementation to be borne by the Federal Government (Base Case)

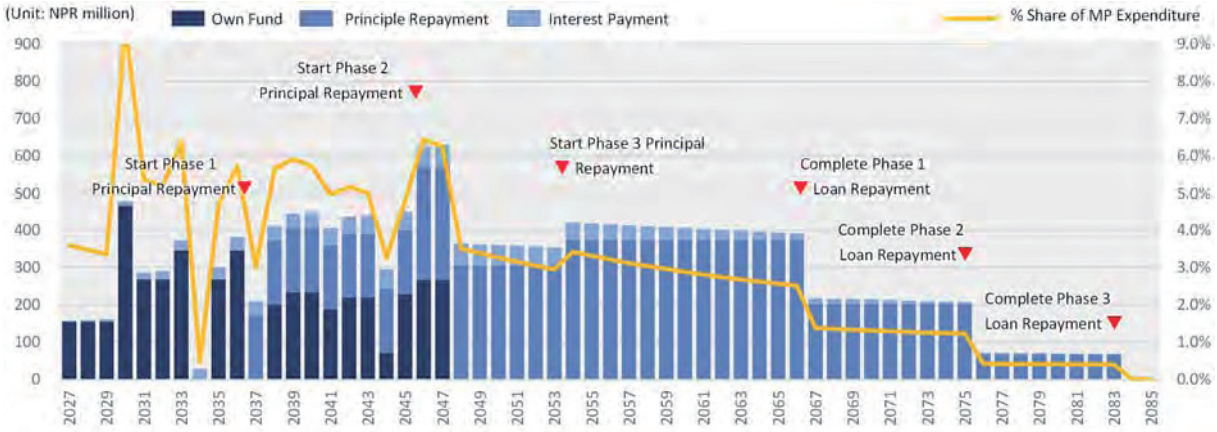
[37] Sewerage project in Biratnagar (Project Number: 36188-023) was covered by ADB/OFID loan. Of which, 14.5% of loan was converted to town development fund (TDP), and the local government needed to repay the loan.

(3) Fiscal Burden of PMC

Figure B5-12 illustrates annual disbursement schedule of PMC's master plan expenditures, which consists of own fund, principal repayment and interest payment of the loan. Yellow line in the graph shows the percentage share of the PMC's master plan expenditures to its development budget for infrastructure.

During the evaluation period, PMC needs to borne around NPR 30 – 630 million per annum. PMC's fiscal burden will become highest in 2046 and 2047, when commencement of the principal repayment of phase 2 project and capital investment for Hemja area and East area from own funds occurs simultaneously.

It was estimated that the percentage share of the PMC's master plan expenditures to its infrastructure development budget will be 3.09% on an average during the evaluation period, and will become highest in 2030 (9.48%). Since capital cost for water and sanitation projects in Pokhara occupied only 2.6-4.8% of its infrastructure development budget during 2019/20 – 2021/22, more than 3% share on an average by sanitation projects only might not affordable to PMC.



Source: JET

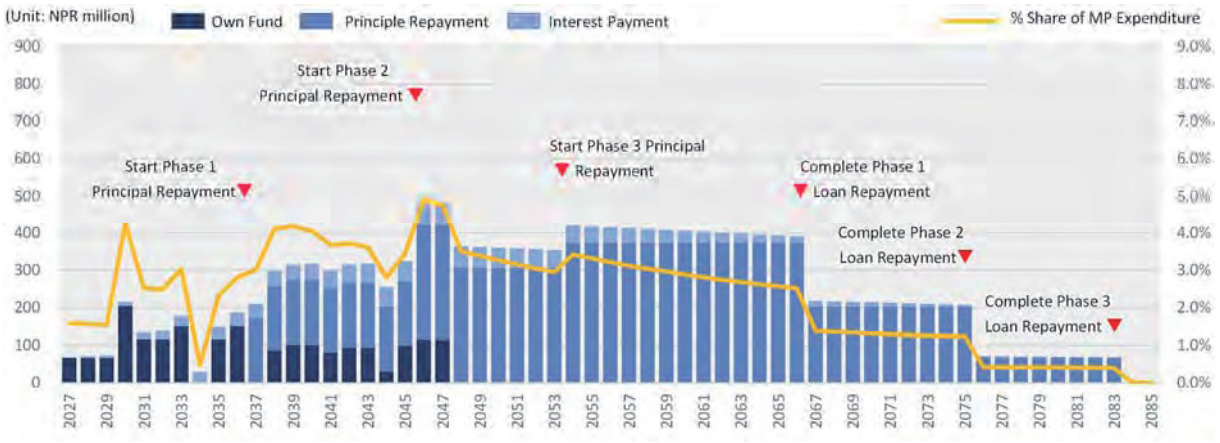
Figure B5-12 Fiscal Burden of Master Plan Implementation to be borne by PMC (Base Case)

(4) Cost Share between the Federal Government and PMC (Alternative Scenario)

Base case scenario of cost share between the Federal Government and PMC mentioned-above was set with referring to the ADB's sewerage project in Biratnagar. However, the above analysis indicated that the expenditures for the MP projects based on above-scenario might put a strain on finance of PMC.

As indicated in Figure B5-12, capital expenditure during construction period places high financial burden on of PMC. In order to relief, the PMC's high fiscal burden during construction period, percentage of cost to be borne by PMC during the period, was assumed to be reduced from 33.3% (base case scenario) to 14.5% (alternative scenario). Under this alternative scenario, the Federal Government needs to borne 85.5% of initial capital expenditure and loan repayment (share of loan repayment obligation between them remain unchanged).

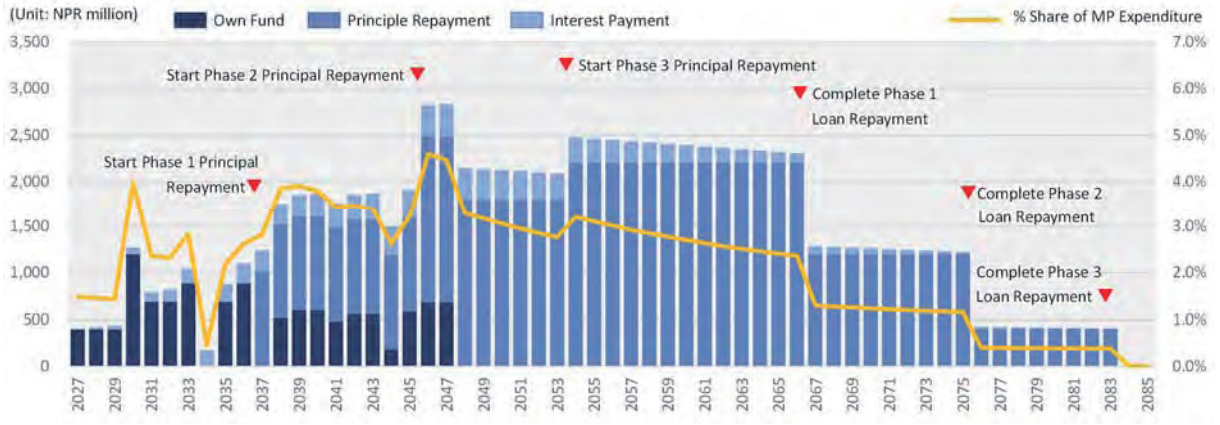
As a result, it was estimated that the percentage share of the PMC's master plan expenditures to its infrastructure development budget will be reduced to reasonable level (from 3.09% to 2.40% on an average, and from 9.48% to 4.90% at maximum).



Source: JET

Figure B5-13 Fiscal Burden of Master Plan Implementation to be borne by PMC (Alternative Case)

On the other hand, fiscal burden of the Federal Government will be increased, while it could be deemed still affordable (it will occupy 2.25% of WASH budget for capital cost of large network system on an average, and 4.60% at maximum).



Source: JET

Figure B5-14 Fiscal Burden of Master Plan Implementation to be borne by the Federal Government (Alternative Case)

B6 Management and O&M Plan

B6.1 Management and O&M Framework

B6.1.1 Overview

(1) O&M of Sewerage System

The purposes of sewerage systems are to secure public health, improve the living environment, conserve water quality in public water areas, and prevent flooding. Management of sewerage system means that the administrator (administrative body) organizes and utilizes various resources (human resources, funds, tools, and information) so that the sewerage facilities under management can perform their functions and achieve their objectives.

"Management" in this chapter includes organizational structure and operational structure including the administrative body, and the outsourcing to private contractors. "O&M" is various tasks and actions necessary to maintain sewerage facilities in good condition so that they can perform their functions effectively. Table B6-1 shows the major work contents relevant to O&M of sewerage systems.

Table B6-1 Major Work Contents Relevant to O&M of Sewerage Systems

Categories	Major Works
1. General Affairs	・ Sewerage ordinance, etc. ・ Other relevant work
2. Budgeting, Accounting	・ Budgeting for O&M ・ Procurement of materials ・ Contract of construction and outsourcing
3. Property management	・ Property management ・ Permission for occupancy and use
4. Fee collection	・ Customer information ・ Determination of tariff and collection of fees ・ Investigation of unpaid fee (Penalty for delinquents)
5. Drainage facilities	・ Direction on installing facilities ・ Inspection of facilities
6. Monitoring and direction of industrial and commercial wastewater	・ Approval of connection to sewerage system (commencement of use) ・ Direction for installation, maintenance and improvement of pre-treatment facility ・ Patrol of pipelines ・ Inspection of facilities
7. Maintenance of pipeline	・ Preparation of maintenance plan ・ Preparation and implementation of patrol and inspection plans ・ Preparation and implementation of cleaning and dredging plans ・ Preparation and implementation of repair and rehabilitation plans
8. O&M of pumping station and WWTP (1) Operation and general management	・ Preparation of operation plan (wastewater treatment, sludge treatment) ・ Preparation and implementation of water quality management ・ Preparation and implementation of energy management ・ Preparation and implementation of waste management ・ Preparation and implementation of building and site space management ・ Recording and reporting of O&M (daily, monthly, and annual reports) ・ Responding to abnormal and emergency situations (plans, system for directions, and SOPs)
(2) Maintenance of facilities	・ Preparation and implementation of plans and manuals for mechanical and electric facilities maintenance ・ Preparation and implementation of plans and manuals for buildings ・ Preparation and implementation of plans and manuals for repair, rehabilitation, and renewal
9. Facility information management	・ Preparations of facility ledger (including update and correction) ・ Recording and organizing facility maintenance information ・ Management of drawings and documents
10. Water quality management	・ Preparation of water quality management plan ・ Preparation and implementation of the plan for water quality and sludge tests ・ Testing the wastewater from factories and workplaces ・ Analyzing data and reporting ・ Maintenance of water quality testing equipment ・ Response to emergencies
11. Environmental management	・ Preparation and implementation of the monitoring plan of surrounding environment (air, noise, odor) ・ Preparation and implementation of the monitoring plan of the area where treated water is being discharged ・ Preparation and implementation of waste management, such as sludge management ・ Preparation and implementation of GHGs reduction plan
12. Occupational safety and health (OSH)	・ Establishment of OSH committee ・ Inspection of the condition of OSH ・ Establishment and improvement of safety and health management system ・ Preparation of BCP (Business Continuity Plan), and response to accidents
13. Human resource management	・ Education and training on O&M

Categories	Major Works
	・ Education and training on OSH, and response to disaster and accidents
14. Public relations, complaint processing	・ Public relations ・ Response to complaints and requests
15. others	・ Submission of reports, notifications, applications, etc. to authorities ・ Support for visitors

Source: JET (Based on "Guidelines of sewerage system O&M" (Japan Sewage Works Association)

B6.1.2 Laws and Regulations Related to Sewerage System O&M

Table B6-2 shows salient laws and regulations in Nepal concerning sewerage system O&M.

Table B6-2 Salient Laws and Regulations Concerning the Sewerage System O&M in Nepal

Category	Law, Regulation, Local Ordinance
Operation and maintenance system (Responsibility, qualifications)	Nepal Water Supply, Sanitation and Hygiene Sector Development Plan
	Local Self-Government Act, 2055 (1999)
	Local Government Operation Act, 2074 (2017)
	Nepal Water Supply Corporation Act (2nd Amendment), 2007)
	Water Supply Management Board Act,2063 (2006)
	Water Supply Tariff Fixation Commission Act, 2063 (2006)
Occupational safety and health	Labour Act, 2074 (2017)
Construction, maintenance, and prevention of fires and disasters	Building Act, 2055 (1998) National Building Code, 2020
Energy supply	Electricity Act, 2049 (1992)
Solid waste disposal	Solid Waste Management Act, 2068 (2011) Solid Waste Management Rules, 2070 (2013)
Dangerous material management	Petroleum Act, 2040 (1983)
Environmental management	Environment Protection Act, 2076 (2019) Water and Sanitation Act* Nepal Gazette based on Environment Protection Act (2001, 2003) National Climate Change Policy, (2019)
Roads and rivers	Water Resource Act, 1992 Public Roads Act, 2031 (1974)
Others	Public-Private Partnership and Investment Act, (2019) Public Procurement Act, 2063 (2007) Radio Act, 2014 (1957) Civil Law, 2074 (2017)

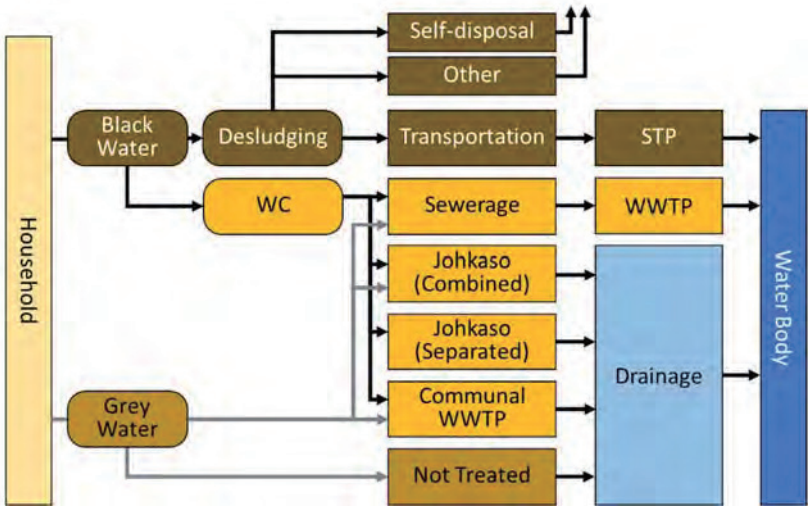
*Note: Water Supply and Sanitation Act is now under deliberation
Source: JET

B6.1.3 Examples of Operation and Maintenance

(1) Examples in Japan

1) Domestic Wastewater Treatment System

Treatment of domestic wastewater containing human excreta in Japan is treated by city-scale sewerage system, communal sewerage system, Jokaso, and fecal sludge treatment, as shown in Figure B6-1. Also, Figure B6-2 shows the legal systems and relevant ministries and agencies related to domestic wastewater treatment.



Source: JET

Figure B6-1 Domestic Wastewater Treatment System in Japan

Under the legal system in Japan, "Sewerage" refers to facilities defined in the Sewerage Act, which mainly remove or treat sewage in urban areas, and are fundamentally installed and managed by cities, towns, or villages, which are the "basic municipalities" in Japan. However, there is also a form of implementation by a "partial affairs association" established jointly by multiple municipalities, or a form of "regional sewerage system" to develop sewerage systems over areas of two or more municipalities. In the "regional sewerage system" area, in principle, municipalities construct and manage the sewerage facilities within their area, and main sewers, pumping stations and final treatment plants are constructed and managed by prefectures.

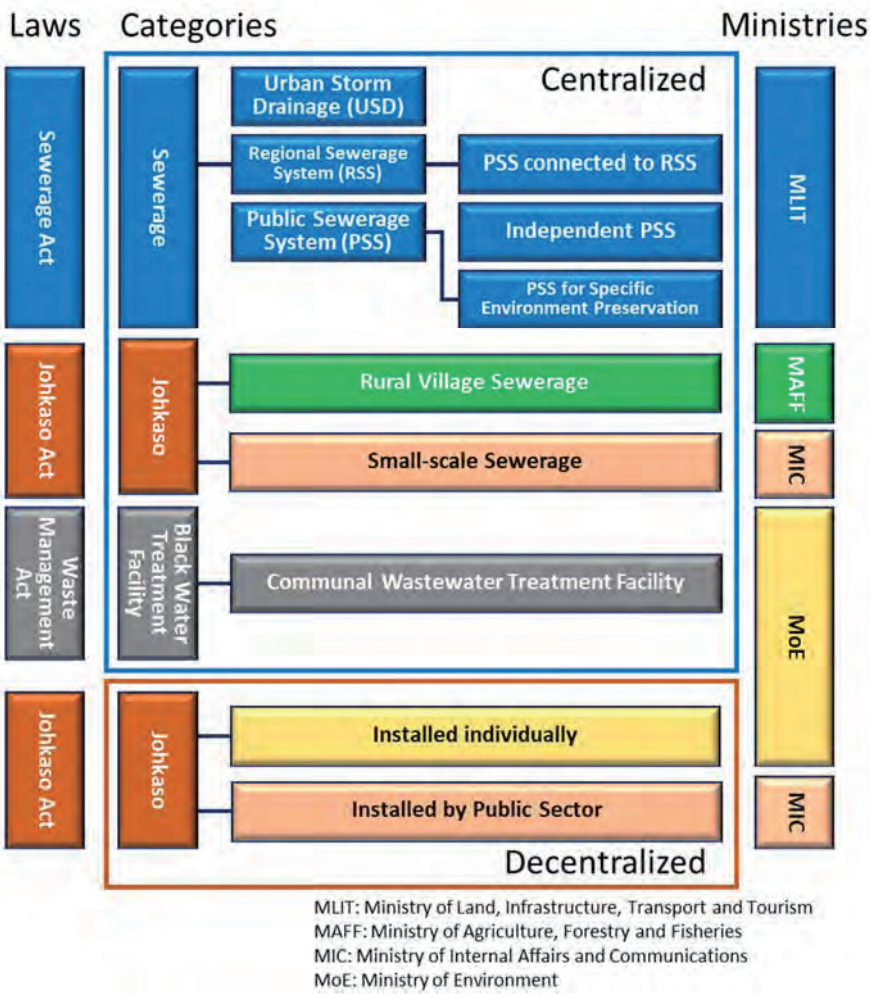
"Rural village sewerage" is a communal sewerage system implemented by MAFF in agricultural, forestry, and fishery communities to protect their living environments, and are installed and managed by the municipalities. "Small-scale sewerage" is another type of communal system implemented as a municipality owned project.

In addition, wastewater treatment facilities installed by developers are legally treated as fecal sludge treatment facilities and are subject to the "Waste Management Law".

Jokaso is a decentralized wastewater treatment facility used in areas where centralized system, such as sewerage system and communal system, is not applicable", and is basically installed and managed by the owner of each building. Generally, municipalities have subsidies to support the installation. Maintenance of Jokaso is carried out by a qualified private maintenance company under contract with the owner of the Jokaso. Some municipalities adopt "public Jokaso" system as an alternative to the sewerage system, in which municipalities install and maintain Jokaso.

Jokaso is a combined treatment system which treats black and grey water in one tank. Installation of separate Jokaso which treats only black water is prohibited. However, existing separate Jokaso are categorized as "deemed Jokaso" and are subject to the Jokaso act.

Newly built toilets must be connected to a sewage system, a community drainage facility, or a Jokaso. Fecal sludge from existing separate treatment septic tanks and temporary toilet used at construction sites is collected periodically by municipalities. Additional or temporary collection is also available, but in many cases, collection fees are higher than regular collection. In general, private companies designated by municipalities collect sludge within each designated area.



Source: JET

Figure B6-2 Legal System and Ministries Related to Domestic Wastewater Treatment

2) Management of Sewerage Systems

As a rule, municipalities are responsible for installing and managing sewerage facilities. However, in many cases, municipalities outsource the O&M to private contractors. In the past, it was common to use yearly contracts based on a "specification order," in which the details of the work were stipulated in the specifications. However, cases of "inclusive service contract" is increasing, in which contracts are signed on a multi-year contract basis and contractors have some direction within the contract.

According to a 2018 survey by MLIT, there are about 2,200 WWTPs in Japan, and the "inclusive service contract" is adopted in 430 cases. On the other hand, the number of "inclusive service contract" is only 29 cases for O&M of pipelines because the risk for contractors is considered to be higher than for treatment plants.

For the projects that require advanced technology, such as the installation and maintenance of sewage sludge incinerators and carbonization furnaces, DBO (Design, Build and Operation) and PFI (BOT, etc.) projects are being adopted. As of 2018, the number of DBO and PFI contracts was 36 cases[38] When evaluating the number of contracts, it should be noted that a single contract may include multiple facilities and multiple contracts may be in place for a single treatment plant.

38 Current Status and Prospects of Inclusive Service Contract of Pipeline Management to Private Sector (Mar. 2018, Japan Sewer Collection System Management Association)

(2) Example in Nepal

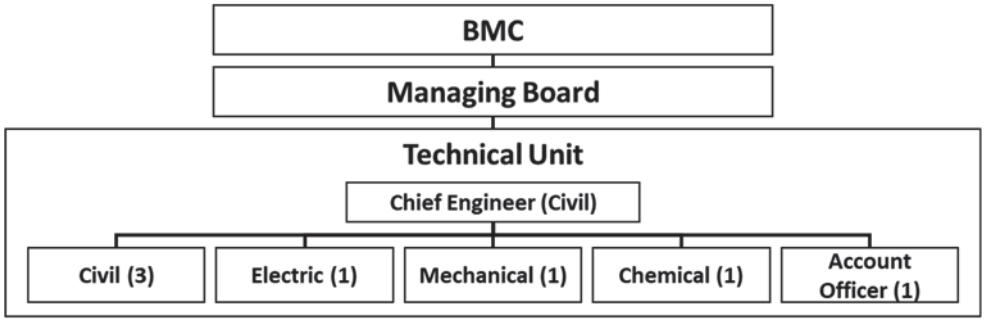
Appendix-9 shows the results of interviews with BMC and KUKL PID regarding the O&M of facilities in Biratnagar City and the Kathmandu Valley.

1) Biratnagar Metropolitan City, BMC

In Biratnagar, a WWTP and sewers were developed as part of the STIUEIP (Secondary Towns Integrated Urban Environmental Improvement Project, 2013-2018) implemented with assistance from ADB and the RUDP (Regional Urban Development Project, 2017-2023), planned to be implemented as an extension of STUEIP. The WWTP started operation in 2017, and was initially managed by the construction contractor, but was handed over to BMC in 2020, and BMC is conducting O&M directly.

In Biratnagar City, separate sewer system is adopted. BMC installs laterals (house connection pipes) between main sewer and house connection chamber. The user connects their drainage system to this chamber. Residents in service area are required by an ordinance to connect their drainage systems to the sewerage system. However, the increase in number of connections is small. As of February 2022, the inflow is only about 10% of the design treatment volume.

There are a total of 8 staff, 7 technical staff and 1 account officer. All the staff are BMC employees, and there is no outsourcing to the private sector. The chief engineer of the treatment plant has been with the company since the start of the project in 2013. Figure B6-3 shows the structure of the operation and management staff of the treatment plant. The fees are set according to water pipe diameter and floor area as shown in Table B6-3.



Source: JET (Based on the interviews)

Figure B6-3 Organizational Structure of WWTP in Biratnagar

Table B6-3 Tariff System in Biratnagar

Category	Total Floor Area (Sq ft)	Monthly Rate (Rs.)
4 inches size	Up to 1,000	100.00
	1001 to 1500	150.00
	1501 to 2500	250.00
	2501 to 4000	500.00
	More than 4000	700.00
	Sewer connection charge (per connection)	3,000.00
6 inches size	Up to 2500	400.00
	2501 to 4000	700.00
	More than 4000	800.00
	Sewer connection charge (per connection)	5,000.00

Source: https://biratnagarmun.gov.np/en/sewaragetax]

2) Example of the Kathmandu valley

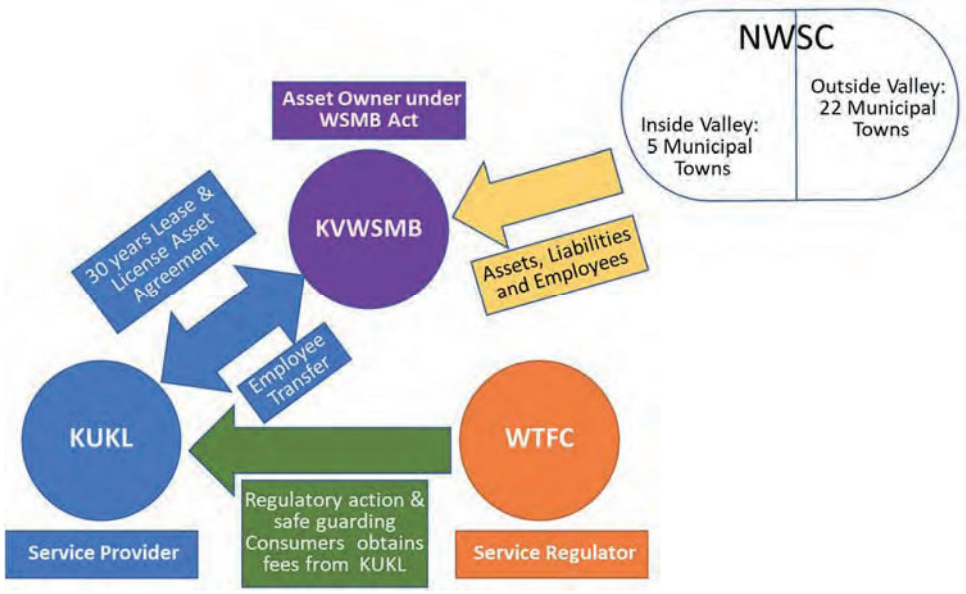
According to past reports, the Kathmandu Valley has WWTPs such as Guheshwori, Dhobighat, Kodku, and Sallahhari, and some small-scale treatment plants (Decentralized Wastewater Treatment System, DEWATS) such as Hanumanghat and Gokarna. As of 2019, though the service coverage was estimated to be greater than 70%, there was only one WWTP in operation: Guheshwori. Fecal sludge from septic tanks outside of the sewer service area is collected by private companies using vacuum vehicles, but

since sludge disposal sites are not developed, the sludge is discharged directly into rivers and other water bodies.[39]

As of 2021, the "Kathmandu Valley Wastewater Management Project" (2013-2022 (planned)) is being implemented with assistance from ADB, in which the rehabilitation and extension of the 5 WWTPs shown above, and the construction of fecal sludge treatment plants in Gokarana and Hanumanghat are being implemented.

In the Kathmandu Valley, assets of water and sewage infrastructure are owned by the Kathmandu Valley Wates Supply Management Board (KVWSMB), an autonomous body established under the WSMB Act (2006), and the services are provided by KUKL (Kathmandu Upatyaka Khanepani Limited).

KUKL is a "public company" established in 2006 based on the "Nepal Government's Company Act 2063 (Nepalese calendar)". According to the articles of association of KUKL, KUKL takes over and manages the water supply and sanitation system in the Kathmandu Valley that had been operated by the NWSC. Based on the license and lease agreements with the facility owner (KVWSMB), KUKL operates water and sewage services for 30 years and will be responsible for the maintenance of all assets received under the lease agreement.[40] (See Figure B6-4)



Source: KUKL Annual Report 2078 (2021)

Figure B6-4 Institutional Reformation of Water Utility Operator of the Kathmandu Valley

In the Kathmandu Valley, projects of HPCIDBC (the High-Powered Committee for Integrated Development of the Bagmati Civilization), a subordinate agency of the Ministry of Urban Development, and KUKL are being implemented simultaneously. HPCIDBC is implementing and monitoring the Bagmati Area Sewerage Construction / Rehabilitation Project (BASP) and is constructing a main sewage system (interceptor system) and a WWTP along the river.

Rehabilitation (16.2 MLD) and expansion work (16.2 MLD) of Guheshwori WWTP (WW/TP/01) in ADB's "Kathmandu Valley Wastewater Management Project" have been completed, and KUKL is in charge of its O&M.

The construction project of the Guheshwori WWTP is carried out on a DBO (10 years) basis, and the actual O&M is being carried out by the DBO contractor VA Tech Wabag Ltd. based in Chennai, India. Dhobighat (37 MLD), Kodku (17.5 MLD), and Sallahhari (14.2 MLD) of WW/TP/02 are being implemented on a DBO (5 years) basis by Shanghai SafBon Water Service Inc., and Dhobighat (37

39 Federal Democratic Republic of Nepal, data collection survey on water supply and waste water sector in Nepal : final report (2019、JICA)

40 https://kathmanduwater.org/index.php/about-us/

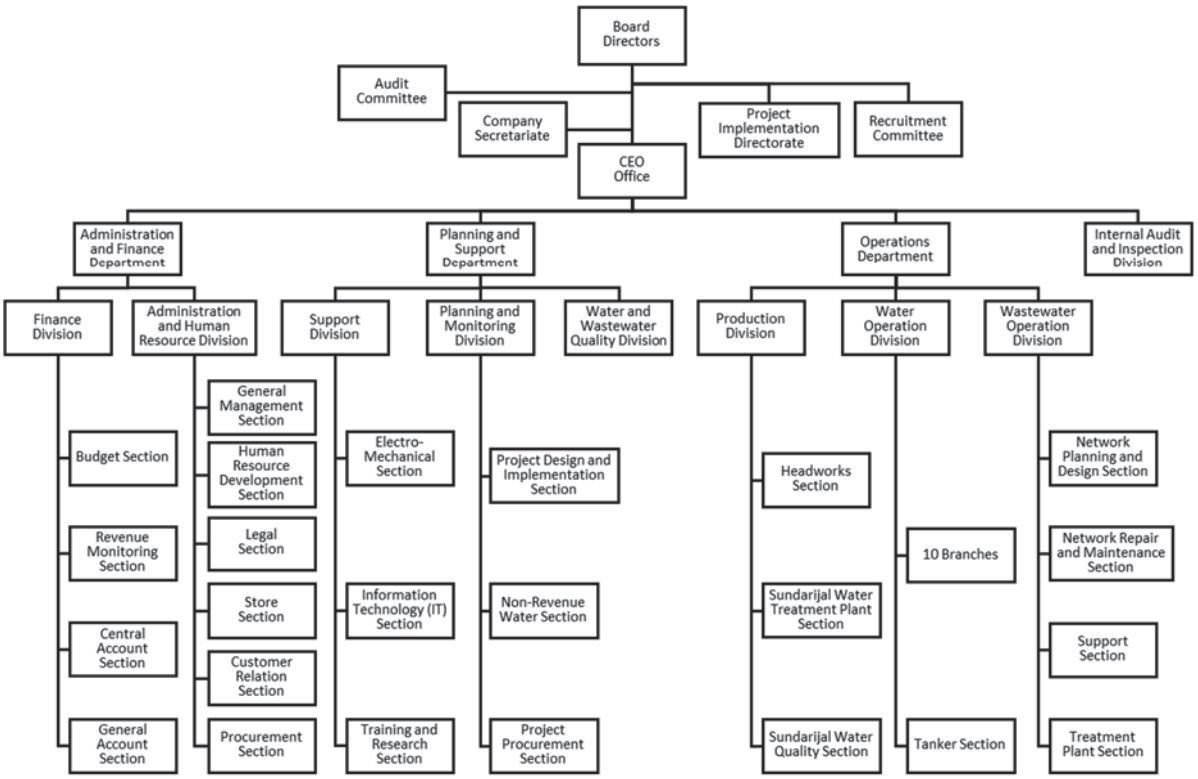
MLD) of WW/TP/03 is also on a DBO (5 years) basis by a Chinese company CGCOC-ATAL J/V. Two small-scale treatment plants ,Gokarna (0.3 MLD) and Hanumanghat (0.1 MLD), are by Nepalese J/V company. TEAMS-BPCL J/V is implementing the project on a DBO (5 years) basis.

Table B6-4 shows the tariff system for water supply and sewerage. Figure B6-1 shows the organizational chart of KUKL. Sewerage fees in the Kathmandu Valley are set at 50% of water charges. The Water Supply Tariff Fixation Commission (WSTFC), which was established based on the Water Tariff Commission Act, functions as an independent regulatory body for water and sewerage service charges. KUKL regularly submits proposals for tariff determination to the Commission. The committee revises and approves it as necessary. The Commission also functions as an arbitrator for customer complaints.

Table B6-4 Tariff System for Water Supply and Sewerage in the Kathmandu Valley

S.N.	Connection Size (inch)	Minimum Consumption (Liters)	Metered		Unmetered
			Minimum Charge (NRs.)	Additional Charge per 1000 Liters (NRs.)	Monthly Fixed Charge (NRs.)
1	1/2”	10,000	100	32	785
2	3/4”	27,000	1,910	71	4,595
3	1”	56,000	3,960	71	9,540
4	1 1/2”	155,000	10,950	71	26,280
5	2”	320,000	22,600	71	54,255
6	3”	881,000	62,240	71	149,415
7	4”	1,810,000	127,865	71	306,880
Sewerage service charge			50% of water bill		

Source: KUKL Annual Report 2078 (2021)



Source: KUKL Annual Report 2078 (2021)

Figure B6-5 KUKL Organizational Structure

3) Lessons from examples in Nepal

Lessons learned from examples in Nepal are shown in Table B6-5.

Table B6-5 Lessons Learned from Examples in Nepal

Category	Lessons Learned
Public authority	・ Biratnagar Municipality (BMC) has enacted the Sewerage Use Ordinance, mandating the connection to sewerage and maintaining the right to enter and inspect business premises. In the case local government manages the sewerage, there is an advantage that inspections can be carried out by exercising public authority, such as when illicit sewage flows into sewerage.
Organization, human resource	・ In Biratnagar City, certain experts have been engaged in the project for a long time. When local government directly operates sewerage systems, it is considered to be difficult to have staff with special knowledge and skills. Especially when the organization is small, it seems difficult to develop appropriate human resources management.
Management, internal communication	・ In the Kathmandu Valley Sewerage Project, operation and management are carried out in a multi-layered and vertically divided manner by KVWSMB, KUKL, HPCIDBC, private contractors, etc., and it is difficult to transfer information and communicate between organizations and departments. ・ In addition, since there is a possibility that roles and responsibilities between organizations and departments become unclear, it is important to prepare accurate and rational rules and communication tools, including the sharing of objectives.
Outsourcing	・ In Biratnagar , they sometimes face difficulty in procuring and storing parts because it is directly managed by the city. By incorporating periodic maintenance inspections, periodic parts replacement, etc. into the contract with major contractors, low-cost and stable procurement can be expected through the procurement capabilities of these companies. ・ In the case of outsourcing to major private contractors, it is expected to utilize their organized employment system at multiple sites, branch offices, headquarters, etc. Ordering party can simplify the organization at O&M site and focus the resource to supervise the contractor. In addition, the need to have skilled labor workers such as electricians, mechanics, and chemists can be reduced.

Source: JET

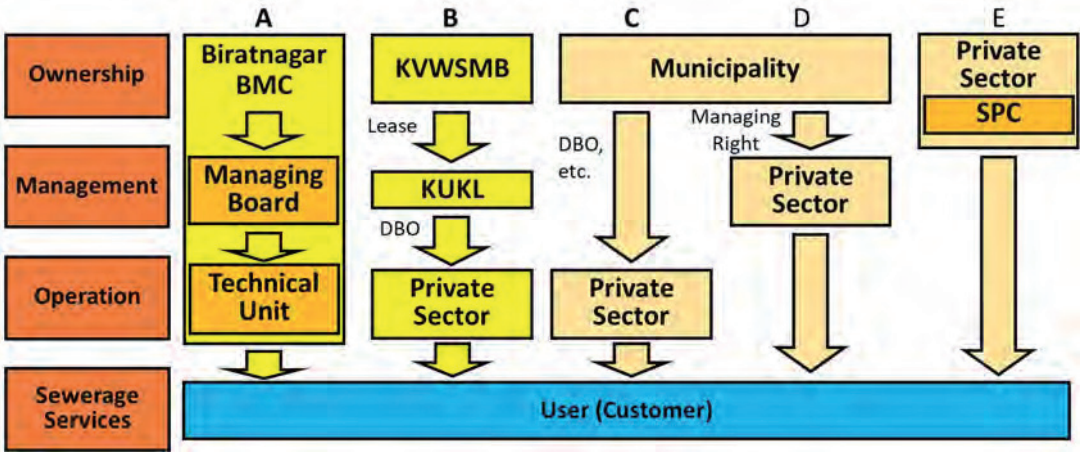
B6.1.4 Management and O&M of Sewerage Systems in Pokhara City

(1) Management Method

Figure B6-6 shows the management methods that are considered to be applicable to Pokhara City, including the examples in Nepal. Table B6-6 explains each method briefly.

Wastewater treatment processes to be applied to Pokhara City are expected to have many more facilities than that of Biratnagar City and require higher levels of operation technology. Method “A” shown is to be managed directly by PMC. It is practically impossible for PMC to have the systems required. For this reason, in the discussion below, Method A (direct management) will be excluded, and discussion will proceed on the premise of “private sector participation”.

In addition, since the project in Pokhara City will be implemented by public funding, Method “E” (PFI) and complete privatization, which are on the basis of private sector funds, are also excluded from consideration.



Source: JET

Figure B6-6 Management Methods Considered to be Applicable to Pokhara City

Table B6-6 Brief Explanation of Each Method

Type	Explanation
A	・ This is the case of Biratnagar City. Facilities are owned by BMC. ・ During the transitional period of three years after the completion of construction, a private constructor performs commissioning, after which it is taken over by BMC. ・ This method requires the operator to hire engineers and skilled laborers as its own staff.
B	・ This is the case of Kathmandu Valley. ・ KVWSMB owns the facility. ・ KUKL is licensed by KVWSMB, and the facilities are leased to KUKL for 30 years. ・ Design, construction, and O&M of the WWTPs are outsourced to private contractors ・ Design, construction, and O&M of the WWTPs are outsourced together to private contractors based on the DBO contracts.
C	・ This method is commonly used in Japan. ・ Public sector owns the facilities and outsources the O&M to private sector. ・ There are many options for outsourcing to private sector ・ There are many options for outsourcing to private sector in the manner and scope of contract, and the responsibilities, risk sharing, and functions that the public sector and the private sector should have will change depending on the contract.
D	・ This system is called “concession”, which recognizes “operating right” as a “property right” and allows it to be transferred. ・ Public side owns the facility and can use the profits from the transfer for debt redemption of the facility construction. Private sector can raise funds using the operating rights as collateral. ・ Operating right includes determining and collecting user fees, but the obligation to exercise public powers, such as stopping the use of sewerage, remains with the public sector. ・ Public sector monitors private contractors.
E	・ This method is the PFI method, and PFI includes BOT, BOOT, BTO, RO and other methods. ・ Construction financing, design, construction, operation and maintenance of facilities are carried out by the private sector. ・ Ownership of the facility differs depending on the method. ・ Public sector monitors private contractors in the same way as the “concession”.

Source: JET

(2) Private Sector Participation

1) Advantages and Disadvantages of Private Sector Participation

Private participation in the water supply and sewage sector generally has advantages and disadvantages as shown in Table B6-7. In many cases in Japan and western countries, private sector participation has been studied to resolve the deadlock (low efficiency, high cost, lack of engineers, etc.) of operations that have been carried out by the public sector. On the other hand, in the case of Nepal, private sector participation is strongly expected to cover the lack of the experience and technical capabilities of the public sector.

Table B6-7 Advantages and Disadvantages of Private Sector Participation

Advantages	・ Participation of the private sector with technical capabilities and management know-how will lead to more appropriate investment and operational management, resulting in lower costs and improved services. ・ In addition, water supply and sewerage operations will become more independent, and it will be possible to reduce subsidies and public expenditures. ・ The profits obtained can be distributed among the private sector, customers, local governments, etc.
Disadvantages	・ Private capital may be more expensive than public funds. ・ Private sectors need to make a profit, so the overall cost may be high. ・ There is a risk of default and service deterioration of private operators. ・ In water supply and sewage business, there is a shortage of private operators with the required operational capabilities. ・ There are various options for private participation, and contracts cannot be standardized. For this reason, relevant tasks, such as contract procedure, monitoring of the performance, etc. are complicated and require high level of knowledge and experience. In addition, it is difficult to optimize these tasks, which may lead to high costs. ・ Since the contract period is generally long, various external and internal factors during the contract period may make it difficult to continue operations. However, it is not possible to stop sewerage services or sell the properties. ・ Water supply and sewerage systems are integrated systems composed of various facilities, which require constant and careful maintenance, inspection, and repair. ・ Due to different natural, geographical, and social conditions, the design, construction and operation characteristics of the facility varies from project to project, and that makes the labor and cost required for competitive bidding (technical proposal) high.

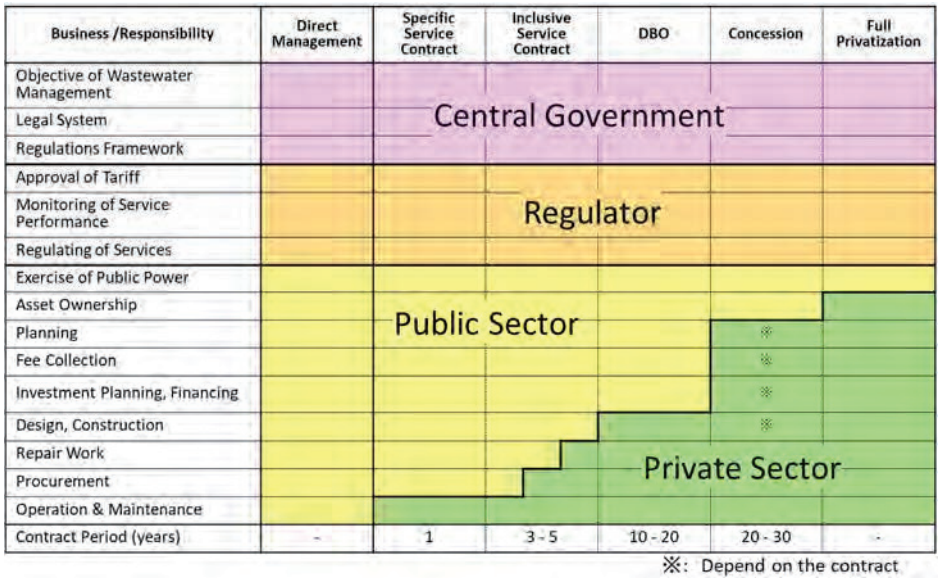
Source: JET (Based on "Privatization and Public Private Partnership in Water supply operations" (H. Saito, Japan Suido Shimbun), 2003)

2) Typical Methods of Private Sector Participation, Roles of Public and Private Sectors, and Risk Sharing

Figure B6-7 shows typical methods of private sector participation in water supply and sewerage operations and the division of roles (functions) between the public and private sectors. In addition to the methods shown here, there are methods that are positioned between direct management by the public sector and complete privatization. And it is possible to apply different methods for each contract. For example, in Japan, some sludge recycling facilities, which require special technical capabilities, are ordered using the PFI method or the DBO method separately from other treatment facilities that are operated under common service contracts.

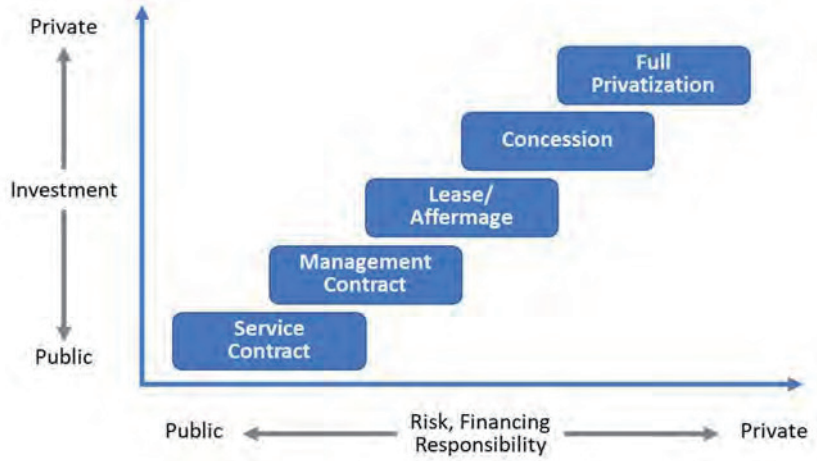
Private sector participation includes the risks inherent in the sewerage operations and risks associated with private sector participation itself. For this reason, it is necessary to clarify in advance the types of risks that exist, the magnitude of the risks, the risk sharing among the parties, the measures to avoid (minimize) the damage, and the processes and allocations for sharing the burden.

Figure B6-8 illustrates the sharing of investment and responsibility between public and private sectors for each typical methods of private sector participation. Table B6-8 shows the types of risks, risk minimization measures, and risk sharing in the sewerage operations, referring to the analysis example of water supply.



Source: JET (Based on "Privatization and Public Private Partnership in Water supply operations" (H. Saito, Japan Suido Shimbun), 2003)

Figure B6-7 Typical Methods of Private Sector Participation in Water Supply and Sewerage Operations and the Division of Roles (Functions) between the Public and Private Sectors



Source: JET (Based on UN Economic and Social Commission for Asia and the Pacific)

Figure B6-8 Sharing of Investment and Responsibility between Public and Private Sector

Table B6-8 Types of Risk, Measures to Minimize the Risk, and Risk Sharing in the Sewerage Operations

Types of Risk		Measures to Minimize the Risk	Risk Sharing
Design and construction stage			
Over budget		Choose a contractor with financial support and experience	Private
Delay in Construction		Ditto	Private / Public
Design	Originality and ingenuity	Ditto	Private
	Technical management	Technical solution	Private
Completion of Construction	Quality of construction	Choose a contractor with financial support and experience	Private
	Coordination, Subcontract	Choose a contractor with coordinating skill	Private
Contingency	Geological features		Public
	Weather		Private / Public

Types of Risk		Measures to Minimize the Risk	Risk Sharing
O&M stage			
Amount of influent	Gap between plan and result	Sufficient data, confirmation of its validity	Private / Public
	Little increase in house connection	Mandatory, PR and support	Public
Price of fee	Exceeds acceptable level		
Decline in revenue	Subsidy not paid	Confirm Governmental pledges	Public
	Non-payment of fees	Reasonable pricing, dunning	Private / Public
Exceeding operating costs	Increased operation cost	Choose an experienced operator	Public
	Increased requirement from public side	Stipulate contract amendments	Public
Economic and financial risk			
Financial variables	Interest rate	Means of guarantee	Bank / Private
	Currency exchange rate	Ditto	Bank / Private / Public
Financial engagement	Refinance		Private / Bank
	C/P	Insurance	Private / Bank
Indirect risk			
Inevitability	Natural disaster		Public / Insurance company
	Political embargo, War	Risk guarantees by bilateral agency, etc.	Public / Insurance company
	Visa, Foreign expert	Administrative assistance	Public
Economic risk	Delay of operation	Renegotiation of contract	Private / Public
	Economic and financial crisis, Currency devaluation	Ditto	Private / Public / Insurance company / Bank
	Lack of energy		Private / Public / Insurance company / Bank
Legal and institutional risk	Indirect institutional change	Renegotiation of contract	Public
	Legal recourse by third parties	Confirm the consistency with current laws	Private / Public
	Dispute on Jurisdiction	Strengthen legal safeguards	Private / Public

Source: JET (Based on "Privatization and Public Private Partnership in Water supply operations" (H. Saito, Japan Suido Shimbun), 2003)

3) Typical Methods of Private Sector Participation, and the Advantages and Disadvantages

Considering the studies above, Table B6-9 summarizes the advantages and disadvantages of typical methods of private sector participation in the context of the conditions in Pokhara City. In all of the methods listed here, the public side raises construction funds, and the private side operates and manages the facilities. However, "DBO" includes design and construction, which can be divided into "DB" and "O" or "DB + C (commissioning)". "Concession" includes design and construction, depending on the contract details.

Table B6-9 Advantages and Disadvantages of Typical Methods of Private Sector Participation

Typical Methods	Advantages and Disadvantages
<u>Individual contract (specification order)</u> ・ Tasks, such as design, construction, operation, maintenance, and repair work, etc. are outsourced to specialized private contractors individually or in unit of several businesses. ・ In operation management, the ordering party generally prepares specifications that stipulate the operation method (e.g., staff assignment, frequency and implementation method of inspections, water quality management method, etc.), and the contractor carries out the operation based on the specifications. ・ Ordering party will allocate staff to the site to	**Advantage** ・ Employment of skilled on-site staff on the public side becomes unnecessary. ・ O&M work based on specifications will be carried out steadily, and it is relatively easy to adopt even for those without experience or know-how in outsourcing. **Disadvantage** ・ No incentive to utilize know-how and ingenuity of private sector, and it is difficult to reduce costs. ・ Although private companies have little discretion, there are many on-site supervisors of the public sector. ・ It is necessary to prepare detailed specifications for each order

Typical Methods	Advantages and Disadvantages
supervise the contractor.	unit, which is difficult for those without experience like PMC.
Inclusive contract (Performance order) ・ In Japan, a multi-year PBC (Performance Based Contract) system is called "inclusive service contract", which includes operation, procurement of fuel and equipment, maintenance, and repairs. ・ In this method, the required level of performance (e.g., effluent water quality, etc.) of the PBC is to be specified, and the contractor decides on its own discretion the number of personnel to be assigned and the work content to meet the level. ・ Depending on the scope of work included in the contract, the effect of know-how utilization and cost reduction will change.	**Advantage** ・ Employment of skilled on-site staff on the public side becomes unnecessary. ・ Operation costs can be reduced by utilizing the know-how and ingenuity of the private sector. **Disadvantage** ・ Business monitoring and evaluation should be carried out. If the PBC concept is not firmly established, there is a risk of contractual trouble. ・ At contract renewals, the public side is likely to try to lower contract prices based on results, which does not incentivize contractors to reduce operating costs. ・ Since the contract term is 3 to 5 years, contractors tend to cut repair costs and make a profit, even if they are included in the contract.
DBO ・ Public sector raises funds and outsources the design, construction, and O&M of the facility to the contractor as a package for several years (generally 10 years or more). ・ Public sector determines the required levels of PBC (e.g., effluent water quality, etc.), and the contractor decides on its own discretion the number of personnel to be assigned and the work content to meet the level. ・ In Japan, most of the cases of this type contracts are for the facilities such as sludge incinerators, but there are also cases of DBO contracts for treatment plants.	**Advantage** ・ It is possible to manage in an integrated manner considering construction, O&M from the design stage. ・ Cost reduction can be expected by using the know-how and ingenuity of the private sector. ・ In many cases, the public sector can raise funds at low interest rates, and the funding risk is low compared to the PFI method. ・ There is no need to determine the method and specifications in advance, and it is possible to select from the proposals of private sector. **Disadvantage** ・ Bidding process is complicated, and technical capabilities are required to examine specialized technical proposals from private companies. ・ It is necessary to monitor and evaluate the performance of contractor compared with the agreed level of performance. ・ If there are large uncertainties such as the growth of inflow water, the contract amount may be higher considering the risk.
Concession ・ The "operating rights" of facilities owned by the public side are recognized as "property rights" and transferred to the private side. ・ Public side owns the facility and can use the profits from the transfer for debt redemption of the facility construction. ・ Private sector can raise funds using the operating rights as collateral. ・ Operating right includes determining and collecting user fees, but the obligation to exercise public powers, such as stopping the use of sewerage, remains with the public sector.	**Advantage** ・ Cost reduction can be expected through utilizing the know-how and ingenuity of the private sector. ・ Public sector can use the proceeds from the transfer to pay off its construction debt. **Disadvantage** ・ A high technical skill is required for public sector to examine whether the proposals of private companies will provide better services at lower prices than those provided by the public sector itself. ・ If the private sector is allowed to decide the fee, it is necessary to clarify the examination and approval process. ・ It is necessary to develop a system for setting and transferring the operating rights, but this has not yet been done in Nepal.

Source: JET

4) Scope and Method of Outsourcing

The methods studied above are different in the terms of whether or not to include design, construction, maintenance, inspection/repair, and purchase of fuel/materials/equipment in the main contract on

treatment plant O&M. It is also an important point whether or not to include pipelines and pumping stations in the package of contract of treatment plants.

Table B6-10 shows the draft policy of contract for the project in Pokhara City. Figure B6-9 shows the flow to decide the type of contract according to the policy, and Figure B6-10 illustrates the scope of contract.

A survey on current situations in the water supply sector reported that GWI (Global Water Intelligence) data on the water supply operations in Nepal does not include any result, and private sector participation is not actively implemented. The same survey also reported that it is difficult to say that policies, systems, organizations, etc. related to the private sector participation in the water supply operations have been established in the country. There are environmental and social risks (including resettlement). Moreover, these countries have issues in the investment environment itself.[41] It is considered to be difficult to adopt a system in which the private sector invests funds and is deeply involved in the management also in sewerage projects.

In Nepal, public sectors do not have sufficient experience and technical capabilities, so they need to rely on private companies with technical capabilities and management know-how. The DBO method is widely adopted for sewerage projects in the Kathmandu Valley and is a convincing choice for Pokhara City.

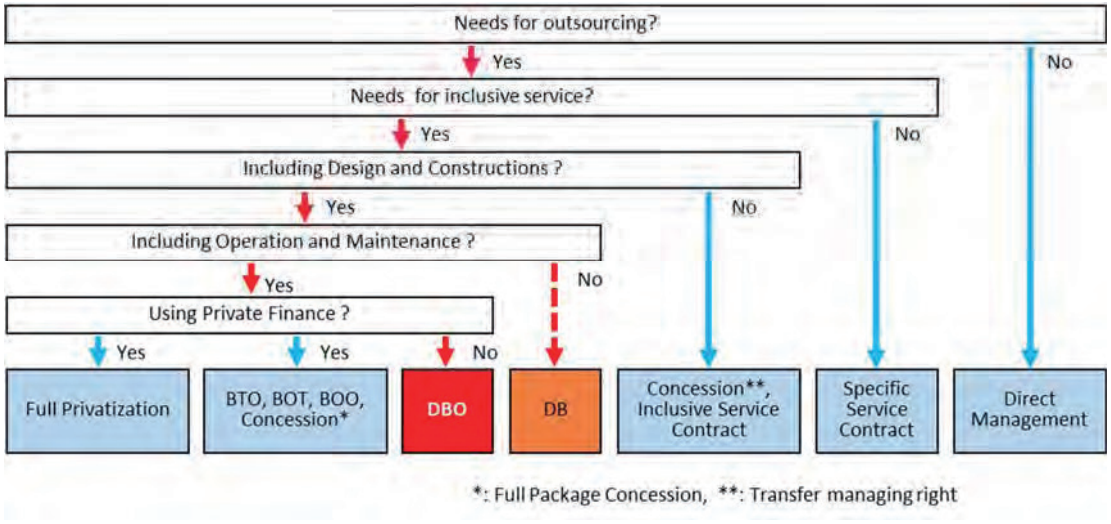
However, since the project is to be divided into multiple treatment areas, other methods can be adopted considering the scale and type of facilities. In addition, to evaluate the performance of DBO contracts, the public sector must have operational experience and knowledge. For this reason, adopting a contract with the initiative of the public sector in one treatment area is considered to be an effective choice.

Table B6-10 Draft Policy of Contract for the Project in Pokhara City

Policy of Contract	Explanation
Adopt private sector participation	・ Wastewater treatment processes in Pokhara City will have many more facilities than that of Biratnagar City and require higher levels of operation technology, so it is practically impossible for a PMC to operate directly.
Adopt an inclusive contract based on performance orders, and include procurement, maintenance inspections, and repairs	・ It is possible to utilize the procurement systems, human resources, materials, and equipment of the private company, and cost reduction can be expected.
Include design and construction of treatment plant facilities	・ It is possible to operate in an integrated manner considering construction and O&M from the design stage. ・ Manpower on the PMC side can be significantly saved. ・ There is no need to determine the treatment process and specifications of facility. It is also possible to decide based on proposals in the tender.
Exclude design and construction of pipelines and pumping stations	・ Construction of pipelines requires consideration of traffic jams and protection of underground buried objects. So, it is inappropriate to include it in an order of a treatment plant since it may place the risk on the contractor. ・ However, it is possible to place an order as a DB contract for each section or route separately from the treatment plant.
Include O&M of treatment plant facilities	・ Integrated operation considering construction, maintenance and management from the design stage is possible. Cost reduction can be expected through the utilization of know-how of private sector.
Exclude private finance	・ Due to the feature of the project, investment of private finance is not planned. ・ Environment for investment of private finance is not sufficiently prepared.

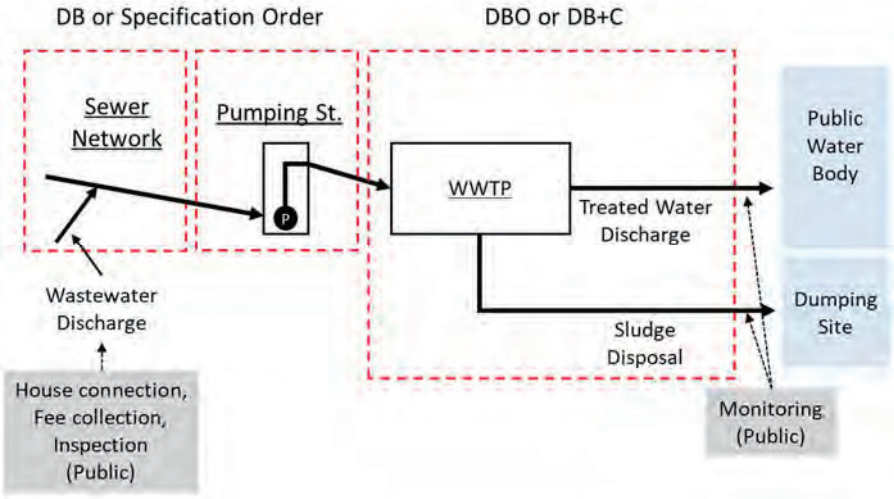
Source: JET

41 A project study on the private sector participation in water supply operations (Jun 2017, JICA)



Source: JET

Figure B6-9 Flow to Decide the Type of Contract



Source: JET

Figure B6-10 Illustration of the Scope of Contract

(3) Operating Body

Currently in Nepal, local governments like PMC, committees established under WSMB law like Kathmandu Valley, and NWSC empowered by NWSC act as entities similar to the "sewerage system administrators" under the Japanese Sewerage Law.

According to the interview, PMC intends to operate the sewerage by themselves. However, there is currently no sewerage system in Pokhara City, and the water supply is operated by the NWSC and several WUSCs. PMC is not involved in its operation and maintenance. NWSC, which operates water supply projects in place of local governments in Nepal, has no experience in sewerage projects, but also would like to participate in the management in the position of KUKL in the Kathmandu Valley.

Table B6-11 shows the evaluation results of PMC and NWSC as the sewerage operator in Pokhara City. NWSC has an advantage in terms of experience in the water supply operations, but otherwise has no major advantages. On the other hand, since PMC does not have organization or experience related to the water supply operations, they should establish a new management system. However, it is considered difficult for both of them to operate the system by themselves. Assuming the technical support for bidding by consultants and the contract by DBO method, the difference between the two is not a problem.

In recent years, NWSC's financial situation has been in the red, and a large proportion of NWSC's revenue are from revenues in Pokhara. So, it is a concern that NWSC will use the revenues from

sewerage operations to improve the financial situation of the NWSC as a whole. It is legally possible for the NWSC to set different tariffs for each city and set a tariff system in line with the political objectives of PMC. However, it is considered to be practically difficult, since NWSC currently sets a uniform water tariff system in areas under their jurisdiction.

Furthermore, the "Water and Sanitation ACT", commonly known as the WASH Bill, includes the principle that water supply and sewage treatment projects are implemented by local governments. That suggests it is appropriate for PMC to be the operating body, and there is no merit to lease to NWSC and entrust the operation.

Table B6-11 Evaluation of PMC and NWSC as the Sewerage Operations Operator

Item	Results
Operating rights, etc.	・ Local Self-Governance Act 2055 (1999), Local Self-Governance Regulation 2056 (1999), and Local Government Operation Act, 2074 (2017) stipulate that water supply and sanitation (especially solid waste), etc. are the roles of local governments. For domestic wastewater treatment, it is not clearly defined which entity has the role. In Biratnagar City, BMC directly manages the sewerage system in the city. ・ The Water and Sanitation Act, commonly known as the WASH Act, will set the principle that water supply and sewerage services should be carried out by local governments. On the other hand, that will stipulate the involvement of the federal government and province governments in the large-scale construction and the projects with the support from international agencies and foreign governments. ・ However, the Nepal Water Supply Corporation Act (NWSC Act 2046 (1989)) will still survive. In this law, the role and authority of the NWSC in carrying out planning, research, facility construction and O&M of water supply and sewerage systems are stipulated.
Experience	・ PMC has no experience in implementing water supply and sewerage operations. ・ NWSC is implementing water supply operations in 23 cities including Pokhara. However, they have no experience in sewerage operations.
Financial conditions	・ In recent years, NWSC's financial situation has continued to be in the red. A large proportion of NWSC's revenue is from the revenue in Pokhara. ・ If NWSC becomes the operating body, the revenue may be used to improve the financial condition in other cities.
Exercise of public authority	・ The NWSC Act 2046 (1989) gives the NWSC the right to set and collect charges for water and sewerage services, suspend water and sewage connections to non-payers, and permit the officials to enter land and buildings where necessary.[42] ・ Regarding solid waste, the Local Self-Government Act stipulates that the PMC can determine and collect fees and impose penalties (fines) on violators, similar to the authority of the NWSC above.[42] PMC needs to have the authority like Biratnagar by enacting an ordinance.
Fee collection	・ NWSC is implementing the water supply operations in Pokhara City and has a fee collection system. However, it does not work as an advantage for the NWSC, as several WUSCs provide water supply services in Pokhara city and well water is widely used. ・ For PMC, it is difficult to collect charges based on metered water volume as data must be provided by NWSC and WUSC. Therefore, PMC should establish a system that uses other parameters such as water pipe diameter or properties, as in the case of Biratnagar, instead of using metered water volume. Such systems are generally used and can be applied to Pokhara.
Human resources management	・ PMC currently does not have any staff for water treatment. In the case PMC operates the system directly, it is necessary to establish a new organizational framework consisting of a large number of professional technical staff, skilled labor staff, and clerical staff who work under the city executives or management committee. ・ As for NWSC, many of the staff are only doing limited work such as pump operation, and a large number of new specialized technical staff, skilled labor staff, and clerical staff will be needed. ・ For this reason, it is difficult for both to operate the systems directly, and both need the outsourcing to a private company and the support of specialized consultants. ・ However, if NWSC widely implement the operation of sewerage operations in Nepal, it may be easier to secure specialized technical staff, maintain stable employment, efficiently allocate human resources, train engineers, and succeed.

Source: JET

42 Water Laws in Nepal (Feb. 2005, WaterAid Nepal)

(4) Work Breakdown Analysis on Management and O&M

Appendix-10 shows the results of the work breakdown analysis on the management and O&M of the sewerage system in Pokhara City. Operations related to sewerage system are broken down to major tasks, and then characteristic, such as the frequency, amount, difficulty and priority, and the possibility for outsourcing were evaluated for each task. In this analysis, in line with the study in "Outsourcing Scope and Outsourcing Method Proposal", DBO method is assumed to be applied for treatment plant, and DB method for pipelines and pumping stations.

(5) Proposal of Management and O&M Framework

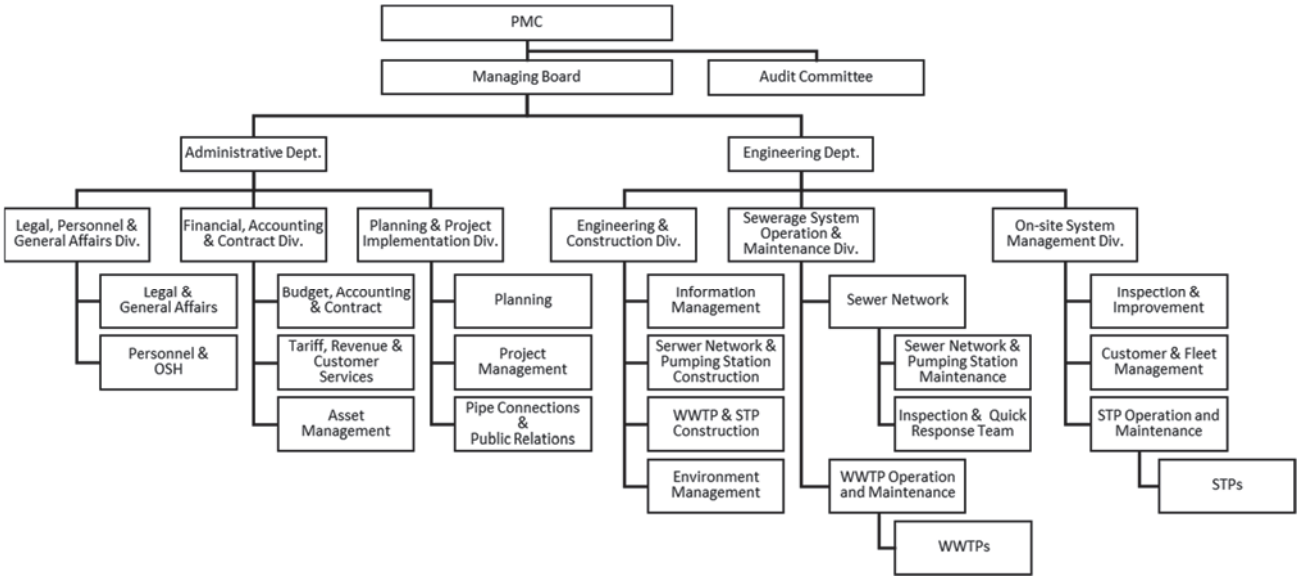
Figure B6-11shows the proposed organizational framework for the management and O&M of the sewerage system, which is based on the results of the work break down analysis. As mentioned above, this proposal is based on the assumption that PMC will be the project operating body and the WWTP will be implemented using the DBO method, and the pipeline and pumping station will be implemented using the DB method. Table B6-12 shows the work contents of each section, and Table B6-13 shows the composition of staff. Job grades are roughly divided into three levels, A to C, according to years of experience, qualifications, etc.

In this proposal, the departments established for sewerage management are located under the Managing Board independent from other PMC departments. However, the functions of finance, accounting and personnel can be incorporated with the departments in PMC. But, in order to realize self-supporting finance through cost recovery through usage fee income and secure highly specialized engineers, it is desirable to ensure the independence of finance, accounting, and personnel affairs.

In this framework, "Planning & Project Implementation Division" is assumed to manage the business related to PIU in PMC.

In Pokhara City, on-site system will remain as a major system in domestic wastewater treatment until the sewage system is developed. For this reason, it is proposed to establish an on-site system management division separate from the divisions related to sewerage. The management of on-site system in this proposal is based on the following assumption. However, regarding the on-site system, it is necessary to coordinate with regulations and inspection frameworks based on the Building Standards Act and sludge removal business currently carried out by private sector. So, details about the management system for on-site system will be considered separately.

- Both regular desludging and on-call desludging will be managed by public sector.
- Desludging service will be provided by private companies. (It is required to enhance their capacity and establish a business registration system.)
- Fees for desludging and sludge treatment will be determined by public sector.
- One sludge treatment plant will be newly constructed. Treatment process consist of thickening/dehydration, drying (or composting), and disposal (or effective use).
- Operation and management of the plant will be carried out by public sector.



Source: JET

Figure B6-11 Proposed Organizational Framework

Table B6-12 Proposed Work Contents of Each Section

Division	Section	Work Contents
Legal, Personnel & General Affairs	Legal & General Affairs	・ Legal affairs, litigation ・ Enactment of sewerage ordinances, etc. ・ Internal compliance ・ Other general affairs
	Personnel & Occupational Safety & Health	・ Personnel, Payroll, Employee benefits ・ Human resource development (Education, training) ・ OSC, BCP, Safety of people outside ・ Education, Response to accidents ・ Preparing apparatuses
Financial, Accounting & Contract	Budget, Accounting & Contract	・ Budgeting ・ Settlement of accounts ・ Contract review ・ Accounting management, Expense reimbursement ・ Other related works
	Tariff, Revenue & Customer Services	・ Business management plan ・ Customer information management ・ Determine of tariff, Fee collection, Receivable fee collection ・ Complaint handling
	Asset Management	・ Asset management plan (properties) ・ Land acquisition, Compensation ・ Management of property ・ Permission for occupancy / use
Planning & Project Implementation (PIU Management)	Planning	・ Medium term, long term, and annual business plans ・ Asset management plan ・ Basin-wide wastewater management plan ・ Other planning works
	Project Management	・ Management on Steering Committee and PIU ・ Loans, subsidies, and debts management ・ Tenders (Technical affairs related to DBO, DB) ・ Environment impact assessment ・ Socio-environmental consideration ・ Other project management works
	Pipe Connections & Public Relation	・ Permission for connection of industrial and commercial sources ・ Direction on installation of pre-treatment ・ Inspection, direction, and application of penalties ・ Promotion of house connection, Prevention of illegal connection ・ Public relations, etc.

Division	Section	Work Contents
Engineering & Construction	Sewer Network & Pumping Station Construction	・ Construction plan ・ Sewer line design, construction (SSC) ・ Pumping station design, construction (DB supervision)
	WWTP & STP Construction (DBO supervision)	・ Construction plan (Stepwise construction) ・ Plant design, construction ・ Repair, rehabilitation plan & implementation Systematic inspection plan & implementation
	Information Management	・ Sewer network information system ・ Facility information system (WWTP, PS) ・ Recording of maintenance information ・ Management of drawings and documents
	Environment Management (DBO supervision)	・ Management plan (during construction and operation) ・ Surrounding environment monitoring (during construction and operation) ・ GHGs management (during construction and operation) ・ Chemicals and hazardous materials management (during construction and operation) ・ Monitoring of effluent impact (before and during operation)
Sewerage System Operation & Maintenance	Sewer Network	(Sewer pipe) ・ Systematic inspection, dredging and cleaning plan ・ Inspection (including emergency response) ・ Dredging and cleaning (including emergency response) ・ Repair, rehabilitation plan ・ Repair, rehabilitation (SSC) ・ Inspection, Emergency response
		(Pumping station) ・ Systematic inspection plan ・ Inspection (SSC supervision) ・ Repair, rehabilitation plans ・ Repair, rehabilitation (SSC supervision) ・ Operation (SSC supervision)
	WWTP Operation and Maintenance (DBO supervision)	・ O&M plan ・ Energy management plan ・ Water quality management ・ Waste management ・ Emergency response plan ・ Procurement (materials, chemicals, fuel and energy) ・ Plant operation ・ Record of operation, Submitting reports
		(Monitoring of DBO contractor at WWTP) ・ Water quality management ・ Plant operation ・ Examination of water and sludge ・ Maintenance of onsite monitoring devices ・ Emergency response ・ Record of operation, Submitting reports
On-site System Management	Inspection & Improvement	・ On-site system improvement and management plan ・ Determine of tariff, Fee collection ・ Inspection, Direction for proper maintenance ・ Registration and direction of private service provider ・ Public relations, etc.
	Customer & Fleet Management	・ Management of customer information system ・ Management of manifest system and fee collection system ・ Operation of systems, Response to desludging requests (on-call)
	STP Operation and Maintenance	・ O&M plan, Waste management plan ・ Plant operation ・ Examination of water and sludge quality ・ Record of operation, Submitting reports ・ Reception of sludge trucks

Source: JET Note: SSC: Specific Service Contract

Table B6-13 Proposed Staff Composition

Division	Administrative Staff			Technical Staff			Skilled Worker	
	Job type	Rank	Number	Job type	Rank	Number	Job type	Number
Legal, Personnel & General Affairs	Legal	A	1					
	Personnel	B	1					
	OSH	B	1					
	Others	C	3					
Financial, Accounting & Contract	Financial, Accounting	A	1					
		B	1					
	Business management	A	1					
		B	1					
	Land Acquisition	B	2					
	Others	C	3					
Planning & Project Implementation (PIU Management)	Management	A	2	Civil	A	1		
		B	2		C	1		
	Assistant, Others	C	3	Environment	B	1		
				Wastewater treatment	B	2		
Engineering & Construction				Civil	A	2	Sewer network information system operator	1
					B	2	Facility information system operator	1
				Mechanical / Electrical	B	4		
					C	1		
				Structure	B	1		
				Wastewater treatment	B	1		
				Environment	B	1		
Sewerage System Operation & Maintenance				Civil	B	2	Patrol / Emergency response	5
				Mechanical / Electrical	B	3		
				Wastewater treatment	B	1		
Operation & Maintenance at WWTPs				Mechanical / Electrical	B	1		
				Wastewater treatment	B	1		
					C	1		
On-site System Management	Business management	B	2	Wastewater treatment	B	1	Customer information system operator	2
	Others	C	1				Facility operator	3
Total	Sub-total		26	Sub-total		23	Sub-total	12

Source: JET

"Rank" in Table B6-13 is classified according to the rough guidelines shown in Table B6-14. The members of each section include the section chief, and it is assumed that an A-rank person will be in charge. If there is no A-ranked person, a B-ranked person will be in charge. Departments, which are higher than departments, have department heads.

Table B6-14 Classification of Staff Rank

Rank		Qualification / Experience
A	e.g., Division Chief Class	Specialized course graduate, Experience more than 7 years
B	e.g., Senior Staff Class	Experience more than 5 years
C	e.g., Staff or Junior (Assistant) Engineer Class	Experience more than 2 years

Source: JET

B6.2 Operation and Maintenance (O&M)

B6.2.1 O&M Activities Based on Public Authority

Table B6-15 shows examples of O&M activities based on public authority.

Table B6-15 Examples of O&M Activities Based on Public Authority

Category	Salient Activities
Promotion of house connections	Direction of the drainage installation Direction of the connection to sewerage
Determination and collection of fees	Determination of fees Fee collection
Regulation of the liquid trade waste*	Approval of connection to sewerage Direction of the installation, operation, and improvement of pre-treatment facility Monitoring and inspection

Note *: Wastewater from the source other than domestic sources, such as factories and other workplaces such as business establishments, hotels, restaurants, etc.

Source: JET

(1) Promotion of Septic Tanks (bottom of septic tank: permeable)

Existing septic tanks in Pokhara City have a permeable bottom. Therefore, when new buildings are constructed or renovated, we will instruct them to install decomposer tanks with a sealed bottom. In addition, guidance will be given on the periodic withdrawal of sludge.

(2) Promotion of House Connections

Separate sewer system is planned to be applied in Pokhara City and the drainage pipe of each house/building will need to be connected to the sewage pipe. If the number of connections is low, as was the case in Biratnagar City, the inflow to the WWTP could be significantly lower than the design volume. This could greatly reduce treatment efficiency (treatment cost per unit of sewage is high). Low number of connections also means low tariff revenues. In order to avoid this, PMC should take measures based on public authority, including the direction on the installation of drainage facilities (flush toilets, home piping, etc.) and on the connection to the sewage system, etc. Table B6-16 shows some measures to promote the house connections. It is necessary to select and implement effective measures according to the conditions and circumstances in Nepal.

Table B6-16 Measures to Promote House Connections

Measure	Explanation
Obligation of house connection	In Japan, toilets must be replaced with flush toilets and connected to the sewage system within 3 years of the start of sewerage services in the area. Public announcements are made to inform residents of who will be eligible. In special cases, special measures can be taken, such as extension of the connection deadline, if it is shown that the discharged wastewater will meet the regulations stipulated by the authority, and the treatment facility is appropriately maintained and managed.
Financial support	Paying the full cost of house connection may be a heavy burden on the user. A subsidy system, in which the public authority bears part of the construction costs, should be considered. In this system, care should be taken not to cause unfairness among users. In addition, if the ODA loan covers the cost inside of an individual's residential land, it is necessary to fully consider the pros and cons of doing so and the clarification of the ownership of the laid pipe.
Public relations	House connection can be promoted through the activities such as public relations and

Measure	Explanation
	environmental education that help residents recognize they are contributing river and lake pollution. The following activities are the examples for raising public awareness. ➢ Public hearings on sewerage projects ➢ Briefing session on sewerage projects to community leaders and representatives ➢ Public relations using media such as magazines and the Internet ➢ Environmental education in schools and communities These activities will promote residents' understanding of the sewerage and increase their participation, which will not only improve the rate of connection, but also make it easier to obtain the cooperation of the residents on the sewerage project. Therefore, in order to avoid delays in the project, activities should be implemented from an early stage.
Adopt efficient method	Application of efficient sewerage systems, such as condominium sewers and interceptor sewers, should be discussed in densely built-up areas where there are many poor people.
Outsourcing	By outsourcing all or part of sewage pipeline construction, management, and house connections to the private sector, the procedures such as connection approval can be simplified and expedited, and costs can be reduced as a whole. However, outsourcing of sewage pipes entails many risks for the private sector and is considered unlikely to be feasible. On the other hand, in large development areas, it may be effective to let the developer carry out the construction of the sewer pipes and house connections. In that case, it is important to require them to carry out precise construction management.
Penalties for illegal connection	Illegal connections to sewers make it difficult to collect fees. Users who connect without permission are subject to penalties such as collection of fines and suspension of water supply.

Source: Edited by JET based on Extraction of "Knowledge Lessons" (A Cross-Sectoral Analysis of Evaluation Results) in the field of sewerage management (2016, JICA)

(3) Determination and Collection of Fees

1) Principle of Fees

In determining sewerage charges, the grounds and principles for collection should be clarified and policy objectives to be considered should be carefully discussed.

Regarding the grounds and principles of collection of fees, the Sewerage Act of Japan stipulates that a Public Sewerage System Administrator may collect fees from persons using Public Sewerage Systems pursuant to the provisions of Prefectural or Municipal Ordinances. In addition, it stipulates that the fees must be provided for pursuant to the following principles:

1) the fees are adequate according to the quantity of Sewage, water quality, and modes of use by the users;
2) the fees do not exceed their proper costs under efficient management;
3) the fees are clearly set as fixed rates or fixed amounts; and
4) any person is not treated in an unfair and discriminatory manner.

Regarding policy objectives, since the water and sewerage tariff systems differ depending on the objectives, various tariff systems are adopted in countries and regions around the world. There can also be trade-offs between policy objectives, such that efforts to achieve one objective may impede the achievement of others. For this reason, there are many difficulties in setting tariffs based on the agreement of various stakeholders. Table B6-17 shows the major policy objectives related to the tariff system.

Table B6-17 Major Policy Objectives Related to the Tariff System

Policy objectives	Explanation
Cost Recovery	・ In the case of electric power and water supply operation, based on the beneficiary pays principle, the concept of "full-cost recovery", in which costs are covered by fees collected from users, is sometimes introduced. ・ In order to secure financial sustainability in the sewerage operation as well, it is desirable to set a rate that can achieve this "full-cost recovery". However, there is a problem that the rate setting to secure financial sustainability creates a trade-off with the possibility of payment.

Policy objectives	Explanation
	・ In addition, in the case of sewerage, the scope of benefits is not limited to users, and the benefits of improving the water quality of public water areas extend to residents in the downstream area. For this reason, it is often difficult to apply "full-cost recovery" to sewerage. ・ Furthermore, in the case of a separate sewerage system, the number of households connected to the sewerage system at the beginning of service is small. Expecting the tariff to recover the total O/M cost and capital cost of sewage treatment during this period would be an excessive burden on users. ・ For this reason, considering the characteristics of the "benefit" of the project, it is necessary to apply tax revenues to the project to ask the burden broadly to the public. In particular, Pokhara's sewerage project contributes to the environmental conservation of Lake Phewa, so national-scale financial support should be considered.
Impartiality	・ "Fairness" here means that fees are treated fairly among "similar users". As "similar users", for example, tariff setting in a plurality of sewerage treatment districts in Pokhara City is assumed. However, in a system based on cost recovery from fee revenue, it is technically difficult to unify tariffs due to differences such as service start times for each treatment area. ・ On the other hand, if the fee is set according to the O&M cost of each treatment area, the grounds the fee are clear. However, in small treatment areas, it is difficult to achieve economies of scale, and so the fee tends to be high.
Ability to pay	・ In order to ensure the collection of usage fees, it is necessary to set fees according to the ability to pay. However, if the tariff is set according to the ability of the poor, the revenue will be insufficient to implement the project sustainably. ・ For this reason, the so-called "Cross-Subsidy" should be adopted, as is widely practiced in Japan's water supply and sewerage. "Cross-Subsidy" includes billing according to the amount of wastewater emissions (progressive type pay-per-use system) and billing for domestic wastewater and other wastewater separately.
Social economy	・ Billing according to the emissions (progressive type pay-per-use) functions not only for "cross-subsidy" but also for improving "social economy" by reducing water usage. ・ In the same way, it is possible to reduce the load on sewage treatment facilities and public water areas by applying fees according to the water quality (load amount) of wastewater discharged into the sewage system, which is adopted by Osaka and Kobe Cities in Japan. In this system, surveys and periodic monitoring are required to certify the water quality (load amount) of the target establishments, and in general, large-scale wastewater discharger are targeted. So, careful consideration should be given to whether or not such targeted establishments exist in Pokhara City.

Source: JET

2) Determination and Collection of Fees

This section presents examples of the methods of determination and collection sewerage fee and considers the issues when implementing them in Pokhara City. And concrete method will be determined through the consultation with relevant organizations.

(a) Determination of Fees

The central part of Pokhara city is supplied with water by NWSC, and the rest of the area is covered by WUSCs. According to a past survey[43], the coverage ratio in Pokhara City was about 81% in 2019, which combines the services of NWSC and WUSC. In cities with such a high-water-supply-coverage ratio, adopting a billing system based on actual water usage (meter count) is an efficient choice, which is widely used in Japan and other countries.

In Japan, as a general rule, municipalities are responsible for both water supply and sewerage services. So, the coordination between water supply and sewerage systems is rarely a problem. On the other hand, in Pokhara City, water is supplied by NWSC and WUSCs, so it is not easy to collaborate with these organizations and share water usage data. In addition, in systems where fees are fixed at a percentage of water charges, like in the Kathmandu Valley, it is difficult to maintain unified fees for the entire service area if there are differences in the timing of tariff revisions, etc. Furthermore, many of the large hotels

43 Federal Democratic Republic of Nepal, Study Report on Detailed Planning of Sewerage Master Plan Formulation Project in Pokhara City (2021, JICA)

in the Lakeside area have their own wells in addition to the water supply, so it is necessary to set a separate tariff system that takes the amount of well water into consideration. For these reasons, it is difficult for Pokhara City to adopt a pay-per-use fee system based on the water usage.

Other than the method based on the water usage, fees based on the size of assets (floor area, etc.) and asset value (Gross Rental Value (GRV), etc.) should be considered. According to a report by the Japan Waterworks Research Center (JWRC)[44], these systems have been adopted in many cases in Europe and the United States. Also, as in Biratnagar City, there are examples of charging based on the water pipe diameter and building floor area. This method can be considered as a method of estimating water consumption from these parameters and can be applied to well water use. Pokhara City has many hotels, restaurants, and other tourism-related facilities. So, a system that uses the number of guest rooms (capacity) and the number of tables (seats) as a basis for calculating fees can also be considered.

(b) Fee Collection

For tariffs based on water usage, fees are usually collected using a water bill payment system. However, it would be necessary in Pokhara City to entrust the collection to the water supply organizations and establish a framework to transfer the fees to the sewerage side. In addition, other collecting system should be prepared for households that do not use supplied water.

Other than collecting with water fee, the method to collect fees in the form of tax, such as Property Tax, Business Tax, or Sewerage Tax are applicable. In this case, it is efficient to use tax ledgers and tax payment systems held by tax departments. However, Pokhara City's capacity for tax collection is low as seen in some developing countries. In addition, it is necessary to transfer a part of the collected tax from the tax department to the sewerage department, and to establish rules such as the transfer ratio by ordinance. Other than through taxes, it is also possible for the sewerage department to construct its own collection system. However, this system is not practical because it will require a lot of money, time, and human resources to establish and operate.

(c) Other Charging Methods

In Biratnagar City, a "sewer connection charge" is charged for each connection when connecting to the sewerage system. With regard to water supply, in many countries, except some areas such as the United Kingdom, the United States, and Germany, the connection charge is charged when starting to use the service. In Japan as well, charges under the context of "water supply subscription fee" are commonly charged, and in the case of sewerage, some local governments collect a "beneficiary contribution" by ordinance. The grounds for these charges include the idea that they are collected as expenses for procedures related to house connections (application procedures, inspection of connection, etc.). Japan's "beneficiary contribution" is defined in the City Planning Law as "In cases where any person is greatly benefited by city planning projects, the state, prefectures or municipalities may burden them with a part of the expenses required for the relevant city planning projects, within the limit of the benefit accruing to them from the city planning projects."

In addition, there are cases where a rate system consisting of a "basic payment" and a "variable payment" is adopted, as commonly seen in Japan. This is based on the fact that the O&M cost consists of expenses that increase in proportion to the amount of water and expenses that are necessary regardless of the amount of water.

3) Revision of Tariffs

The tariffs need to be revised appropriately according to the economic situations and the management situations of the operating entity. When revising tariffs, it is important to ensure the validity of the revision and the transparency of the setting process. For this purpose, a mechanism should be established which includes review by an independent organization such as the WSTFC in the Kathmandu Valley or approval by the parliament. However, excessive materials for procedures and the lack of personnel for review may prevent appropriate revision of tariff. Rules and systems to avoid this should be prepared.

44 Study on international comparison of water supply - water tariff in overseas countries (2016, Japan Water Research Center)

(4) Wastewater Measures for Factories and Workplaces

In Nepal, the wastewater discharged to the sewerage system from factories and workplaces (hereinafter referred to as "factories, etc.") is regulated according to the notification (2001, 2003) on the effluent quality standards based on the Environment Protection Act, 2076 (2019). However, it is pointed out that effective measures have not been implemented in developing countries due to the inadequate systems, and the following factors are cited as reasons for this.[45]

Table B6-18 Problems on Wastewater Measures for Factories, etc. in Developing Countries

Category	Problems
Factories, etc.	・ Non-compliance ・ Lack of technology and funds ・ Inadequate check system
Regulator side	・ No environmental standards, no quality standards for discharged water ・ No penalties ・ No inventory of factories, etc. ・ Insufficient/no inspection ・ Lack of capacity/ability of laboratory

Source: Extraction of "Knowledge Lessons" (A Cross-Sectoral Analysis of Evaluation Results) in the field of sewerage management (2016, JICA)

Considering these problems, Table B6-19 shows the proposed methods for Pokhara City to make the wastewater measures effective. In Pokhara City, there may be few large-scale factories. On the other hand, wastewater from kitchens of hotels and restaurants, especially fats, oils, and grease (hereinafter referred to as "FOG"), which may cause clogging, should be carefully considered.

Table B6-19 Proposed Wastewater Measures in Pokhara City

Category	Examples of Measures
Inventory	・ Collection of information in cooperation with environmental departments, commercial and industrial departments, etc. ・ Cooperation with hotel associations, etc. ・ Obligation of notification
Laboratory	・ Enhancement of capacity for daily examination ・ Enhancement of ability for emergency response ・ Improvement of efficiency by outsourcing to other public and private laboratories
Inspection	・ On-site inspection of factories, etc. ・ Request to submit records and reports ・ Patrol/inspection of sewer lines and manholes
Pre-treatment	・ Formulation of standards on installation of pre-treatment facilities ・ Formulation of guidance, directions, and penal provisions
FOG	・ Ordinance to obligate installation and cleaning of grease trap ・ Activities for waste FOG collection ・ Public relations
Response to accidents	・ Preparation of materials for emergency response ・ Establishment of publicity and information system ・ Preparation of manuals, training

Source: JET

1) Inventory, Pre-treatment

Inventory is a "written list" in which information on factories that may discharge pernicious sewage, their facilities, the amount and quality of wastewater, and the types and structures of treatment facilities are summarized. When conducting wastewater measures for factories, monitoring, on-site inspections,

45 Extraction of "Knowledge Lessons" (A Cross-Sectoral Analysis of Evaluation Results) in the field of sewerage management (2016,JICA)

direction, etc. are carried out based on this inventory.

The approval procedures for connection should require the notification of necessary information such as the type of the specified facilities, structure and construction of the specified facilities, quantity and quality of the effluent, means of treatment of polluted water, etc. Then, the inventory is prepared based on the information submitted. In Japan, the Water Pollution Control Law and the Act on Special Measures against Dioxins, which correspond to Nepal's environmental protection laws, require notification of the specified facilities. The Sewerage Act also requires the same notifications as these laws. This enables the sewerage department to understand and monitor the actual conditions of factories. "Specified facility" is a facility that discharges sewage containing substances that may cause damage to human health and the living environment in the manufacturing process of factories and is stipulated by law and cabinet order.

Nepal does not have similar laws and regulations, so regulations will be implemented within the framework of the Environmental Protection Law. However, it is practically impossible for environmental departments to monitor wastewater discharged into the sewage system. It is the sewerage side that suffers directly from bad/harmful wastewater. So, the patrol of pipelines and manholes conducted by sewerage department and measurement by monitoring meters installed at pumping stations will play an important role. In addition, it will be necessary to institutionalize the authority of the sewerage department by laws or ordinances so that they are similar to those in Japan. Until being institutionalized, a basic inventory can be prepared using customer information documented by NWSC and WUSC, the monitoring list of environmental departments, the information of department of commerce and industry, and the information of hotels and restaurant associations. The targets of the inventory are factories, etc. that handle hazardous substances and dangerous substances, and that may discharge wastewater containing high-concentration SS, acids, and FOG that can damage sewage pipes and treatment facilities.

Information submitted during the approval process should be examined carefully. If examination reveals some possibility of the wastewater quality not meeting discharge standards, the business operator will need to install additional treatment facilities before discharging wastewater into the sewer system. Ordinances to compel businesses to do so need to be created.

2) Enhancement of Laboratory

It is important to develop a system to conduct on-site inspections and daily patrols of factories, etc. as well as quick water quality examinations when hazardous or abnormal sewage flows in. For such a case, in addition to the daily monitoring at each treatment plant, monitoring meters should be installed at pumping stations to detect abnormal water quality.

However, it is not rational in terms of human resources and costs for the sewerage department to have its own analysis capabilities to examine various harmful substances. For this reason, collaboration with other public analytical institutions, such as DSSWM Pokhara Branch (FWSSMP), should be considered. This requires improvement of these laboratories.

3) Inspection

For the purpose of proper management of the sewage system, it is necessary to prepare legal and organizational system that allows public sector officers to enter people's private property or buildings in the treatment area and inspect drainage facilities, pre-treatment facilities, and other related facilities at any time. In addition, factories, etc. must measure the water quality of wastewater discharged into the sewage system, keep records for a certain period of time, and submit those records to authorities when requested.

In order to supplement the on-site inspection, water quality monitoring at the confluence of main trunk lines and visual inspection of pipelines and manholes should be carried out together, which will make it efficient to narrow down the sources of problematic wastewater discharge and inspection sites.

4) Countermeasures for FOG

FOG discharged from food-related establishment often clogs sewage pipes. Pokhara City has concerns FOG discharged from its many hotels and restaurants and the problems it can cause.

The principle for FOG is “No use”, “No discharge”, and “Recover”. As for “No use”, it is necessary to reduce the amount of FOG used and use it repeatedly. As for “No discharge”, it is conceivable to put the used FOG in a special container and collect and recycle it by a specialized company or NGO. For “Recover”, FOG in wastewater is separated by a grease trap before discharging into sewerage system. Grease traps need to be cleaned regularly, and a system for collecting and disposing of scum removed by cleaning needs to be established.

Since FOG is also discharged from ordinary households, PR for residents is also important. Figure B6-12 shows an example of a blockage of a sewage pipe by FOG in Tokyo and an example of a PR poster for residents. In Japan, many people wipe oil off of cooking utensils with paper towels before washing. Waste oil is also collected by the government or NGOs.





Source: Tokyo Metropolitan (https://www.gesui.metro.tokyo.lg.jp/news/2021/1001_5772.html)

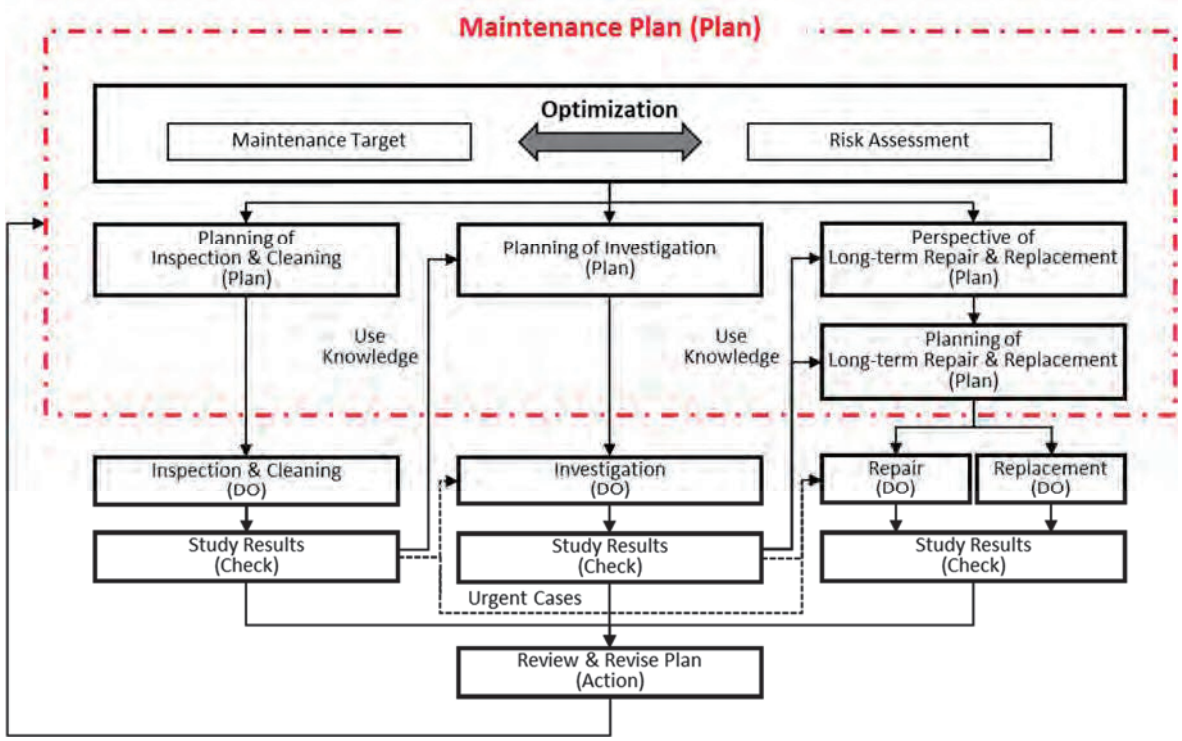
Figure B6-12 An Example of Clogged Pipe, and an Example of a PR Poster for Residents

B6.2.2 Maintenance of Pipelines

(1) Systematic Maintenance of Pipelines

Sewer pipes are subject to various problems, such as blockage due to FOG and sediment, corrosion and foul odors caused by H_2S gas generated inside the pipe, damage due to aging, infiltration of rainwater, and deterioration of manhole covers. In addition, since pipes are usually buried under roads in urban areas, sanitary sewer overflow (SSO) due to clogged pipes or infiltration of rainwater can cause serious impacts on the lives of citizens. Moreover, road collapse due to the damage of pipe can cause accidents involving third parties. Therefore, adequate maintenance is required to keep pipelines in sound condition. This is accomplished by conducting inspections and investigations and carrying out necessary repairs and rehabilitation. It is expected that the cost (Life Cycle Cost (LCC)) will be reduced through proper maintenance.

However, the length of the sewage pipeline including branches is enormous, so it is difficult to know the situation of all of them. Therefore, it is necessary to carry out efficient maintenance through systematic surveys, patrols/inspections, and cleaning. Figure B6-13 shows the procedure of systematic maintenance of sewage pipes through the PDCA cycle.



Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Figure B6-13 Procedure of Systematic Maintenance

1) Setting of Targets

In setting the maintenance targets for the pipeline, the targets will be set according to the actual conditions of Pokhara City, taking into account that pipelines will be buried underground. In Japan, since there are many pipelines which have been used for a long time, data such as deterioration of pipelines, the number of accidents, and the number of complaints about odors, etc. have been accumulated. Based on the data, outcome targets such as reduction of accidents caused by road collapse, output targets and indicators such as average soundness of pipes, and input targets such as frequency of patrols, inspections and cleanings are set.

On the other hand, in the case of Pokhara City, there is no such accumulated data, making it difficult to set numerical targets. However, it is desirable to set goals in some way. For example, referring to the situation in Biratnagar City, which is adopting the separate flow pipe facility planned for Pokhara City, it is conceivable to set the goal of suppressing the occurrence of SSO due to infiltration during rainfall. In addition, since there are many hotels and restaurants, prevention of pipe clogging due to FOG may also be a goal. Furthermore, it is practical to select the risk described below that matches the actual situation, set the initial target, and review it as necessary during the implementation of maintenance.

2) Risk Identification and Assessment

Risk identification and assessment involves systematic, routine, and comprehensive identification of unfavorable events that may affect or damage the lives of citizens, as well as their causes. Table B6-20 provides examples of possible risks associated with pipeline facilities.

Table B6-20 Examples of Possible Risks Associated with Pipeline Facilities

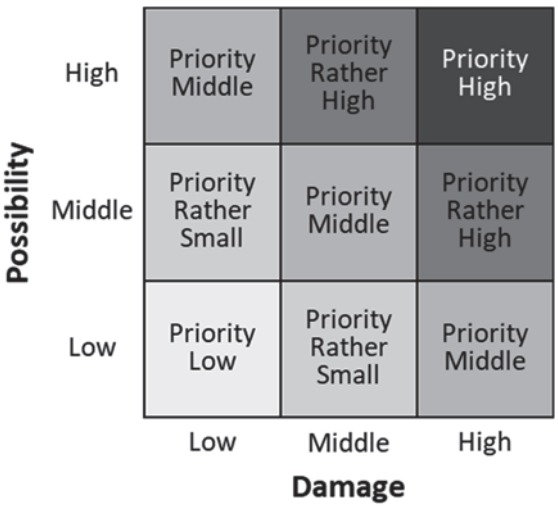
Event	Risk (Impacts Caused by Event)
Damage/cracks of pipes	・ Traffic jam and personal injury due to road subsidence ・ Inconvenience due to restrictions of sewerage use
Infiltration of groundwater, etc.	・ Increase in costs due to increase of influent
Infiltration of rainwater	・ Sewage overflow (SSO) ・ Inundation

Event	Risk (Impacts Caused by Event)
Stagnation of sewage due to sagging, etc.	・ Foul odor
Clogging due to FOG, mortar, etc.	・ Sewage overflow (SSO) ・ Inconvenience due to restrictions of sewerage use
Deterioration of manhole cover	・ Noise and vibrations caused by rattling ・ Personal injury or property damage due to damaged cover
Harmful gas and odor generation	・ Harmful gas (H_2S, etc.) and corrosion ・ Foul odor
Water leakage	・ Contamination of groundwater, soil, etc.
Inflow of harmful or dangerous substances	・ Negative effects on treatment processes ・ Fires or explosions
Abnormal rise in pipe pressure	・ Traffic jam and personal injury due to flying manhole covers
Damage to pipes due to other construction work	・ Traffic jam and personal injury due to road subsidence ・ Inconvenience due to restrictions of sewerage use

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Risk evaluation is objectively analyzed from the impact and likelihood when an accident occurs. Efficient maintenance is achieved by prioritizing patrols, inspections, surveys, and cleaning for high-risk facilities and locations. Figure B6-14 shows an image of priority consideration through risk assessment, and Table B6-21 shows the viewpoints for qualitative evaluation and the examples on "Impact".

Regarding the likelihood, in Japan, a method using a prediction formula for the soundness of pipes, Weibull distribution approximation formula and Markov transition probability model, is proposed. In the case of Nepal, there is not enough data for an accurate evaluation of probability. For this reason, it is conceivable to qualitatively identify the conditions under which pipe deterioration is likely to progress, instead of methods using probabilities. Table B6-22 shows the viewpoints of qualitative evaluation and the examples on "Likelihood".



Source: Edited by JET based on" Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Figure B6-14 An Image of Priority Consideration through Risk Assessment

Table B6-21 Viewpoints for Qualitative Evaluation and the Examples on "Impact"

Viewpoint	Example (Location with Possibility of High Impact)
Functionally important facilities	Major pipeline
	Pipeline directly connected to the treatment plant
	Confluence points of pipelines
Facilities with large social impacts	Critical or Emergency Transportation Routes

Viewpoint	Example (Location with Possibility of High Impact)
	River crossing points (siphon, water pipe bridge)
Facilities that are difficult for accident response	Siphon culvert
	Pipeline of deep burial depth
	Locations where it is difficult to detour pipes
	Places where other underground utilities or buried cultural properties exist

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Table B6-22 Viewpoints of Qualitative Evaluation and the Examples on "Likelihood"

Viewpoint	Example (Location with Possibility of High Likelihood)
Damage/cracks of pipes	Heavy traffic volume, shallow pipe covering
	Soft ground (Pipe subsidence is likely to occur)
	Aged pipe (Long period since construction)
	Near trees (Roots grow into pipe)
Infiltration (ground water, rainwater)	High ground water level
	Aged pipe (Long period since construction)
	High frequency of flooding
Clogging due to FOG,	Many hotels and restaurants
	Near food processing factories
Harmful gas	Pressure pipe outlet
	Drop work
	Stagnation of sewage at sagged pipes or siphons

Source: JET

(2) Patrol, Inspection and Investigation

When conducting patrols, inspections, and investigations, it is important to conduct them systematically, efficiently, and rationally based on the results of risk assessments.

Patrols and inspections are basically carried out visually from the ground, but methods using mirrors and pipe inspection cameras from manholes are also available. If necessary, workers may enter the manhole to check. Regarding the frequency of patrol inspections, based on risk assessment is necessary to prioritize high-risk areas as "priority routes" or "priority areas" and to secure efficiency considering budget and human resources. In order to prevent road subsidence, which is highly likely to lead to a serious accident, it is desirable to carry out road patrol using patrol vehicles as often as possible.

In the case of Pokhara City, they cannot set the implementation frequency because there is no record of maintenance. Initially, it is recommended to formulate a plan with reference to domestic and overseas cases, etc., the plan should be revised and optimized as more local data is gathered and accumulated.

Investigations are carried out in order to grasp the detailed status of facilities in necessary locations based on patrol/inspection results and information on abnormal condition, etc., or to confirm the state of deterioration based on risk assessment. The basic method of investigation is visual inspection by human eyes, but in recent years, self-propelled robot and drone have also been put into practical use.

Table B6-23 and Table B6-24 are examples of patrol/inspection and investigation implementation cycles given in guidelines commonly used in Japan. They can be used as reference examples when no maintenance records are available. Photo B6-1 is an example of a self-propelled robot.

Table B6-23 Examples of Implementation Cycle (Patrol/inspection)

Years since putting in use	Manhole Pipe	Siphon	Manhole Pump	Household Chamber	Pipe Bridge*
0 – 30 years	Once per 3 years	Once a year	Once a month	Once per 3 years	Once per 2-5 years
More than 30 years	Once a year	Once a year	Once a month	Once per 3 years	Once per 2-5 years

Source: JIS A7501-2013 Guidelines on planning for sewer system maintenance (2013, Japan Standards Association),
* Guidance for formulating a pipeline maintenance manual (2014, Japan Water Research Center)

Table B6-24 Examples of Implementation Cycle (Investigation)

Investigation	Location	Years since putting in use	Implementation Cycle	Remarks
Visual inspection (Manhole)	Manhole and connected pipes	0 - 30years	Once per 5 years	
		> 30years	Once per 3 years	
Visual inspection (Pipes)	Inside diameter > 800mm	0 - 30years	Once per 10 years	Including laterals (House connection pipe)
		> 30years	Once per 7 years	
TV camera inspection	Inside diameter < 800mm	0 - 30years	Once per 10 years	
		> 30years	Once per 7 years	

Source: JIS A7501-2013 Guidelines on planning for sewer system maintenance (2013, Japan Standards Association)



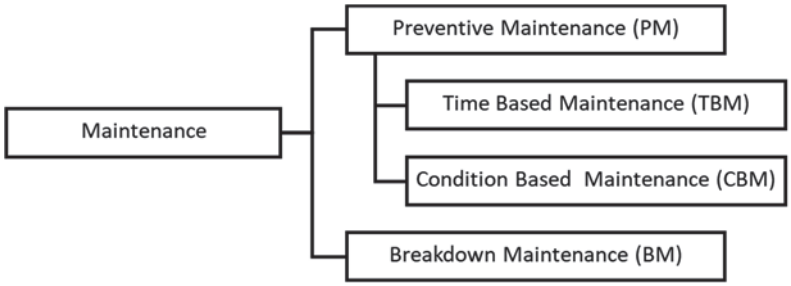
Source: Ministry of Land, Infrastructure and Transport and Tourism
(https://www.mlit.go.jp/sogoseisaku/maintenance/index.html)

Photo B6-1 An Example of a Self-propelled Robot

B6.2.3 O&M of Pumping Stations and WWTPs

(1) Systematic Facility Maintenance

Sewerage system is an important infrastructure for the lives of citizens and interruptions in service can have serious negative impacts. On the other hand, pumping stations and treatment plants are integrated systems composed of various facilities and equipment, such as civil engineering/building facilities and electrical/mechanical equipment. The conditions in which they operate expose them to hazardous materials and corrosive gases, which are hostile especially towards electrical and mechanical equipment. For this reason, proper and efficient inspections and investigations, and repairs based on the findings are essential when implementing maintenance. In addition, it is necessary to reduce costs (Life Cycle Cost (LCC)) by conducting planned and efficient maintenance management according to the characteristics of the facilities and equipment. Figure B6-15 and Table B6-25 show the concept of maintenance considering the characteristics of facilities and equipment (priorities, failure patterns, etc.).



Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Figure B6-15 Concept of Maintenance Considering the Characteristics of Facilities and Equipment

Table B6-25 Methods of Maintenance Considering the Characteristics of Facilities and Equipment

	Characteristics of Facilities/equipment		Breakdown Maintenance (BM)
	Condition-based Maintenance (CBM)	Time-based Maintenance (TBM)	
Method	Take measures according to the condition of equipment	Take measures at a certain interval	Take measures after signs of abnormality (deterioration of function, etc.) appears or after failure occurs
Applicable conditions	High priority (Impact on operation, safety, cost, etc.)		Low priority
	・Possible to grasp deterioration ・Hard to get deteriorated ・Deterioration rate is not constant	・Easy to set interval ・Standard interval set by regulation ・Difficult to grasp deterioration	・Little impact ・Economically advantageous to respond after the breakdown
Notes	Necessary to conduct a survey to grasp the deterioration status.	Necessary to set an interval (Target life span)	Necessary to ensure the supply of repair parts
Example	Main pump, Screen	Power receiving and transforming unit	Submerged pump, crane

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

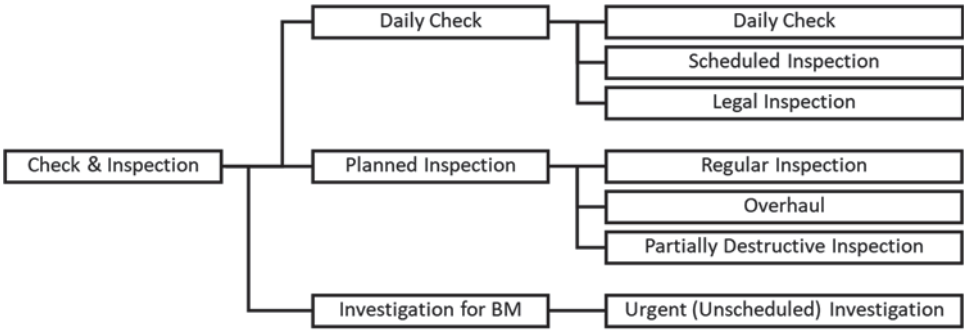
(2) Daily Check, Inspection and Investigation of Pumping Stations and WWTPs

Figure B6-16 shows the inspection and survey system for pumping stations and treatment plants.

Daily checks are usually carried out along a fixed route, using human sense and various indicated values of the equipment to observe lubrication conditions, joints between main equipment, and condition on the route, such as dirt, foreign matter, noise, heat, vibration and smell. It is desirable to set the routes and inspection workers for each type of facility, such as water treatment, sludge treatment, and electrical equipment, considering the time and the skills expertise required for inspection.

The data should be collected in a quantitative and concrete form as much as possible. Avoid lists that involve human subjectivity, such as checking "OK" or "No abnormality". The inspection cycle should be based on the instruction manual and manufacturer's recommended inspection methods, and an appropriate cycle should be set in consideration of the importance of the equipment, past maintenance records, etc. By compiling check sheets based on the facility and inspection cycle, inspections can be carried out efficiently and reliably.

In the investigation of the equipment categorized to "condition-based maintenance", main parts will be taken off from equipment. If an inspection by the manufacturer is required, an overhaul inspection at the factory will be carried out to check for deterioration, etc. In the investigation of civil engineering facilities and buildings, partial destructive investigations, such as concrete core extraction test to investigate the degree of neutralization, etc., may be conducted.



Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Figure B6-16 Inspection and Survey System for Pumping Station and Treatment Plant

(3) O&M of Pumping Station and WWTP

In O&M of pumping stations and WWTPs, the goal is to achieve appropriate and stable water quality with efficient cost and energy consumption, and to reduce the effects of waste and surrounding environment as much as possible.

For this purpose, it is necessary to understand the fluctuating pattern of inflow in order to control the pumps to reduce the effects on water treatment and to suppress power consumption. In addition, the flow rate may increase significantly due to rainwater even in separated systems. It is necessary to prepare for flooding due to rainwater and to establish systems to relate weather information to coordinated operation of relay pumps in advance. The O&M of the treatment plant is described in "Water quality management".

B6.2.4 Facility Information Management

(1) Facility Information

Facility information is essential for proper management of the sewerage facility. It is desirable, in advance from the facility planning stage, to determine the information to be managed and the rules for handing over the information, as well as to establish a policy regarding the efficiency of facility management using information. Information subject to facility information management is organized as shown in Table B6-26.

Table B6-26 Information Subject to Facility Information Management

Category	Example of Information
Specifications of sewerage facilities	Fundamental information such as facility structure, capacity, type, year of installation, installation cost, etc., and the following information: ・For pipeline facilities, refer to "General specifications of pipeline facilities" described later. ・For pumping stations and treatment facilities, more specific specifications are required depending on the characteristics of the facilities and equipment.
Maintenance information	Organize and manage the following information generated in the maintenance of sewerage facilities. ・History information such as failure, repair, inspection/survey and cleaning, operation records ・Supplemental materials related to the above such as reports, forms, drawings, various records, etc. ・Results of expenditure for the maintenance such as survey costs and repair costs
Other incidental information	Organize and manage the following information such as information required for facility maintenance, and information related to repair and rehabilitation plans. ・Information necessary to facility management (boring data, land, occupancy, background map, etc.) ・Information on facility soundness assessment ・Information such as completion drawings, completed documents, design drawings, etc.

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

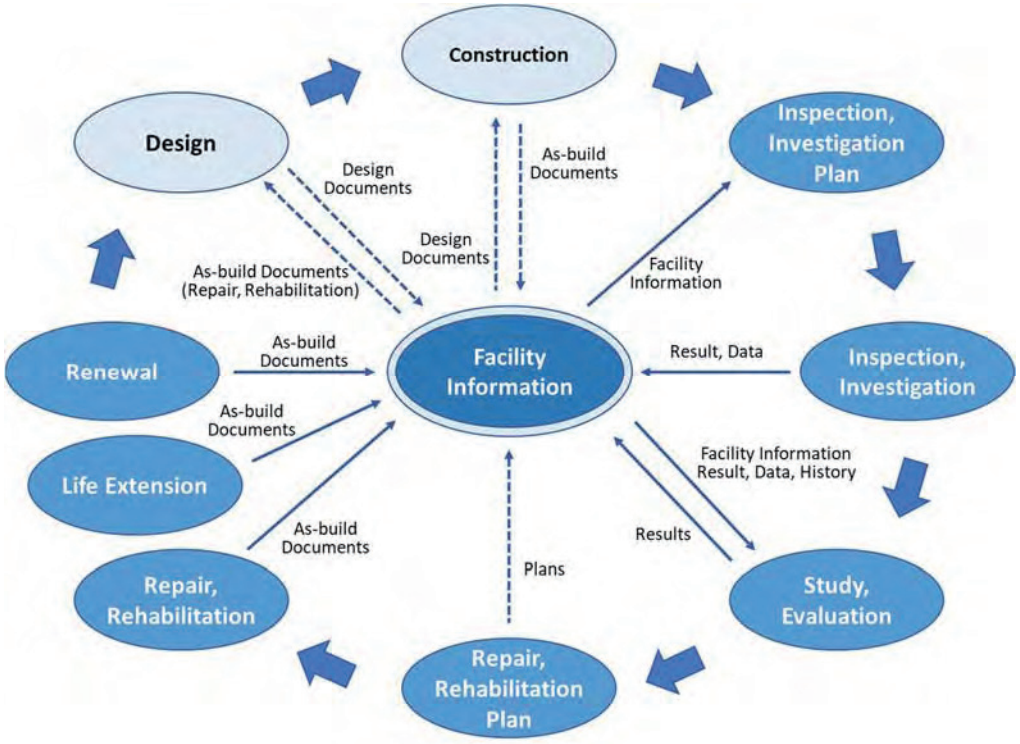
(2) Handing over the Information

Facility information of sewerage facilities is generated at each step of the life cycle such as planning, design, construction, rehabilitation, and maintenance. Therefore, it is important to clarify the division of roles and scope of responsibility among organizations and persons in charge who handle the information. In addition, the content, form, format, etc. of the data to be handed over should be determined in advance.

Digitization of design drawings, completion drawings, photographs, etc. and registration in the GIS system should be specified in the specifications when ordering design work and construction work. Figure B6-17 is an illustration of the workflow of the sewerage management, collection of facility information, and flow of information handover.

In the proposal of management and O&M framework, a section in charge of information management is placed under the Engineering & Construction Division, and facility information will be centrally managed by this section. However, from the perspective of asset management, it is desirable to consider

linkage with financial systems that manage assets/properties. In addition, when outsourcing design, construction, and maintenance work by DBO method, etc., it is necessary to make arrangements with the contractor regarding information collection and handover.



Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Figure B6-17 Illustration of the Workflow of the Management of Sewerage System, Collection of Facility Information, and the Information Handover

(3) Facility Information Management for Pipelines

The facility information of pipelines includes specification information, maintenance information, and other incidental information. Table B6-27 to Table B6-29 summarize this information.

Table B6-27 provides examples of general information for each category. As a general rule, sewer facilities are managed by each span, which is a block between manholes. It is desirable to assign a systematic and explicit facility ID to each facility using treatment area, branch, and span.

Table B6-27 Common Specification Information of Pipeline Facilities

Facility	Example of Specification Information
Pipeline	Facility number, cross-sectional shape, pipe type, pipe diameter, distance between manhole centers, installation year, slope, upstream pipe bottom height, downstream pipe bottom height, installation cost (unit price per unit length is also acceptable)
Manhole	Facility number, manhole standard, manhole depth, frame material, construction year, ground height, manhole cover (installation year, type, material, strength, diameter, installation cost)
Lateral	Facility number, cross-sectional shape, pipe type, pipe diameter, horizontal extension, installation cost
Household Chamber	Facility number, type, depth, installation cost
Others	Siphon, water pipe bridge

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Table B6-28 Common Maintenance Information of Pipeline Facilities

Category		Example of Information
Patrol and inspection information	Road surface	・ Ground surface (road surface) conditions
	Manhole	・ Damage, corrosion, misalignment, etc. of the manhole ・ Damage near the manhole inlet and outlet ・ Corrosion of step irons ・ Groundwater infiltration ・ Flow conditions and sedimentation in manhole ・ Flow conditions during rainy weather (to grasp rainwater infiltration) ・ Condition of manhole pump (visual check)
Investigation information	Pipe	・ Corrosion, sagging, breakage, gaps, infiltration of water, adhesion of oils and fats, intrusion of plant roots, etc.
	Manhole	In addition to the items for pipe, ・ Pavement cracks, etc.
	Manhole cover	・ Deterioration, rattling, abrasion, unevenness, etc.
	Manhole pump	・ Appearance, current value, etc.
	Others	・ Survey date, selection of countermeasure construction method, estimated project cost, etc.
Repair information	cleaning	・ Cleaning location, date, cleaning method, etc.
	repair	・ Repair location, date, repair details, repair method, repair cost, etc.
	failure	Regarding failure of manhole pumps ・ Date of occurrence, type and details of failure, cause, countermeasures, cost, etc.
Others	Request, complaint	・ Target and location, details of request/complaint, cause ・ Date of receipt, date of response, details of response, etc.

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Table B6-29 Other Incidental Information of Pipeline Facilities

Category	Example of Information
Map (GIS) information	・ Background map information (Terrain, roads, underground facilities such as water supply, buildings, etc.) ・ Aerial photograph, satellite photograph
Facility soundness information	・ Investigation results of pipeline ・ Repair and rehabilitation plan (measures, schedule)
Risk information	・ Importance of pipeline facilities (main roads, etc.) ・ Social Impact (emergency transportation routes, river crossing points, etc.)
Facility management information	・ Occupation/use information (rivers, roads, private land, etc.) ・ Factories, pre-treatment facilities (location, size, type, etc.) ・ Boring data, ground information ・ Important facility information (disaster management bases, emergency response routes, etc.)
Others	・ Complementary documents, drawings, photographs, etc.

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

(4) Facility Information Management for Pumping Stations and WWTPs

As with pipeline facilities, facility information of the pumping stations and WWTPs includes specifications information of facility/equipment, maintenance and management information, and other incidental information. There are many types of pumping stations and treatment facilities, such as civil engineering/building facilities and electrical/mechanical facilities, and their specification information is diverse and enormous. For this reason, the types of facilities/equipment and the composition of the treatment flow are considered in the classification/hierarchy. It is desirable to manage the information of civil engineering/building facilities in unit of "subcategory" shown in Table B6-30, and for electrical/mechanical facilities in unit of "further subcategory".

Table B6-31 to Table B6-33 are examples of general information regarding specifications, maintenance, and other incidental information.

Table B6-30 An Example of Classification/hierarchy

Category	Subcategory	Further Subcategory
Water Treatment	Primary sedimentation tank	Sludge collector
		Scum skimmer
		Scum separator
		Scum pump
		Sludge pump

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Table B6-31 Examples of General Information on Specification

Category	Information
General	・ Name, Category (Sub-category, further sub-category) ・ Type of facility (civil engineering, building, electrical, mechanical, others) ・ Location and year of installation
Structure, specification	・ Structure, specifications ・ Size, capacity (defined according to the type of facility/equipment) ・ Parts configuration, main parts ・ Manufacturer, construction contractor, year of manufacture
Maintenance	・ Depreciation period (useful life), target years of use ・ Operational status (operating, outage, decommissioned, removed, operating hours, etc.)
Others	・ Installation cost

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Table B6-32 Examples of General Information on Maintenance

Category	Information
Records of maintenance and inspection	・ Daily maintenance and inspection report (Record of daily check) ・ Periodic inspection records (statutory inspections, periodic inspections specified in the manufacturer's specifications, etc.) ・ Repair history (overhaul, parts replacement, repair costs, etc.) ・ Accident/failure history (date and time, location, type and details of accident/failure, cause, details of response (time from occurrence to resolution, parts delivery time, cost, etc.)
Record of investigation	・ Vibration, noise, temperature, wear, rust, corrosion, deformation, cracks, leaks, etc. ・ Current value, insulation resistance, pressure, etc. ・ Set other items according to the characteristics of facilities
Record of facility operation	・ Operation record (volume of inflow and effluent, electricity consumption, usage of chemicals, blower flow rate, drained sludge volume, transported sludge volume, disposed waste volume, etc.) *If operation data is available through the SCADA (Supervisory Control and Data Acquisition) system, reporting function of the SCADA can be used. ・ Daily operation report (prepared to summarize the data in the operation record and to share the information) ・ Monthly/annual operation report (prepared to share the operation status with the management of the department and the upper organizations, and is part of the monthly/annual management report)
Record of water quality management	・ Water quality examination records (including original data such as examined data, chart paper and field notes) ・ Daily water quality report (prepared to summarize analysis record data and to share the information) ・ Monthly/annual water quality report (prepared to share the status of water quality management with the management of the department and the upper organizations, and is a part of the monthly/annual management report)
Others	・ Energy management records (energy usage, power generation, etc.) ・ Waste management record

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

Table B6-33 Example of Other Incidental Information

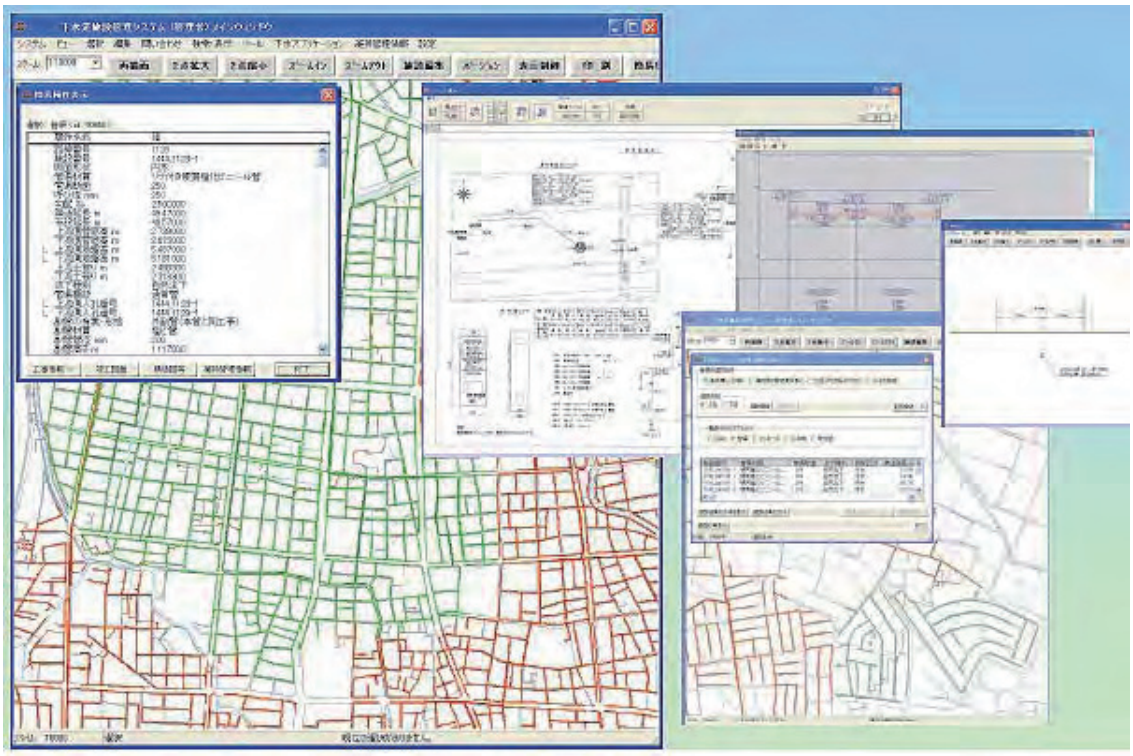
Category	Information
Soundness evaluation	・ Investigation results of facilities and equipment ・ Repair and rehabilitation plan (contents, schedule)
Risk information	・ Information on the surrounding environment of facilities ・ Information on the social impact of failures/accidents
Others	・ Instruction manuals, operating procedures (SOPs), operating manuals ・ Supplementary documents, drawings, photographs, etc.

Source: Edited by JET based on "Guidelines on operation and maintenance of sewerage system (2014, Japan Sewage Works Association)"

(5) Creating a Database of Facility Information and the Utilization

As shown in (1) to (4) above, information on sewerage facilities is diverse and enormous, and is accumulated and updated through daily work. Therefore, it is necessary to systematize and structure such information to make it easy to search, browse, edit, and manage, and to collect, hand over, accumulate, and utilize it reliably and efficiently. The system for this is a "database" and is usually configured in a computer system. The features of the "database" configured as a computer system is that it can extract and edit data not only in the original data format as stored in database but also in various formats according to the user's request. Sharing and utilizing the data between departments also becomes possible.

A typical example of a database for pipeline information is the Geographic Information System (GIS), which combines pipeline information with information of road and underground facilities such as water supply system. Table B6-21igure Figure B6-18 is an example of the screen output of the sewage pipe information system combined with GIS.



Source: Nihon Suido Consultants Co., Ltd. (http://www.nissuicon.co.jp/jigyou/jousys/gis-gesui/)

Figure B6-18 An Example of Screen Output Image of Pipeline Information System

B6.2.5 Water Quality Management

Table B6-34 shows the outline of water quality management carried out in the operation of sewerage systems.

Table B6-34 Water Quality Management Carried out in the Operation of Sewerage Systems

Category	Tasks
Water quality management plan	・ Setting water quality management targets ・ Setting items of water quality and sludge examinations ・ Formulation of operation management plan ・ Monitoring of operating conditions
Daily examination of water quality and sludge	・ Confirmation that effluent quality meets legal standards ・ Confirmation that the effluent quality meets the "required level" of the contract ・ Collection of data necessary for process operation ・ Confirmation that sludge quality meets the standards for disposal and utilization
Examination of wastewater from factories	・ Confirmation that the quality meets the standards
Recording and analysis of examination data, and submission of reports	・ Preparation of daily, monthly, and annual reports and submission to supervisory authorities ・ Utilization of data analysis results in process operation
Maintenance and calibration of equipment	・ Inspection and calibration of laboratory equipment and portable measuring equipment ・ Inspection and calibration of on-line monitoring equipment
Storage and management of chemical reagents	・ Storage of chemical substances and dangerous substances (locking, usage records) ・ Proper management of liquid and solid waste

Source: JET

(1) Water Quality Management Plan

Water quality management plan sets the water quality management target, which is the required effluent quality to achieve the target of water quality and ecological environment of the public water body where treated sewage is discharged, and proposes the measure to achieve the target.

Water quality management targets in Japan are generally set based on the permissible discharge load to achieve the environmental standards set for the receiving water body. In the case of Pokhara City, it is assumed that the treated sewage will be discharged to rivers such as the Seti Gandaki River, for which environmental standards have not been set. For this reason, the water quality target is set as a target for process operation necessary to comply with the water quality standards imposed by law. The water quality of effluent fluctuates under the influence of volume and water quality of influent, weather, etc. In order to ensure stable effluent quality and not to exceed the standard value, it is necessary to set the target stricter than the legal standard. When outsourcing the O&M to contractors, the effluent quality set as a "required level" should correspond to this target.

In addition to the standard items stipulated by law, select items of water quality and sludge tests necessary for operation management should be determined. In order to accurately grasp operation conditions, it is important to conduct monitoring at appropriate locations and frequencies. In addition, real-time online monitoring linked to the operation management system which contributes to automatic operation is to be considered. Table B6-35 shows examples of items required for operation management, and Table B6-36 shows examples of indicators for process operation. Since the test items differ depending on the water and sludge treatment process, the items for conventional activated sludge process are listed as an example.

Table B6-35 Examples of Items Required for Operation Management

Category	Items of Examination
Influent	Flow rate, pH, appearance (color, turbidity, oil film), smell, etc.
Water treatment	Flow rate, temperature, transparency, pH, alkalinity, SS (TSS), BOD, COD, NH_4^+ SV, SVI, MLSS, MLVSS, MLDO, Biota in activated sludge, etc.
Sludge treatment	Temperature, pH, TS, VTS, alkalinity, crude fiber Contents in supernatant (SS, BOD, COD, nitrogen) Water content in dewatered sludge, etc.
Effluent	pH, SS, turbidity, BOD, COD, residual chlorine, E. coli (Coliform group)

Source: JET

Table B6-36 Examples of Indicators for Process Operation

Process	Indicators
Water treatment	Flow rate (Pump flow rate) Sedimentation tank surface load, HRT, MLSS, BOD-SS Load, MLDO, supplied air flow rate Amount of excess sludge, SRT, A-SRT, return sludge flow rate, sludge-liquid interface in sedimentation tank
Sludge treatment	Sludge flow rate, coagulant dosage rate Centrifuge, differential rate (for centrifugal dehydrator) Screw revolution rate, sludge injection pressure, presser pressure (for screw press dehydrator)

Source: JET

(2) Organizing, Analyzing of Data and Preparing Reports

Data related to water quality management is organized, analyzed, and reported regularly. Reports are generally arranged in the form of daily, weekly, monthly, and annual reports.

Daily reports are mainly intended to record daily water quality and operation management data and activities, and to share them within the group. Weekly reports are a compilation of daily reports and are used at weekly meetings to share information between groups (for example, laboratory staff and operation staff). Monthly and annual reports are created to share the operation management status, activities, and results of the entire entity with the management within the department and the upper organizations.

In addition, it is desirable to summarize the monthly and annual reports concisely and disclose to the public.

B6.2.6 Environment Management

While the sewerage system functions to protect the living environment and the water environment, the WWTPs and pumping stations generate odors, air pollution, noise, and vibration as a result of the facility operation. Therefore, it is necessary to take appropriate measures to preserve the living environment of the surrounding residents and the working environment in the facility. Appropriate measures must also be taken to properly treat and dispose of waste such as sludge generated through the operation, and to control greenhouse gases generated in sewerage facilities and by energy consumption. Table B6-37 shows the major environmental management activities. Working environment in the facility is described in “Safety, Health, and Crisis Management”.

Table B6-37 Major Environmental Management Works

Category	Activity
Surrounding living environment	・ Countermeasures against sources of odor, air pollution, noise, and vibration ・ Surrounding environment monitoring
Environment of water body where treated water is discharged	・ Water quality survey ・ Sediment survey and biological survey
Sludge and other waste management	・ Reduction and utilization of sludge ・ Examination of waste (hazardous contents) ・ Appropriate treatment and disposal of waste ・ Monitoring at the disposal site (if necessary)
Reduction of greenhouse gas (GHG) emissions	・ Use of energy-efficient equipment ・ Use of renewable energy ・ Proper operation of equipment

Source: JET

(1) Surrounding Living Environment

Against odor, air pollution, noise and vibration generated in WWTPs, it is effective to cover the facility to prevent free dispersion and to deodorize the odor before release. Nepal has environmental standards

for air pollution and noise. So, it is recommended to confirm the regional division of the standards on the exhaust gas from incinerators and power generators, noise from blowers, etc., and take measures if necessary.

Although Nepal does not have environmental standards for odors, odors from WWTPs, pumping stations, manholes, etc. not only damage the surrounding living environment, but also may lead to deterioration of the working environment within the sewage system. For this reason, it is necessary to take measures to prevent the generation and leakage of odors, and to carry out periodic monitoring; preferably sensory tests and measuring the concentration of odorants.

Table B6-38 Standards on Surrounding Living Environment

Category	Standard
Environmental standard on air pollution	National Ambient Air Quality Standards for Nepal, 2012
Environmental standard on noise	National Ambient Sound Quality Standard 2012
Standard on exhaust gas from newly installed diesel power generator	Nepal Gazette Notification by Ministry of Environment, Science and Technology 2069/07/13 (2012)

Source: JET

(2) Environment of Water Body where Treated Water is Discharged

The sewage system contributes to conserve the water environment of the public water body by reducing the water pollution load. However, the discharge of treated water may have an impact on the water area close to the discharge point. For this reason, it is desirable that the sewerage department is held responsible for conducting monitoring as a discharger. Table B6-39 shows the recommended monitoring contents.

Monitoring should be conducted continuously from before the start of discharge. In addition, monitoring points should be placed at appropriate locations upstream and downstream of the discharge point, taking into consideration the range affected by the discharge.

Table B6-39 Recommended Monitoring Contents

Monitoring	Items	Frequency
Water quality	Flow rate, temperature, transparency, appearance, smell pH, electric conductivity (EC), SS, BOD (COD), NH_4	4 times per year Day not affected by rainfall Include dry season
Sediment	Ignition loss, heavy metals	Once per year
Living thing	Aquatic plants	2 times per year (Spring, Summer

Source: JET

(3) Waste management including waste sludge

The treatment and disposal of waste (sewage sludge, screenings, etc.) generated from sewerage system is a serious problem not only in developing countries. Table B6-40 shows the major waste generated in the operation of sewerage systems.

Table B6-40 Waste generated by the operation of sewerage systems

Facility	Waste generated
Pipeline	Sludge and residue generated when cleaning pipes
Pumping station	Sediments in grit chamber, screenings
WWTP	Screenings, grit, sludge (raw sludge, excess sludge), waste materials generated from repairs, chemicals and equipment used in laboratories, disposable protective equipment (PPE), domestic (non-industrial) waste generated from business activities such as paper

Source: JET

Of these wastes listed in Table B6-40, the handling of the sewage sludge may become a serious problem for the sustainable management of sewerage systems. Sewage sludge is generally subjected to processes of volume reduction (concentration, dehydration), stabilization (digestion, incineration), and finally

landfill disposal. Instead of landfilling, sewage sludge has value as "biomass" and is being used effectively in various ways. An example of the sludge utilization method in Nepal is composting at the Kathmandu Guheshwori WWTP, which is carried out by a contract with private sector.

In Pokhara city, solid waste is dumped at a sanitary landfill site. So, the sludge will most likely be dumped there. However, the lack of landfill sites is a serious problem in many cities in developing countries. It is necessary to have sufficient consultation with the department in charge of waste management. In addition, in order to avoid the risk of the landfill being stopped for some reason, alternative methods such as composting must be considered. Pokhara City has a composting facility, but it is not currently in operation, and only faecal sludge from household septic tanks is dumped. It is necessary to investigate the cause and, if necessary, add dewatering, drying (sun drying bed), etc.

(4) Reduction of Greenhouse Gas (GHG) Emissions

In the sewage treatment process, greenhouse gases are generated in various activities, such as the operation of facilities, the use of electricity and fuel, and the treatment and disposal of sludge. Examples of the activities are shown in Table B6-41.

Table B6-41 Example of Greenhouse Gas Generation in Sewage Treatment

Source	Greenhouse Gas	Activity
Emissions associated with consumption of energy such as electricity and fuel (oil, gas)	CO_2	・ Use of fuel ・ Use of electricity and heat supplied from other sources
	CH_4	・ Use of gas/gasoline engines, etc. ・ Driving of automobiles
	N_2O	・ Use of fuel in gas/gasoline engines, etc. ・ Driving of automobiles
Emissions from treatment process	CH_4	・ Sewage treatment ・ Landfill disposal of sewage sludge
	N_2O	・ Sewage treatment ・ Incineration of industrial waste (sludge)
Emission associated with consumption water and chemicals	CO_2	・ Consumption of tap water, industrial water, and chemicals

Source: Edited by JET based on "Guideline for developing global warming prevention promotion plans for sewerage systems (March 2009, Ministry of Land, Infrastructure, Transport and Tourism)"

Among the activities shown in Table B6-41, the emissions from treatment process should be noted when considering the treatment process and operation in Pokhara City. Table B6-42 shows examples of major energy saving measures introduced at WWTPs in Japan. The use of fuel and electricity accounts for a large proportion of the operation cost, it is also important for cost reduction measures.

Table B6-42 Examples of Major Energy Saving Measures

Facility	Sub-category	Measures for Energy Saving
Pretreatment	Grit chamber	・ Intermittent operation of grit chamber equipment
	Pump	・ Inverter control
Water treatment	Sedimentation tank	・ Control by the number of primary sedimentation tank (set by water surface load) ・ Optimization of return sludge flow rate ・ Inverter control of return sludge pump
	Reaction tank (aeration tank)	・ Reduction of airflow rate by introduction of ultra-fine bubble diffuser ・ Optimization of aeration by feedback control with DO or NH^{4+} monitoring ・ Optimization of aeration by installing of air volume control valve to the reaction tank ・ Optimization of MLSS (SRT)

Facility	Sub-category	Measures for Energy Saving
		・ Use of energy-efficient equipment, such as submersible agitator ・ Improvement of operating method
Common facility	Air conditioner	・ Intermittent operation of air supply/discharge fan ・ Adequate temperature settings
	Lighting	・ Conscientiously turning off the lights
Others	Electric meter	・ Understand the power consumption of each facility to consider countermeasures

Source: JET

B6.2.7 Safety, Health and Risk Management

(1) Occupation Safety and Health Management System (OSHMS)

The Labour Act of Nepal (Labour Act, 2074 (2017)) has provisions related to occupational safety and health management at WWTPs, etc., as shown in Table B6-43.

In addition, Table B6-44 shows the measures to be taken to ensure the safety and health of workers engaged in sewage works and third parties based on the provisions of the Labor Law and Japanese cases. The contents shown in Table B6-44 are measures that can be implemented and should be implemented from the initial stage of the sewerage operation, considering the current situation in Nepal and Pokhara City.

Table B6-43 Provisions of the Labour Act, 2074 (2017) Related to Sewerage System Operation

Provision	Description
Safety and health policy	・ The employer shall formulate and implement a policy on safety and health of the laborers and other persons at the workplace.
Safety and health committee	・ The employer shall form such a safety and health committee with representation of the laborers. ・ The committee shall give advice to the employer regularly on the arrangement on safety and health required to be made in the workplace and on making such an arrangement effective. ・ The committee shall evaluate the arrangement on safety and health made in the workplace and draw the attention of the employer for making such an arrangement more effective.
Duties of employer towards laborer	・ The employer shall make safe environment for work by making appropriate safety and health arrangements at the workplace. ・ The employer shall make provision for the use, operation, storing and transportation of chemical, physical or biological materials or equipment so that it would not adversely affect the safety and health. ・ The employer shall provide necessary information, notice and training relating to the safety and health to the laborer, as required.
Duties of employer towards non-laborer	・ The employer shall make such provision as may be necessary to avoid any adverse effect on the safety and health of any non-laborer who walks in and out of, or passes through, the workplace. ・ Any enterprise that uses or manufactures chemical materials shall so manage that the chemical substance, gas or any other thing emitting during the operation of its business does not cause any adverse effect on the local animals, vegetation, human beings and environment
Duties of the responsible person	・ "Responsible person" means any person who has the ownership or control over the workplace, equipment, product or material, and this term also includes any person or organization assigned with the ownership or control in accordance with the agreement. ・ It shall be the duty of the responsible person to ensure whether any workplace, equipment, product, or material is safe and healthy for the concerned work.

Source: Edited by JET based The Labour Act, 2074 (2017)

Table B6-44 Measures to be Implemented to Ensure Safety and Health

Category	Measures
Organizational system for safety and health	・ Formulation of health and safety policy ・ Establishment of Safety and Health Committee

Category	Measures
	・ Assignment of responsible person for health and safety
Safety and health system	・ Preparing a safe work manual ・ Preparing safety and health equipment ・ Restrictions on operations (limiting workers to qualified personnel, etc.)
Safety and health arrangements at the workplace	・ Hazardous area indication ・ Restriction on entry of access-limited area ・ Installation of handrails, safety stairs, safety passages, etc. ・ Appropriate management of chemicals, etc. ・ Monitoring of workplace environment ・ Employee medical checkup
Safety of non-laborers	・ Restrictions for non-laborer on entry to facilities ・ Inspection of road subsidence risk points ・ Use of manhole covers with locks to prevent lifting and slipping off
Safety and health education and training	・ Education and training on health and safety ・ Sharing near-miss incident cases ・ KY (hazard prediction) activities
Accident response	・ Preparing accident response manual ・ Preparing BCP (Business Continuity Plan) ・ Establishing emergency contact system

Source: JET

B6.2.8 Monitoring of Status and Performance of the Operation

KPI (Key Performance Indicator) is a method used for evaluating the operation status of sewerage system operation and monitoring the achievement status of required standards in PFI, DBO, etc. In sewerage system operation, attempts are being made to improve operations through the PDCA cycle with KPI as an indicator. However, in Pokhara City, facilities will be constructed in the future and the project implementation system is being developed. For the cities like Pokhara City, it may be effective to adopt a method called OODA (Observe, Orient, Decide, Act), in which necessary measures are taken promptly based on a recognition of the current situation, rather than conducting regular operational evaluations.

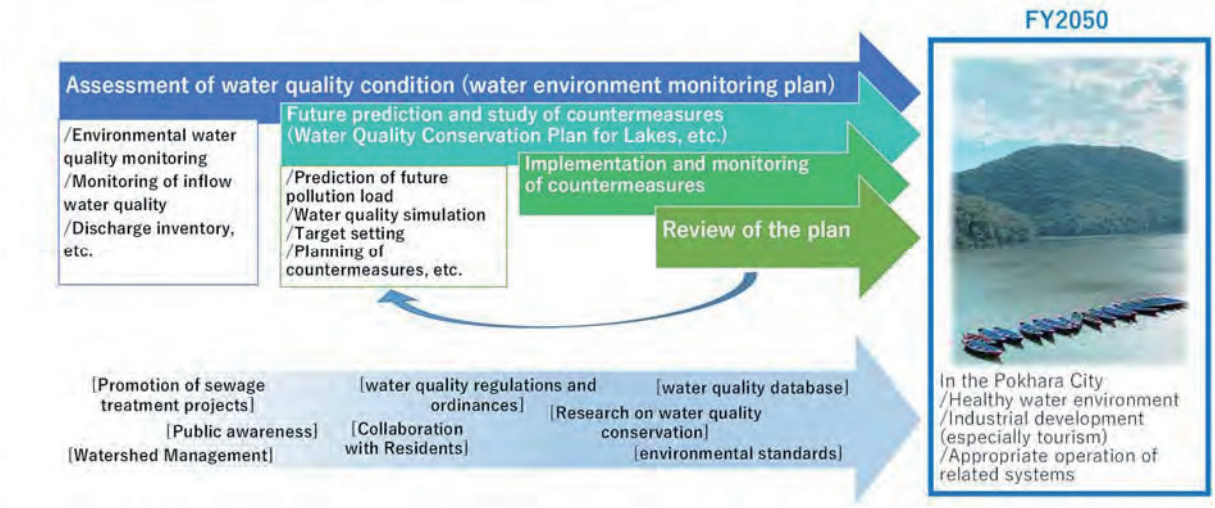
The check sheet shown in Appendix-11 was created by JET based on CMOM (Capacity, Management, Operations, and Maintenance), a self-assessment method for sewage pipe systems provided by USEPA. The interview surveys in Biratnagar and Kathmandu Valley introduced in this paper were conducted using this check sheet, and it is considered to be useful as a method for grasping the situation of operation also in Pokhara City.

B7 Draft Plan for the Monitoring System of Ramsar Wetlands in Pokhara City

B7.1 Purpose of Water Environment Monitoring

The Lake Cluster of Pokhara Valley including Lake Phewa which is registered with the Ramsar Convention is located in Pokhara City and water environment management is an urgent task for biodiversity conservation and protection of tourism resources. However, there is currently a lack of information on water quality, which is necessary for taking effective measures for water environment conservation, and even the Gandaki Province and PMC, which are in charge of environmental administration, have not yet grasped the actual situation of water quality conservation. Therefore, the PMC will develop a water environment monitoring plan (hereinafter referred to as the "Monitoring Plan") in order to continuously and systematically monitor water quality in Pokhara City, with a view to formulating a water quality conservation plan for lakes and marshes, including an understanding of environmental water quality and measures to prevent and improve water pollution. In addition to the development and implementation of the plan on water quality protection, the PMC will promote sewage treatment projects and other related activities, aiming for a healthy water environment, industrial

development (especially tourism), and appropriate operation of related systems in Pokhara City by 2050 as a role model of water quality protection administration in Nepal (see Figure B7-1).



Source: JET

Figure B7-1 Roadmap of Efforts for Water Quality Protection in Pokhara City (Draft)

The purpose of the Monitoring Plan is to control environmental water quality and monitor wastewater discharged in Pokhara City.

[Purpose of water environment monitoring plan]

- To continuously grasp the condition of environmental water quality (rivers, lakes, and groundwater) in Pokhara City with monitoring.
- To grasp changes over time in the water quality of Lake Phewa by continuously observing and recording the water quality of Lake Phewa and rivers (rivers, canals, drainage, ditches, and groundwater) that flow into Lake Phewa.
- To control wastewater discharged in the Pokhara watershed and to monitor wastewater discharged by dischargers that flow into Lake Phewa and rivers, etc. in order to reduce the total pollution load entering Lake Phewa.

B7.2 Outline of the Plan

The Monitoring Plan covers the entire city of Pokhara, and aims to monitor the environmental water quality in the city's rivers and streams, with a focus on Lake Phewa. In order to implement the plan, which is the water environment monitoring in Pokhara City, a new Water Environment team (hereinafter referred to as the "Monitoring Team") will be established in the PMC, as it is required to be implemented by an organization specializing in water quality conservation. The FWSSMP will be in charge of the analysis of monitoring items (Refer to Table B7-1).

Although Lake Phewa is registered as a Ramsar wetland, monitoring of the water environment has not been conducted in Pokhara City, and since this is a new challenges for the PMC, a realistic and effective plan will be developed with target years in the medium and long term. In addition, the Monitoring Plan will be developed in accordance with the characteristics of the monitoring water to be covered.

Table B7-1 Summary of the Monitoring Plan

Item	Description
Target area	All of Pokhara City (especially Lake Phewa and river, groundwater, drainage flow into Lake Phewa)
Implementation agency	Pokhara Metropolitan City (PMC) FWSSMP
Target period	2023 to 2050 Target year of mid-term plan: 2030 Target year of long-term plan: 2050
Target water quality	Ambient environment: lake water, river water (including water in canals, drainage, side ditches), groundwater Business wastewater: wastewater that flow into Lake Phewa and rivers etc. from discharging business (hotels, factories, businesses, sewage etc.) Domestic wastewater: effluent discharged from sewage system and on-site treatment of household

Source: JET

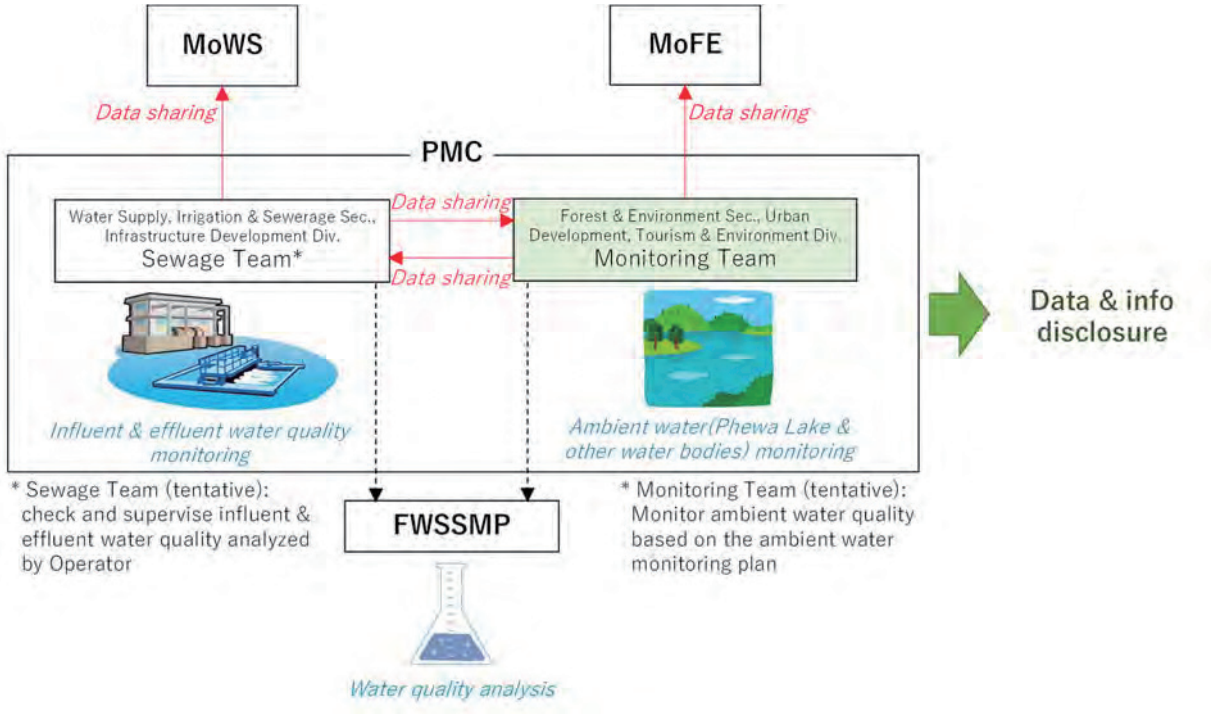
B7.3 Implementation Structure and Roles for Plan

The PMC is the central organization for implementation of the Monitoring Plan, various related organizations is involved with implementation of the Monitoring Plan with their respective roles. The roles and responsibilities of each related organization in the Monitoring Plan are shown in Table B7-2 and Figure B7-2.

Table B7-2 Roles and Responsibilities of Each Related Organization in the Monitoring Plan

Related Organization	Roles and Responsibilities
PMC Water Environment, Monitoring Section, Urban Development, Tourism & Environment Division	➢ Water quality surveys in ambient environment for monitoring is conducted in Lake Phewa and rivers etc in Pokhara City in accordance with the Monitoring Plan. ➢ The results of water quality surveys of wastewater discharged by the discharging business in accordance with their own management plans is collected and managed. ➢ Wastewater discharged by discharging business (including sewage) is inspected, if necessary.
PMC Sewage Team	➢ Effluent discharged from sewage is observed. ➢ Effluent discharged from on-site treatment facilities is monitored.
FWSSMP	➢ Water quality of wastewater is analyzed.
MOFE	➢ The record of water quality results in the entire country is centrally stored by sharing data of water quality conducted in Lake Phewa and rivers in Pokhara City, etc..
MOWS	➢ From the perspective of proper operation and management of sewage, by sharing data of the water quality of effluent treated, the record of wastewater treatment by sewage is centrally stored throughout the country.

Source: JET



Source: JET

Figure B7-2 Water Environment Monitoring System in the Pokhara Basin (Draft) (Mid-term Plan Target Year 2030)

In addition to that, after 2030, the Water Environment Conservation Council will be established by adding related organizations, businesses, and residents' groups to the above structure, and will promote that the public and private sectors work together for water quality elutriation and environmental conservation in the Pokhara Basin.

B7.4 Monitoring Plan

As indicated in the purpose, the Monitoring Plan will be developed and implemented for each of the main factors such as ambient environment, industrial wastewater and domestic wastewater in order to monitor environmental water quality in Pokhara City.

Table B7-3 Composition of the Monitoring Plan

Plan	Target	Implementation Organization	Monitoring Contents
Environmental Water Quality Monitoring Plan	Ambient environment	Monitoring Team (tentative)	➢ Environmental water quality monitoring is continuously implemented at monitoring points in Pokhara City.
Wastewater Inspection Plan	Business wastewater Domestic wastewater	Monitoring Team (tentative)	➢ Wastewater from discharging business (hotels, factories, businesses, sewage, etc.) that flow into Lake Phewa and rivers, etc is inspected.

Source: JET

B7.4.1 Environmental Water Quality Monitoring Plan

(1) Outline of Environmental Water Quality Monitoring Plan

The Environmental Water Quality Monitoring Plan is a continuous monitoring program for lakes, rivers, drainage and groundwater in the Pokhara City, in order to grasp the water quality condition of water bodies in the city.

This plan is divided into three phases, the establishment of monitoring system for Lake Phewa and its

surrounding area, as an area of high importance is high priority, and the target area will be expanded to cover the entire city by 2030, the target year of the mid-term plan. In addition to that, by 2050, the target year of the long-term plan, a monitoring system will be established to grasp the condition of water quality conservation using numerical data obtained by automatic monitoring or water quality measurement by sampling for all monitoring items specified in the entire Pokhara City. The basic points of the Environmental Water Quality Monitoring Plan are shown in Table B7-4.

Table B7-4 Basic points of Environmental Water Quality Monitoring Plan

Item	Description
Target area	All of Pokhara City (especially Lake Phewa, and river, groundwater and drainage flow into Lake Phewa)
Implementation agency	Executing agency (including sampling): Monitoring Team (PMC) Analysis agency: FWSSMP
Water quality of monitoring target	Lake water, river water, groundwater (shallow and deep), others (wastewater of drainage etc.)
Other	Implementation period: The Environmental Water Quality Monitoring Plan will be developed in phases. Phase 1: July 2023 to June 2026 (3 years) Phase 2: July 2026 to June 2030 (4 years) Phase 3: July 2030 onward to 2050

Source: JET

(2) Basic Policy for Establishing a Monitoring System for Environmental Water Quality

The basic policies for each phase of establishing a monitoring system for environmental water quality are shown below.

1) Basic Policy for the Monitoring System to be Established in Phase 1 (by 2026)

- To establish an organization (including sampling and analysis) capable of conducting environmental water quality monitoring in rivers, lakes, etc. in Pokhara City.
- To establish a monitoring system of environmental water quality in Lake Phewa and surrounding areas where water pollution is increasing.
- To monitor environmental water quality of surface water at 5 (five) points in Lake Phewa.
- To monitor environmental water quality of rivers in the Harpan and Frike rivers that flow into Lake Phewa, and in the Seti and Furse rivers that pass through the urban area.
- To monitor environmental water quality of drainage in 3 (three) drainage that flow into Lake Phewa.
- To monitor environmental water quality of groundwater at 4 (four) groundwater monitoring wells (shallow) in the upstream area of the lake, around the lake, and in the downstream area of the lake, which is newly installed for monitoring of water quality condition in Lake Phewa.
- To monitor environmental water quality of groundwater at 5 (five) groundwater monitoring wells which is used for drinking water and mainly existing in the urban area.

2) Basic Policy for the Monitoring System to be Established in Phase 2 (by 2030)

- To establish a monitoring system of environmental water quality in the entire city of Pokhara.
- To monitor environmental water quality of surface water at 10 points in Lake Phewa.
- To monitor environmental water quality of rivers in the vicinity of the treatment facilities in addition to the four rivers flowing into Lake Phewa.
- To monitor environmental water quality of drainage in 5 (five) drainage in total that flow into rivers, in addition to that flow into Lake Phewa.
- To monitor environmental water quality of groundwater at 8 (eight) groundwater monitoring wells (shallow) in the upstream area of the lake, around the lake, and in the downstream area of the lake, 4 of which is newly installed in Phase 2 for monitoring of water quality condition in Lake Phewa.

- To monitor environmental water quality of groundwater at 10 (ten) groundwater monitoring wells in total, which is used for drinking water, 5 of which is mainly existing in the urban area and 5 of which is in densely populated residential areas as additional area.

3) Basic Policy for the Monitoring System to be Established in Phase 3 (by 2050)

- To maintain a monitoring system that can monitor the condition of water quality conservation in entire Pokhara City by verifying the effectiveness of points, frequency and items of environmental water quality monitoring.
- To install an automatic monitoring system to continuously collect data on field measurement items (water temperature, pH, EC, and DO) in order to strengthen and streamline the implementation of environmental water quality monitoring in entire Pokhara City.
- To establish a system to collect data by depth at monitoring points in Lake Phewa.

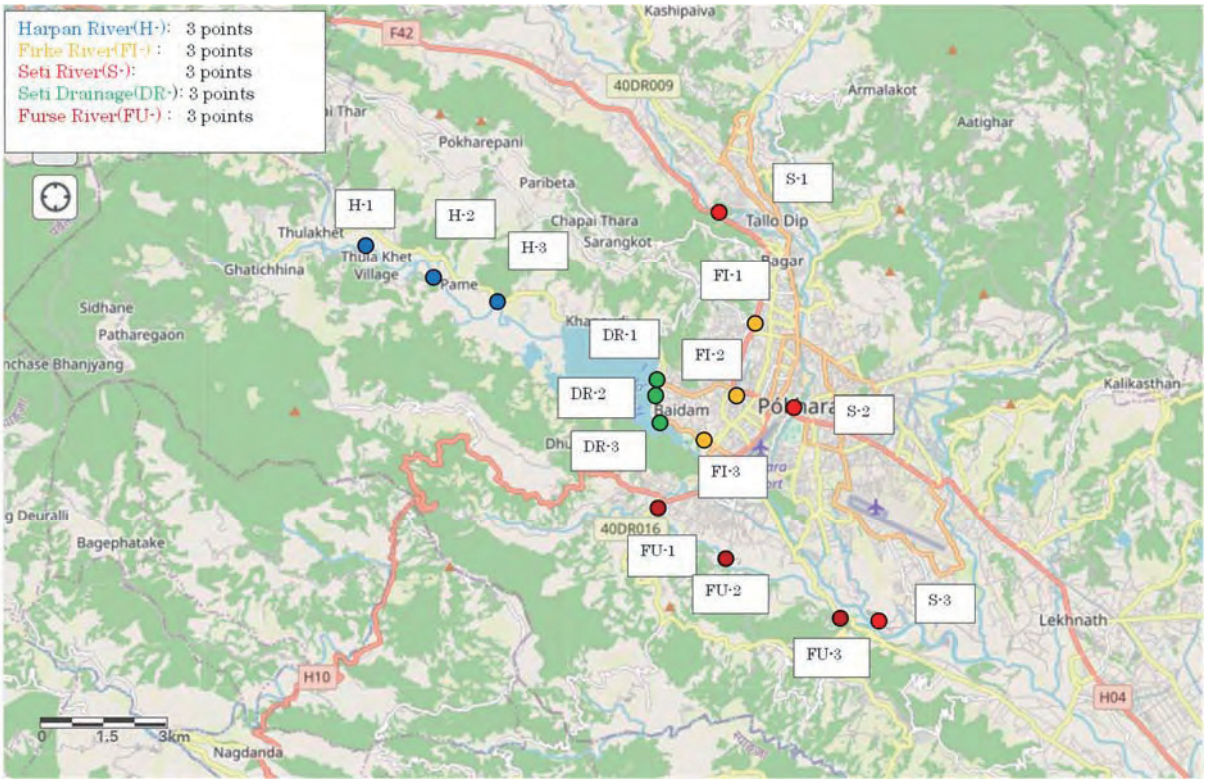
B7.4.2 Implementation Plan on Environmental Water Quality Monitoring

The implementation plan on environmental water quality monitoring is shown in Table B7-5.

Table B7-5 Summary of Implementation Plan on Environmental Water Quality Monitoring

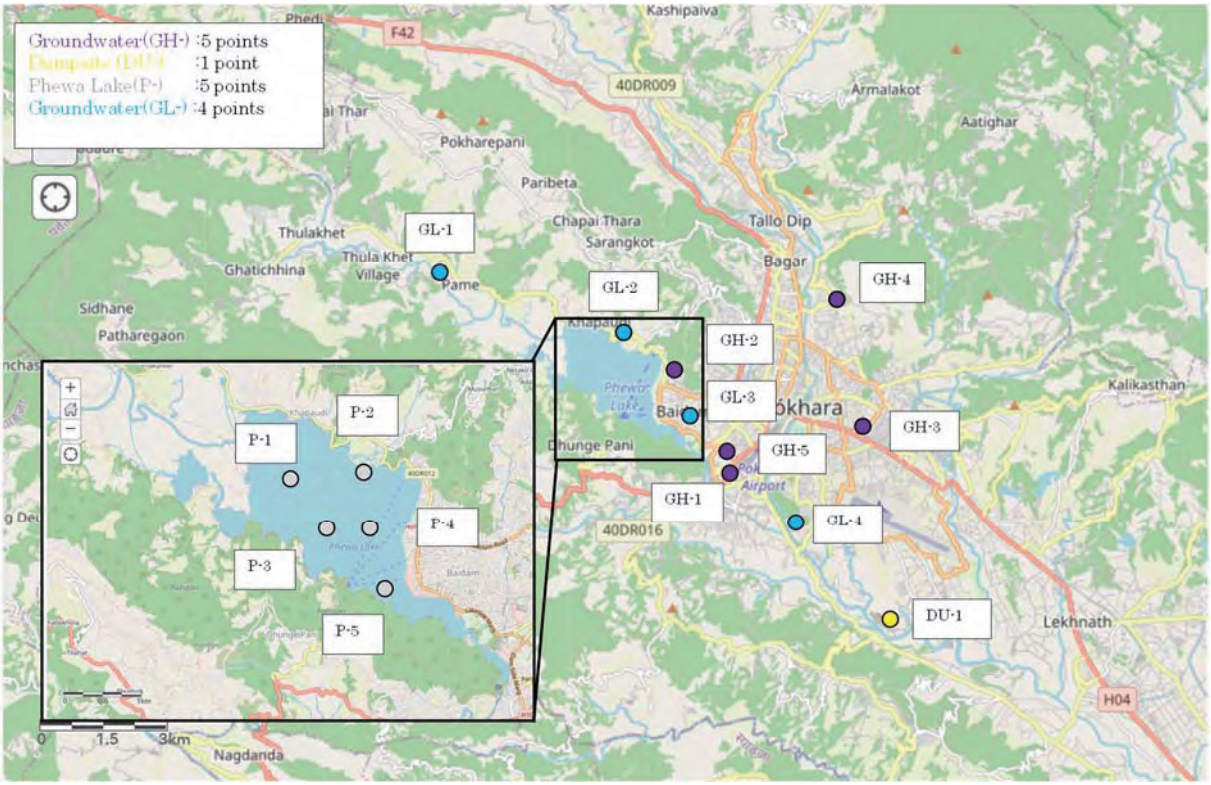
Item	Phase 1 (2023/7~2026/6)	Phase 2 (2026/7~2030/6)	Phase 3 (2030/7~2050)
Monitoring target	Lake Phewa and river, drainage, groundwater		
Monitoring point	Lake Phewa : 5 points Rivers (Harpan River, Firke River, Seti River, Furse River): 12 points (3 points/1 river) Drainage: 3 points (1 point / 1 drainage) Groundwater (shallow): 4 points (1 point on the upstream side, 2 points around the lake, 1 point on the downstream side of the urban area) Groundwater (deep): 5 points (urban area)	Lake Phewa : 10 points Rivers (Harpan River, Firke River, Seti River, Furse River): Same as on the left River (around treatment facilities): 8 points (2 points/1 facility) Drainage: 5 points (1 point/1 drainage) Groundwater (shallow): 8 points (2 points on the upstream side, 4 points around the lake, 2 points on the downstream side of urban area) Groundwater (deep): 10 points (urban area)	Lake Phewa: 10 points Other lakes: 16 points (2 points/1 lake) Rivers (all rivers in the city): 30 points Rivers (around treatment facilities): 8 points (2 points/1 facility) Drainage canals: Same as on the left Groundwater: Same as on the left
Monitoring frequency	Lake Phewa, rivers, etc.: 1 time/month (2nd week of each month)		
Monitoring item	Field measurement items (4 items): water temperature, pH, EC, DO Instrumental analysis items (6 items): TSS, BOD, COD, T-N, T-P, E.Coli	Field measurement items (4 items): water temperature, pH, EC, DO Instrumental analysis items (6 items): TSS, BOD, COD, T-N, T-P, E.Coli	Field measurement items (4 items): water temperature, pH, EC, DO Instrumental analysis items: All items covered if specified by MoFE

Note: For new groundwater monitoring wells to be installed, the appropriate depth for monitoring as well as the location will be considered.
Source: JET



Source: JET

Figure B7-3 Monitoring Points (Rivers) in the Environmental Water quality Monitoring Plan (Phase 1) (Draft)



Source: JET

Figure B7-4 Monitoring Points (Lakes, Groundwater) in the Environmental Water Quality Monitoring Plan (Phase 1) (Draft)

B7.5 Wastewater Inspection Plan

B7.5.1 Outline of Wastewater Inspection Plan

The Wastewater Inspection Plan aims to examine the contamination situation of wastewater from business entities such as hotels, restaurants, factories, offices, and to inspect wastewater from wastewater facilities in Pokhara City that flow into Lake Phewa and rivers as appropriate. The basic points of Wastewater Inspection Plan are shown in Table B7-6.

Table B7-6 Basic points of Wastewater Inspection Plan

Item	Description
Target area	Wastewater facilities in Pokhara City (hotels, restaurants, factories, businesses, schools, hospitals, sewerage, etc.)
Implementation agency	Executing agency (including sampling): Monitoring Team (PMC) Analysis agency: FWSSMP
Water quality of monitoring target	Wastewater from discharging businesses (hotels, restaurants, factories, offices, sewers, etc.) that flow into Lake Phewa and rivers, etc.
Other	Implementation period: The Wastewater Inspection Plan will be developed in phases. Phase 1: July 2023 to June 2026 (3 years) Phase 2: July 2026 to June 2030 (4 years) Phase 3: July 2030 onward to 2050

Source: JET

B7.5.2 Basic Policy for Establishing an Implementation Structure for Wastewater Inspection

The basic policies for each phase of establishing an implementation structure for wastewater inspection are shown below.

1) Basic Policy for the Implementation Structure to be Established in Phase 1 (by 2026)

- To establish an organization (including sampling and analysis) capable of inspecting the quality of effluent water discharged from wastewater facilities.
- To develop an inventory of wastewater facilities in Pokhara City, and to establish an inspection system based on criteria for wastewater facilities to be inspected.
- To conduct wastewater inspections targeting wastewater facilities in Lake Phewa and surrounding areas where water pollution is increasing.
- To conduct inspections for basic items at wastewater facilities (2 facilities/month) that facilities are large in scale and there are concern about the impact on water pollution.

2) Basic Policy for the Implementation Structure to be Established in Phase 2 (by 2030)

- To conduct wastewater inspections targeting wastewater facilities in Pokhara City.
- To conduct inspections for effluent standard items at wastewater facilities (5 facilities/month) where there is concern about the impact on water pollution.

(2) Basic Policy for the Implementation Structure to be Established in Phase 3 (by 2050)

- To conduct wastewater inspections at wastewater facilities subject to effluent standards in Pokhara City.

B7.5.3 Implementation plan on Wastewater Inspection

The implementation plan on wastewater inspection is shown in Table B7-7.

Table B7-7 Summary of Implementation Plan on Wastewater Inspection

Item	Phase 1 (2023/7~2026/6)	Phase 2 (2026/7~2030/6)	Phase 3 (030/7~2050)
Monitoring target	Wastewater facilities (hotels, factories, etc.)		
Monitoring point	Outlet of wastewater facility (effluent water outlet)		
Monitoring frequency	Wastewater facilities: 2 facilities/month (per year: approx. 20 facilities)	Wastewater facilities: 5 facilities/month (per year: approx. 50 facilities)	Wastewater facilities: 10 facilities/month (per year: approx. 100 facilities)
Monitoring item	Field measurement items (6 items): water temperature, pH, EC, DO, TDS, turbidity Instrumental analysis items (6 items): TSS, BOD, COD, T-N, T-P, E.Coli	Effluent standard items	Effluent standard items

Source: JET

B7.6 Equipment Procurement Plan

The analysis in Table B7-8 is required in implementing the Environmental Water Quality Monitoring Plan and the Wastewater Inspection Plan.

Table B7-8 Summary of Water Quality Analysis

Plan	Analysis Item
Environmental Water Quality Monitoring Plan	Field measurement items (4 items): water temperature, pH, EC, DO Instrumental analysis items (6 items): TSS, BOD, COD, T-N, T-P, E.Coli
Wastewater Inspection Plan.	Field measurement items (6 items): water temperature, pH, EC, DO, TDS, turbidity Instrumental analysis items (6 items): TSS, BOD, COD, T-N, T-P, E.Coli

Source: JET

Field measurement items will be performed by PMC and instrumental analysis items will be performed by FWSSMP. The FWSSMP already has a water quality analysis laboratory and is still capable of analyzing the above items. Based on the above, the PMC will take samples and conduct simple analysis in the field, therefore, equipment procurement will be required as shown in Table B7-9. These will be increasing in stages in accordance with the increase the quantity of targets of environmental water quality monitoring and wastewater inspection.

Table B7-9 Equipment Procurement Plan for Water Environment Improvement (Draft)

No.	Item	Equipment	Purpose of Use	Recipient Institution
1	Installation of monitoring wells	Monitoring well drilling	To install monitoring wells in the upstream side of Lake Phewa.	Monitoring Team (PMC)
2	Sampling	Water samplers for lakes (e.g. Bandone water samplers)	To be used for depth sampling at high depths such as lakes.	Monitoring Team (PMC)
		Water samplers for rivers (e.g. Hi-Rot water samplers)	To be used for depth sampling at relatively low depths, such as rivers.	Monitoring Team (PMC)
		Small pumps	To be used for groundwater sampling.	Monitoring Team (PMC)
		Water sampling bottles	To preserve water samples.	Monitoring Team (PMC)

No.	Item	Equipment	Purpose of Use	Recipient Institution
3	Analytical Equipment	Portable water quality meter	To be used for on-site measurement of water temperature, pH, EC, DO, TDS, and turbidity.	Monitoring Team (PMC)
		Pack test (BOD)	To estimate approximate values of BOD in the field.	Monitoring Team (PMC)
		Packed test (COD)	To estimate approximate values of COD in the field.	Monitoring Team (PMC)
		Pack Test (Ammonium)	To estimate approximate values of ammonia in the field.	Monitoring Team (PMC)
		Pack Test (Total Nitrogen)	To estimate approximate values of Total Nitrogen in the field.	Monitoring Team (PMC)
		Pack Test (Nitric Acid)	To estimate approximate values of Nitric Acid in the field.	Monitoring Team (PMC)
		Pack Test (Nitrite)	To estimate approximate values of Nitrite in the field.	Monitoring Team (PMC)
		Pack Test (Phosphoric Acid)	To estimate approximate values of Phosphoric Acid) in the field.	Monitoring Team (PMC)

Note: Pack tests will be conducted as necessary at the time of sampling.
Source: JET

B8 Environmental and Social Consideration

B8.1 Overview of Business Components that have Environmental and Social Impacts

The project components and environmental impacts anticipated for the project are shown in Table B8-1.

Table B8-1 Project Components for Cooperation

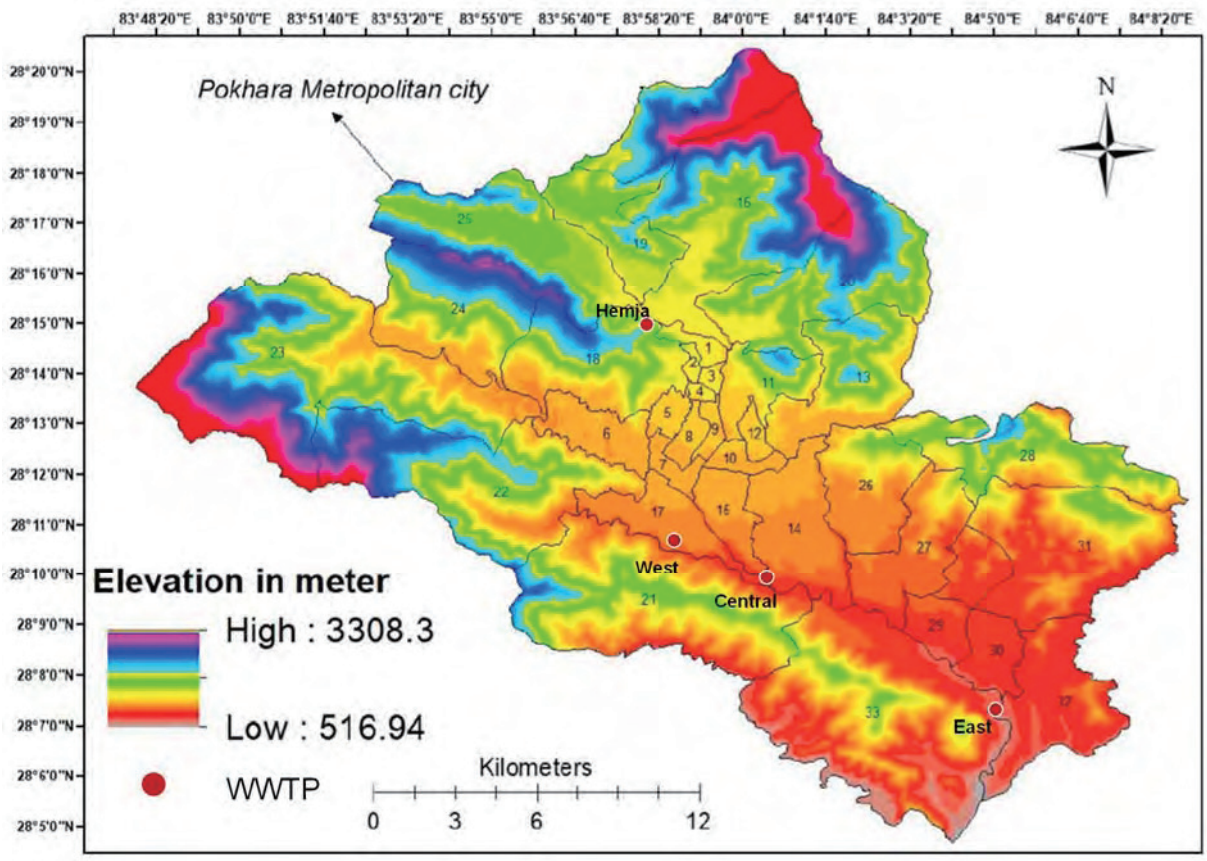
Category	Project Component	Overview
Off-site Treatment	Construction of WWTP facilities	Construction of new facilities with lands acquisitions
	Construction of pumping stations	Construction of new facilities with lands acquisitions
	Construction of sewage culverts	Installation of pipe culverts (trunk lines, sub-trunk lines, installation pipes, etc.) to be connected to the sewage treatment system
On-site Treatment	Construction of on-site treatment facilities	Installation in individual houses or small facilities: Septic tanks, septic tanks, etc.
	Construction of STP	Construction of new facilities for treatment and reuse of sludge from sludge and septic tanks with lands acquisitions

Source: JET

B8.2 Base Environmental and Social Conditions

B8.2.1 Altitude

The elevation of Pokhara City is shown in Figure B8-1, ranging from about 500 m to 3,300 m. The elevation gradually increases from the southeast side to the north and west, with the highest point in the north being 3,308.3 m.

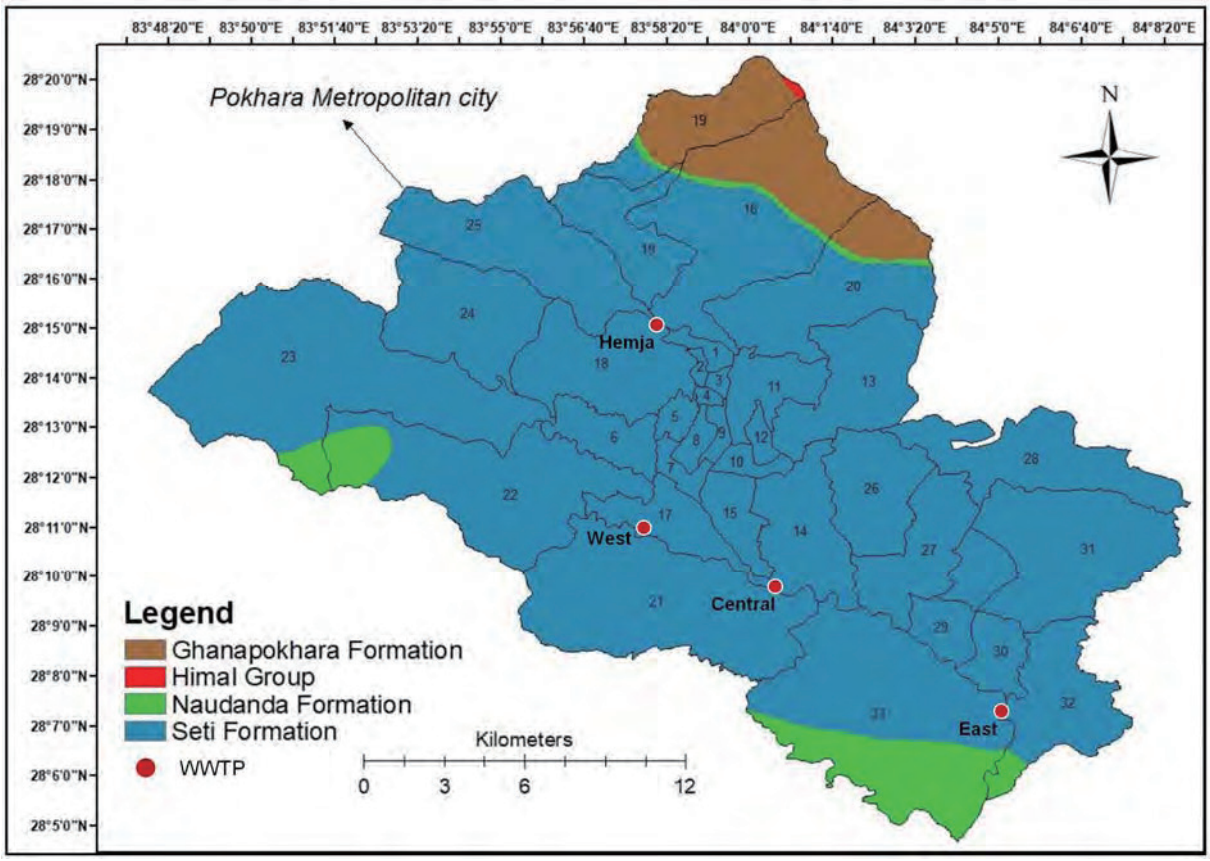


Source: Digital Elevation Model, 2021; Survey Department, 2021

Figure B8-1 Elevation Topographic Map (2021)

B8.2.2 Geology and Stratigraphy

A geologic map of Pokhara City is shown in Figure B8-2. There are four types of formations in Pokhara City: The Gana Pokhara Formation, the Himar Formation, the Naudanda Formation, and the Seti Formation, and the Seti Formation makes up the majority of the PMC. The Seti Formation is composed mainly of limestone and albite, and is prone to the formation of caves and grottoes.

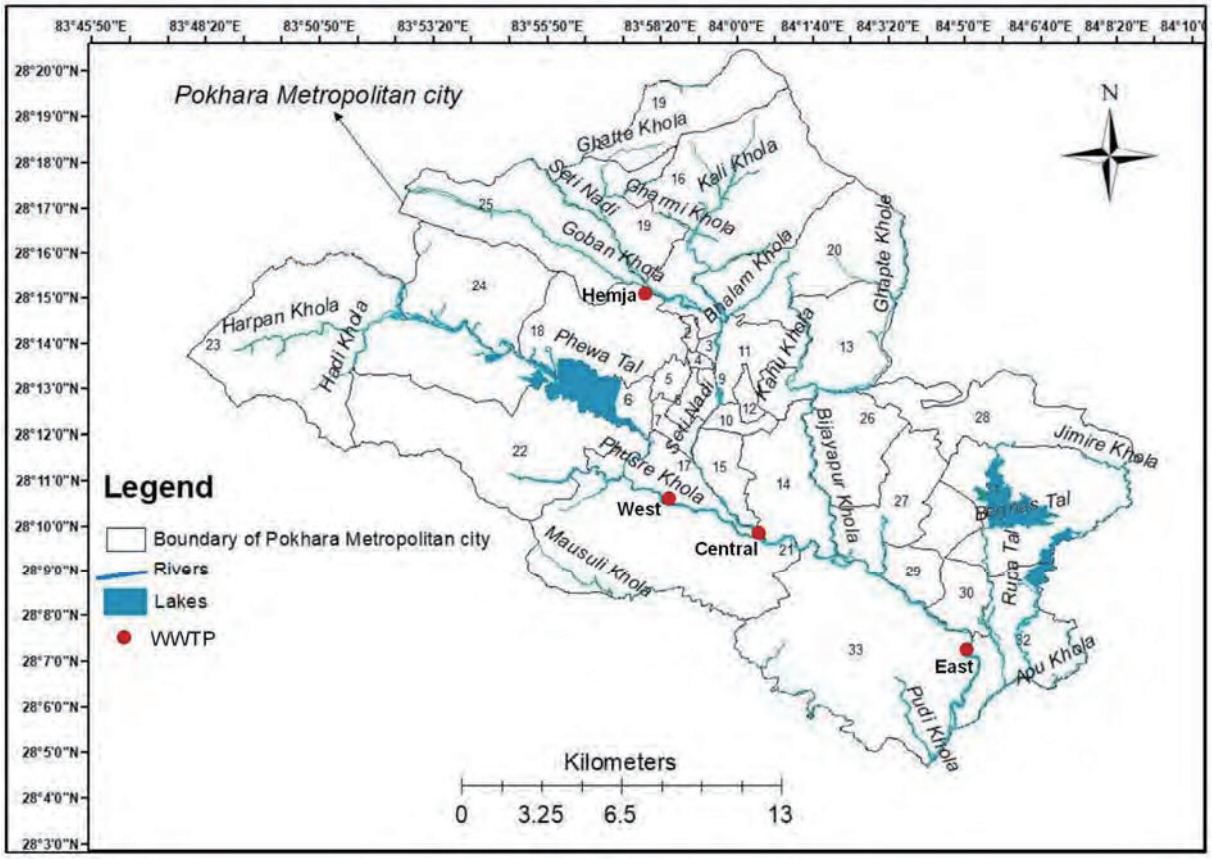


Source: Department of Mines and Geology, 1994; Survey Department, 2021

Figure B8-2 Topographic Map of Pokhara City

B8.2.3 Water Body

The locations of major rivers and lakes in Pokhara City are shown in Figure B8-3. PMC has the Seti River flowing from northwest to southeast direction. In addition, Lake Phewa, the largest lake in PMC, is located in Ward 6, and water from the Harpan River flows into Lake Phewa.



Source: Digital Elevation Model, 2021; Survey Department, 2021

Figure B8-3 Major Rivers and Lakes in Pokhara

According to the Integrated Lake Basin Management Plan of Lake Cluster of Pokhara Valley, Nepal (2018-2023), the lake area in Pokhara city has decreased over the past 20 years, with a particularly significant 4% decrease in Phewa Lake. This is due to the inflow of sediment and silt resulting from landslides and fluvial erosion in the upper reaches, and to counteract this, a siltation dam was constructed by Gandaki State and PMC in 2019.

B8.2.4 Air Quality

Refer to C.2.8.1 (1).

B8.2.5 Noise

Refer to C.2.8.1 (3).

B8.2.6 Land Use

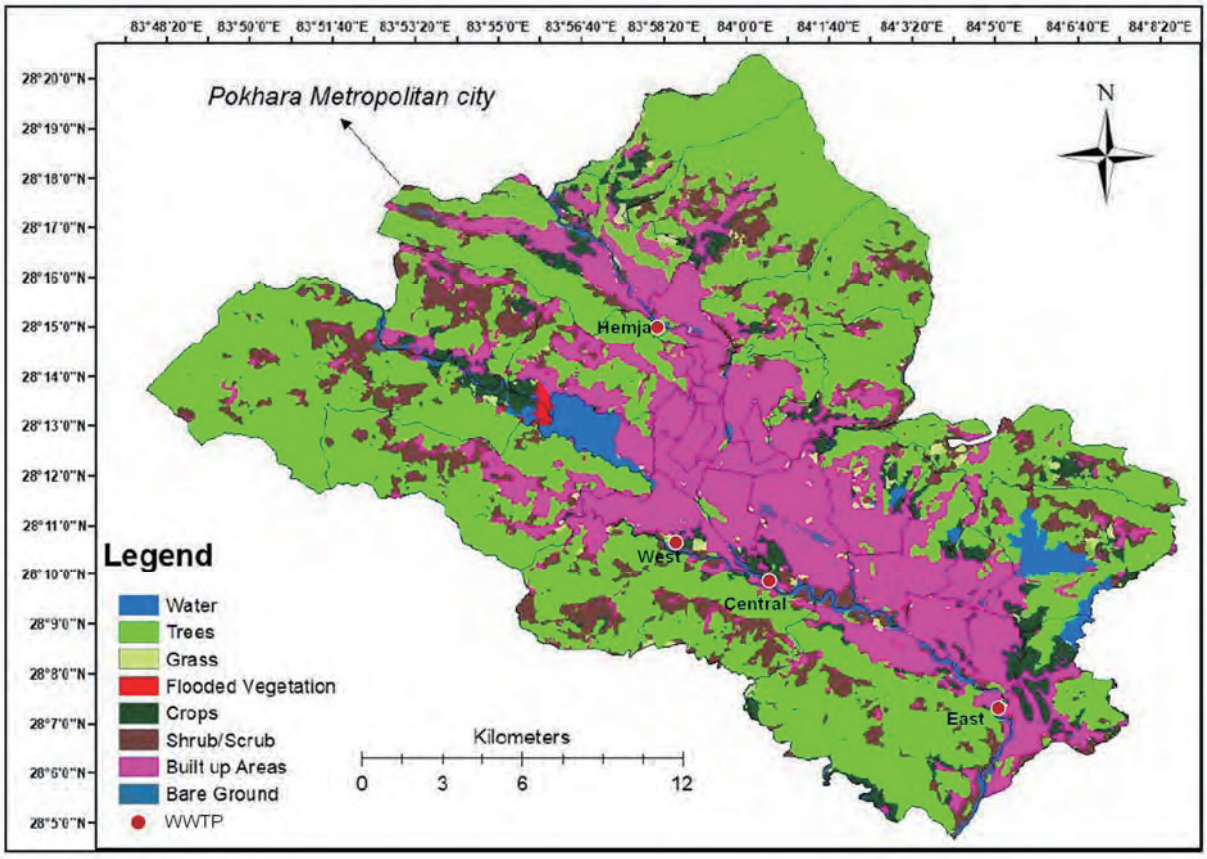
Table B8-2 shows the land use in Pokhara City as of 2020, and Figure B8-4 shows the current land use map. Shrub/wooded area is the most common land use at 43.3%, followed by agricultural land at 17.5%. Developed land, which is people's living area, is concentrated in the central and southeastern parts of Pokhara, accounting for 8.5% of the city.

Table B8-2 Land Use of Pokhara City (2020)

Distinction	Area (km^2)	Percentage (%)
Water	44.3	9.5
Forests	76.9	16.5
Grassland	14.3	3.1
Wetland	2.7	0.6

Distinction	Area (km^2)	Percentage (%)
Agricultural Land	81.2	17.5
Shrub/Wooded	201.3	43.3
Cultivated Land	39.4	8.5
Bare Ground	5.0	1.1
Total	465	100

Note: Totals may not match due to rounding
Source: ESRI (Environmental Systems Research Institute), 2020



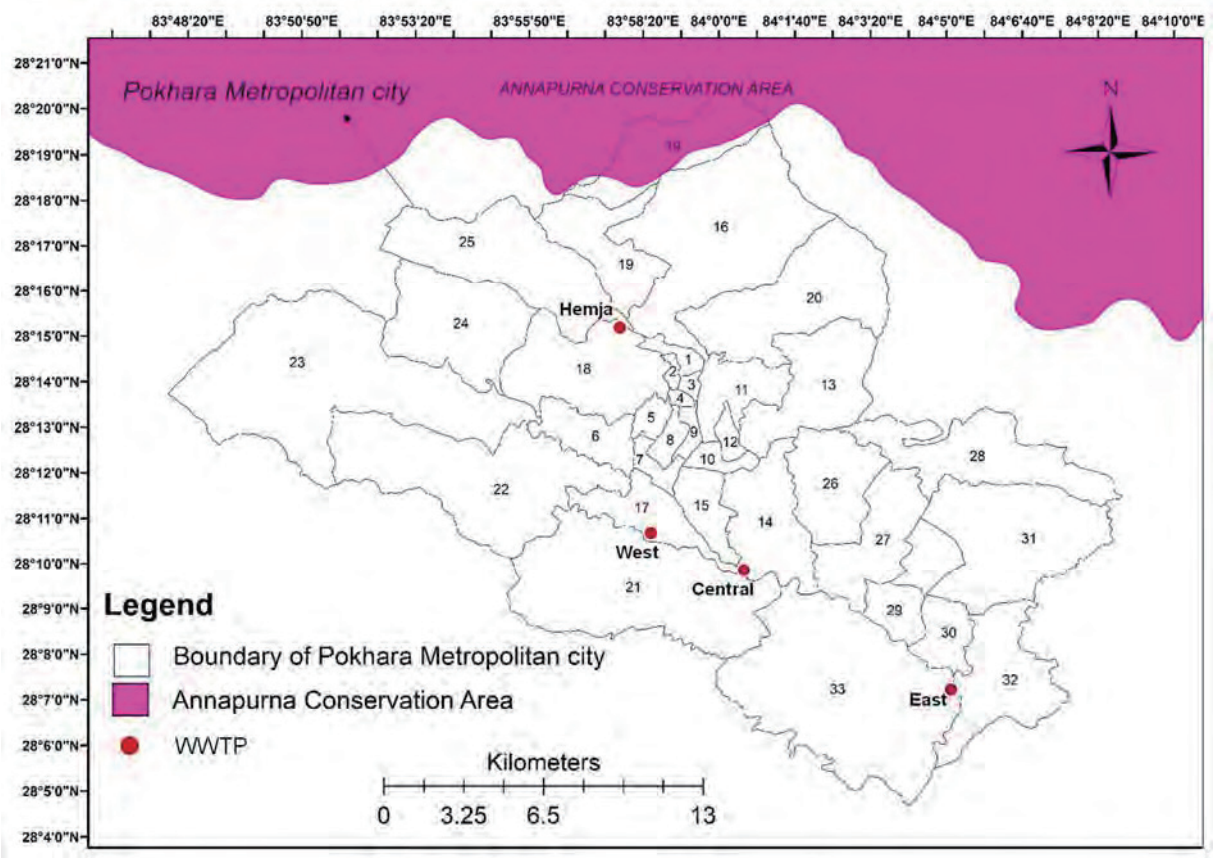
Source: ESRI (Environmental Systems Research Institute), 2020; Survey Department, 2021

Figure B8-4 Land Use Map (2020)

B8.2.7 Protected Area

Nepal has 12 National Parks, 1 Wildlife Reserves and 1 Hunting Reserves, 6 Conservation Areas, and 13 Buffer Zones surrounding National Parks and Wildlife Reserves. In addition, 13 buffer zones have been designated around national parks and wildlife refuges, covering about 23% of the country. These protected areas are defined by the National Parks and Wildlife Conservation Act (1973) and managed by the Department of National Parks and Wildlife Conservation (DNPWC). Among these areas, the one associated with PMC is the Annapurna Conservation Area. As shown in Figure B8-5, its location is limited to Ward 19 in the northern part of the municipality, and no buffer zone has been established. It covers an area of 7,629 km^2 and is home to 1,226 species of flowering plants, 105 species of mammals, 518 species of birds, 40 species of reptiles, and 23 species of amphibians. The lake and its catchment area are home to many globally endangered endemic species, birds, and wetland-dependent mammals. In addition, 60 aquatic plant species and 203 terrestrial plant species have been identified (Tamrakar, 2008), as well as the rare marsh wild rice Oryza rufipogon. Nepal has 31 registered Key Biodiversity Areas (KBA), In Nepal also 27 Important Bird Areas and Biodiversity Areas (IBA) are registered with a total area of 2,651,592 ha, which are habitats for a wide variety of bird species. Annapurna Conservation Area is a nature reserve registered in 1986 and also registered as a KBA and IBA in 2005.

There are no other sites registered as KBA or IBA in Pokhara City.



Source: Department of Mines and Geology, 1994; Survey Department, 2021

Figure B8-5 Location map of Annapurna Conservation Area

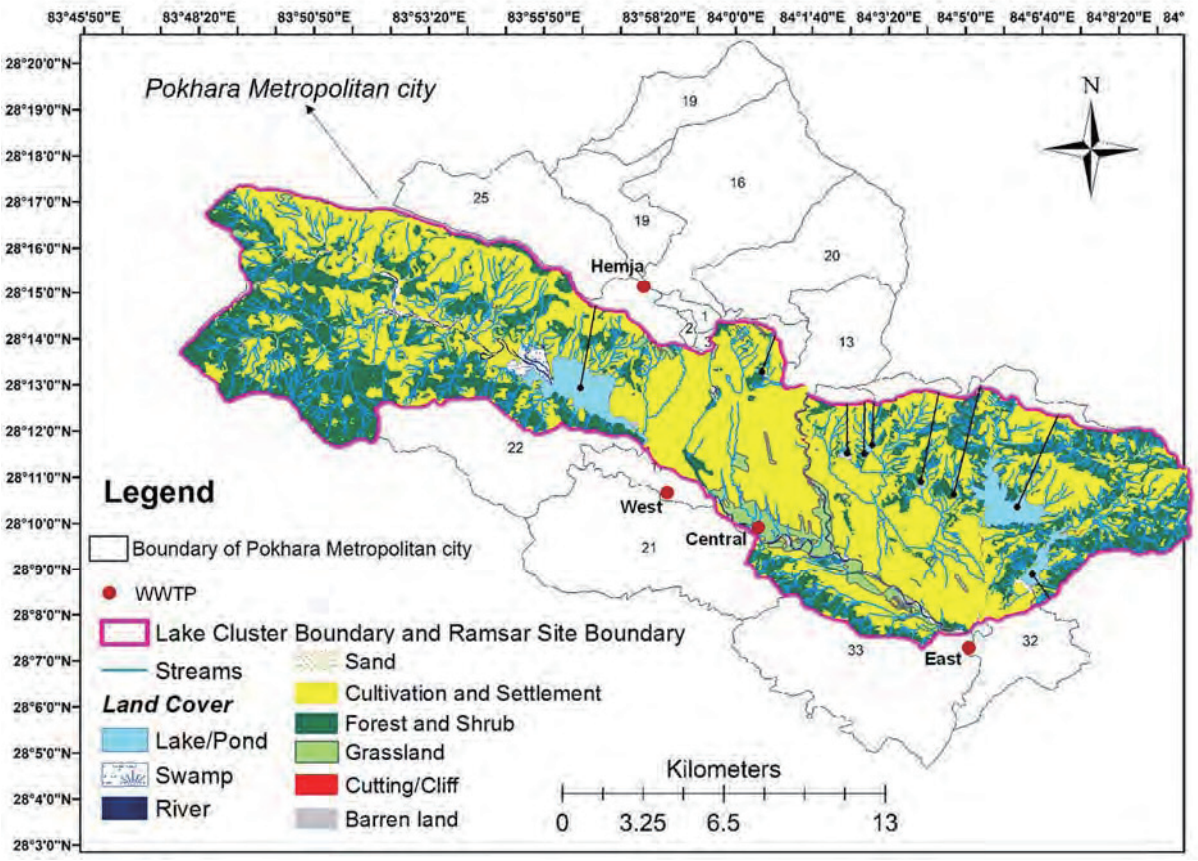
The Pokhara Basin area, including Lake Phewa and eight other lakes, is registered as a Ramsar wetland under the Convention on Wetlands of International Importance especially as Waterfowl Habitat, commonly known as the Ramsar Convention. A summary of the registration is shown in Table B8-3 and the registered areas are indicated in Figure B8-6.

Table B8-3 Summary of Ramsar Wetlands

Item	Content
Registered Name	Lake Cluster of Pokhara Valley
Registered Area	26,106 ha
Registration Date	2nd February
Registration Criteria	Criterion 1: Representative, rare or unique natural or near-natural wetland types Criterion 2: Rare species and threatened ecological communities Criterion 3: Biological diversity Criterion 7: Significant and representative fish

Source: Ramsar Sites Information Service

The Central WWTP is the proposed site for the construction of the sewage treatment plant, and West, Central, and East are all located within the Ramsar wetlands as the areas where sewage pipes will be constructed. This project is expected to contribute to the improvement of the environment of the Ramsar wetlands by reducing the discharge of sewage into lakes and rivers. On the other hand, consideration must be given to the potential construction site of the sewage treatment plant if it is a habitat for birds.



Source: Prepared by JET based on Ramsar Sites Information Service (https://rsis.ramsar.org/ris/2257)

Figure B8-6 Location of Ramsar Wetlands

B8.2.8 Ecosystems

Nepal has a very unique ecosystem due to its land with extreme altitude variation in its horizontal east-west and narrow north-south geography, and its varied topographical and climatic conditions. The following is a list of flora and fauna inhabiting the Ramsar wetlands of the Pokhara Valley, according to the Ramsar Sites Information Service. 56 plant species have been identified. As for animal species, 26 species of mammals, 3 species of reptiles, 10 species of amphibians, 10 species of fish, and 191 species of birds have been registered under the IUCN (International Union for Conservation of Nature) category.

Table B8-4 Plant Species Distributed in the Ramsar Wetlands of the Pokhara Valley

No.	Species Name	Scientific Name	IUCN Category
	Land Plant		
1	Sweet Flag	Acorus calamus	—
2	Plumed Cockscomb	Celosia argentea	—
3	Nutgall Tree	Rhus chinensis	—
4	Centella	Centella asiatica	—
5	Blackboard Tree	Alstonia scholaris	—
6	Spreading Sneeze Weed	Centipeda minima	—
7	Black Myrobalan	Terminalia chebula	—
8	Dodder	Cuscuta reflexa	—
9	Sal	Shorea robusta	—
10	Angeri	Lyonia ovalifolia	—
11	Palans	Butea monosperma	—
12	Golden Shower Tree	Cassia fistula	—
13	Indian Chestnut	Castanopsis indica	—
14	Spearmint	Mentha spicata	—
15	Corn Mint	Mentha arvensis	—

No.	Species Name	Scientific Name	IUCN Category
16	Chinese Chastetree	Vitex negundo	—
17	Tejpat	Cinnamomum tamala	—
18	Camphor	Cinnamomum camphora	—
19	Mountain Pepper	Litsea cubeba	—
20	Crape Myrtle	Lagerstroemia parviflora	—
21	Dhairo	Woodfordia fruticosa	—
22	Cotton Tree	Bombax ceiba	—
23	Neem	Azadirachta indica	—
24	Pakhuri	Ficus glaberrima	—
25	Guava	Psidium guajava	—
26	Jamun	Syzygium cumini	—
27	Golden Himalayan Raspberry	Rubus ellipticus	—
28	Bael	Aegle marmelos	—
29	Toothache Tree	Zanthoxylum armatum	—
30	Tiju	Picrasma javanica	—
	Aquatic Plant		
1	Common Duckweed	Lemna minor	—
2	Greater Duckweed	Spirodela polyrhiza	—
3	Marshpennywort	Hydrocotyle sibthorpioides	—
4	Watercresses	Nasturtium officinale	—
5	Hornwort	Ceratophyllum demersum	—
5	Compact Stonewort	Nitella mucronata	—
6	Rough Chara	Chara aspera	—
7	Spikerush	Eleocharis atropurpurea	—
8	Yellow Nut Grass	Cyperus esculentus	—
9	Purple Spikerush	Eleocharis atropurpurea	—
10	Chinese Water Chestnut	Eleocharis dulcis	—
11	Spikerush	Eleocharis congesta	—
12	Bristleleaf Bulrush	Isolepis setacea	—
13	Pipewort	Eriocaulon cinereum	—
14	Waterthyme	Hydrilla verticillata	—
15	Eelgrass	Vallisneria spiralis	—
16	Bladderwort	Utricularia australis	—
17	Humped Bladderwort	Utricularia gibba	—
18	Water Primrose	Ludwigia adscendens	—
19	Wild Rice	Oryza rufipogon	—
20	Shama Millet	Echinochloa colona	—
21	Torpedo Grass	Panicum repens	—
22	Reed Chamorro	Phragmites karka	—
23	Pale Smart Weed	Persicaria lapathifolia	—
24		Potamogeton octandrus	—
25	Longleaf Pondweed	Potamogeton nodosus	—
26	Indian Fern	Ceratopteris thalictroides	—

Source: THE IUCN RED LIST OF THREATENED SPECIES

Table B8-5 Mammals Inhabiting Ramsar Wetlands in the Pokhara Valley (IUCN Categorical)

No.	Species Name	Scientific Name	IUCN Category
1	Golden Jackal	Canis aureus	LC
2	Rhesus Macaque	Macaca mulata	LC
3	Leopard	Panthera pardus	NT
4	Indian Crested Porcupine	Hystrix indica	LC
5	Barking Deer	Muntiacus muntjak	LC
6	European Otter	Lutra lutra	NT
7	Three-Striped Palm Squirre	Funambulus polmarum	LC
8	Antelope Rat	Tatera indica	LC
9	Common Grey Mongoose	Herpestes edwardsii	LC

No.	Species Name	Scientific Name	IUCN Category
10	Black-Naped Hare	Lepus nigricollis	LC
11	Yellow-Throated Marten	Martes flavigula	LC
12	Bengal Fox	Vulpes bengalensis	LC
13	Leopard Cat	Felis Bengalensis	LC
14	Jungle Cat	Felis chaus	LC
15	Clouded Leopard	Neofelis nebulosa	VU
16	Crab-Eating Mongoose	Herpetes urva	LC
17	Indian Pangolin	Manis crassicaudata	EN
18	Little Indian Field Mouse	Mus booduga	LC
19	Black Rat	Rattus rattus	LC
20	Greater Short-Nosed Fruit Bat	Cynopterus sphinx	LC
21	Indian Flying Fox	Pteropus giganteus	LC
22	Irrawaddy Squirrel	Callosciurs pygerythrus	LC
23	Asian House Shrew	Suncus murinus	LC
24	Asian Black Bear	Selenarctos thibetanus	VU
25	Masked Palm Civet	Poguma larvata	LC
26	Large Indian Civet	Viverra zibetha	NT

Source: THE IUCN RED LIST OF THREATENED SPECIES
Note: DD…Data Deficient, LC…Least Concern, NT…Near Threatened, VU…Vulnerable, EN…Endangered, CR…Critically Endangered, EW…Extinct In The Wild, EX…Extinct, NE…Not Evaluated, ND…Not Data

Table B8-6 Reptiles Inhabiting Ramsar Wetlands in the Pokhara Valley (IUCN Categorical)

No.	Species Name	Scientific Name	IUCN Category
1	Bhahiminy Skink	Mabuya carinata	LC
2	Bengal/Common Monitor	Varanus begalensis	LC
3	Tricarinate Hill Turtle	Melanochelys tricarinata	VU

Source: THE IUCN RED LIST OF THREATENED SPECIES
Note: DD…Data Deficient, LC…Least Concern, NT…Near Threatened, VU…Vulnerable, EN…Endangered, CR…Critically Endangered, EW…Extinct In The Wild, EX…Extinct, NE…Not Evaluated, ND…Not Data

Table B8-7 Amphibian Inhabiting Ramsar Wetlands in the Pokhara Valley (IUCN Categorical)

No.	Species Name	Scientific Name	IUCN Category
1	Toad	Bufo anderssoni	LC
2	Asian Common Toad	Bufo melanostictus	LC
3	Indian Marbled Toad	Bufo stomaticus	LC
4	Ornate Narrow-Mouthed Frog	Microhyla oranata	LC
5	Marbled Cascade Frog	Amolops marmoratus	LC
6	Skittering Frog	Euphlyctis cyanophlyctis	LC
7	Indian Bull Frog	Hoplobatrachus tigerinus	LC
8	Blanford's Paa Frog	Paa blanfordii	LC
9	Asian Grass Frog	Rana limnochoris	LC
10	Northern Leopard Frog	Rana pipens	LC

Source: THE IUCN RED LIST OF THREATENED SPECIES
Note: DD…Data Deficient, LC…Least Concern, NT…Near Threatened, VU…Vulnerable, EN…Endangered, CR…Critically Endangered, EW…Extinct In The Wild, EX…Extinct, NE…Not Evaluated, ND…Not Data

Table B8-8 Fish Inhabiting Ramsar Wetlands in the Pokhara Valley (IUCN Categorical)

No.	Species Name	Scientific Name	IUCN Category
1	Silver Carp	Hypothalamoichys molitrix	NT
2	Olive Barb	Puntios sarona	LC
3	Major (Indian) Carp	Catla catla	LC
4	Cyprinid Fish	Chagunius chagunio	LC
5	Dwarf Snakehead	Channa gachuwa	LC
6	Mrigal Carp	Cirrhina mrigala	VU
7	Common Carp	Cyprinis carpio	VU
8	Rahu	Labeo rahu	LC
9	(Tor Mahaseer)Mahaseer	Tor tor	NT
10	Ticto Barb	Puntius ticto	LC

Source: THE IUCN RED LIST OF THREATENED SPECIES
Note: DD…Data Deficient, LC…Least Concern, NT…Near Threatened, VU…Vulnerable, EN…Endangered, CR…Critically Endangered, EW…Extinct In The Wild, EX…Extinct, NE…Not Evaluated, ND…Not Data

Table B8-9 Birds Inhabiting Ramsar Wetlands in the Pokhara Valley (IUCN Categorical)

No.	Species Name	Scientific Name	IUCN Category
Wetland Birds			
1	Great Crested Grebe	Podiceps cristatus	LC
2	Little Grebe	Tachybaptus ruficollis	LC
3	Oriental Darter	Anhinga melanogaster	NT
4	Great Cormorant	Phalacrocorax carbo	LC
5	Little Cormorant	Phalacrocorax niger	LC
6	Cattle Egret	Bubulcus ibis	LC
7	Great Egret	Casmerodius albus	LC
8	Indian Pond Heron	Ardoila Grayii	LC
9	Intermediate Egret	Mesophoyx intermedia	LC
10	Little Egret	Egretta garzetta	LC
11	Grey Heron	Ardea cinerea	LC
12	Little Heron	Butorides striatus	LC
13	Baer's Pochard	Aythya baeri	CR
14	Bar-Headed Goose	Anser indicus	LC
15	Comb Duck	Sarkidiornis melanotos	LC
16	Common Golden Eye	Bucephala clangula	LC
17	Common Pochard	Aythya ferina	VU
18	Common Shelduck	Tadorna tadorna	LC
19	Common Teal	Anas crecca	LC
20	Cotton Pygmy-Goose	Nettapus coromandelianus	LC
21	Eurasian Wigeon	Anas penelope	LC
22	Falcatted Duck	Anas falcata	NT
23	Ferruginous Pochard	Aythya nyroca	NT
24	Gadwall	Anas strepera	LC
25	Garganey	Anas querquedula	LC
26	Mallard	Anas platyrhynchos	LC
27	Northern Pintail	Anas acuta	LC
28	Northern Shoveler	Anas clypeta	LC
29	Red-Crested Pochard	Rhodonessa rufina	LC
30	Ruddy Shelduck	Tadorna ferruginea	LC
31	Tufted Duck	Aythya fuligula	LC
32	Lesser Whistling Duck	Dendrocygna javanica	LC
33	Common Coot	Fulica atra	LC
34	Common Moorhen	Gallinula chloropus	LC
35	Purple Swamphen	Porphyrio porphyrio	LC
36	White-Breasted Waterhen	Amaurornis poenicurus	LC
37	Bronzed-Winged Jacana	Metopidius indicus	LC
38	Pheasant-Tailed Jacana	Hydrophasianus chirurgus	LC
39	Little Ringed Plover	Charadrius dubius	LC
40	Red-Wattled Lapwing	Vanellus indicus	LC
41	Common Kingfisher	Alcedo atthis	LC
42	Pied Kingfisher	Ceryle rudis	LC
43	White-Throated Kingfisher	Halcyon smyrnensis	LC

No.	Species Name	Scientific Name	IUCN Category
44	Wolly-Necked Stork	Ciconia episcopus	VU
45	Plumbeous Water Redstart	Rhyacornis fuliginosus	LC
46	White Wagtail	Motacila alba	LC
47	White-Browed Wagtail	Motacila maderaspatensis	LC
48	Citrine Wagtail	Motacilla citreola	LC
49	Grey Wagtail	Motacilla cinerea	LC
50	Greated Painted Snipe	Rostratula benghalensis	LC
51	Common Sandpiper	Actitis hypoleucos	LC
52	Marsh Sandpiper	Tringa stagnatilis	LC
Other Birds			
1	Black Kite	Milvus migrans	LC
2	White Rumped Vulture	Gyps bengalensis	CR
3	Egyptian Vulture	Neophron percnopterus	EN
4	Indian Griffon	Gyps indicus	CR
5	Eurasian Griffon	Gyps fulvous	LC
6	Shikra	Accipiter badius	LC
7	Besra	Accipiter virgatus	LC
8	Osprey	Pandion haliaetus	LC
9	Crested Serpent Eagle	Spilornis cheela	LC
10	Mountain Hawk Eagle	Spizaetus nipalensis	LC
11	Red Headed Vulture	Sarcogyps calvus	CR
12	White-Tailed Eagle	Haliaeetus albicilla	LC
13	Steppe Eagle	Aquila nipalensis	EN
14	Common Kingfisher	Alcedo atthis	LC
15	Northern Pintail	Anas acuta	LC
16	House Swift	Apus affinis	LC
17	Indian Pond Heron	Ardeola grayii	LC
18	Little Green Egret	Butroides striatus	LC
19	Black Stork	Ciconia nigra	LC
20	Crested Kingfisher	Megaceryle lugubris	LC
21	Blue Throated Barbet	Megalaima asiatica	LC
22	Coppersmith Barbet	Megalaima haemacephala	LC
23	Great Barbet	Megalaima virens	LC
24	Red-Wattled Lapwing	Vanellus indicus	LC
25	Spotted Dove	Streptopelia chinensis	LC
26	Oriental Turtle Dove	Streptopelia orientalis	LC
27	Yellow-Footed Green Pigeon	Treron phoenicoptera	LC
28	Blue Rock Pigeon	Columca livia	LC
29	Hill Pigeon	Columca rupentris	LC
30	Eurasian Collared Dove	Streptopelia decaocto	LC
31	Indian Roller	Coracias benghalensis	LC
32	Jungle Nightjar	Caprimulgus indicus	LC
33	Common Green Magpie	Cissa chinensis	LC
34	Red-Billed Blue Magpie	Urocissa erythrorhyncha	LC
35	Large Billed Crow	Corvus macrorhynchos	LC
36	Himalayan Tree Pie	Dendrocitta formosae	LC
37	Common Lora	Aegithina tiphia	LC
38	Rufuos Tree Pie	Dendrocitta vagabunda	LC
39	Scarlet Minivet	Pericrocotus speciosus	LC
40	Black Winged Cuckoo-Shrike	Coracina melaschistos	LC
41	Black Drongo	Dicrurus macrocercus	LC
42	Little Bronze Drongo	Dicrurus aeneus	LC
43	Hair Crested Drongo	Dicrurus hottentottus	LC
44	Yellow-Beplied Fantail	Rhipidura hypoxantha	LC
45	Ashy Drango	Dicrurus leucophaeus	LC
46	Golden-Oriole	Oriolus oriolus	LC
47	Maroon-Oriole	Oriolus traillii	LC
48	Black Napped Oriole	Oriolus chinensis	LC
49	House Crow	Corvus splendens	LC
50	Eurasian Cuckoo	Cuculus canorus	LC
51	Indian Cuckoo	Cuculus micropterus	LC
52	Asian Koel	Eudynamys scolopacea	LC

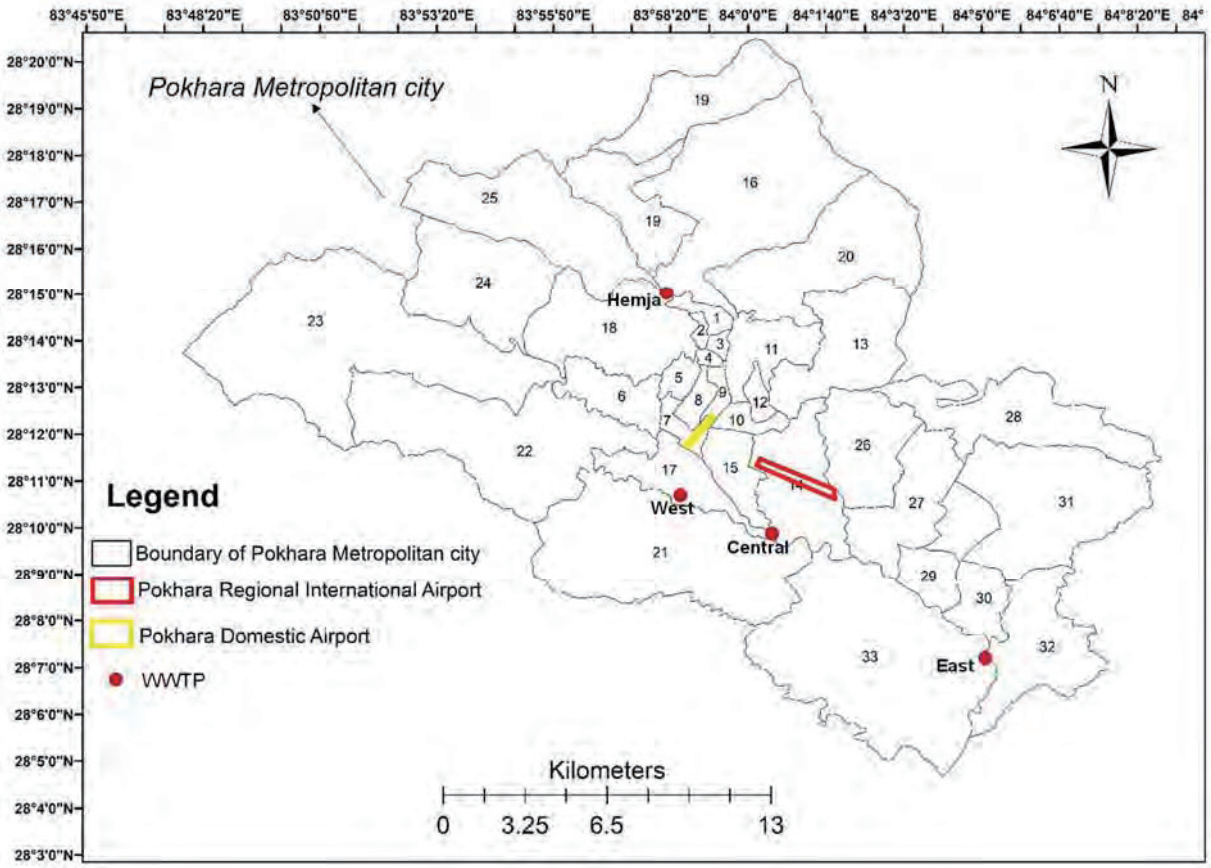
No.	Species Name	Scientific Name	IUCN Category
53	Green-Billed Malkoha	Phaenicophaeus tristis	LC
54	Chest Nut Winged Cuckoo	Clamator coromandus	LC
55	White Throated Kingfisher	Halcyon smyrmensis	LC
56	Common Kestrel	Falco tinnunculus	LC
57	Collared Falconet	Microhierax caerulescens	LC
58	Crested Bunting	Melophus lathimi	LC
59	Nepal House Martin	Delichon nipalensis	LC
60	Barn Swallow	Hirundo rustica	LC
61	Sand Martin	Riparia riparia	LC
62	Red Rumped Swallow	Hirundo daurica	LC
63	Bronze Winged Jacana	Metopidius indicus	LC
64	Long-Tailed Shrike	Lanius schach	LC
65	Blue Bearded Bee-Eater	Nyctyornis athertoni	LC
66	Grey-Headed Canary-Flycatcher	Culicicapa ceylonensis	LC
67	White- Throated Flycatcher	Empidonax albigularis	LC
68	Rufous-Gorgetted Flycatcher	Ficedula strophiata	LC
69	Rufous Bellied Niltava	Niltava sundara	LC
70	Oriental Magpie Robin	Copsychus saularis	LC
71	Common Stonechat	Saxicola torquata	LC
72	Indian Robin	Saxicoloides fulicata	LC
73	Spotted Forktail	Enicurus maculatus	LC
74	White Tailed Bushchat	Saxicola leucura	LC
75	Black-Backed Forktail	Enicurus immaculatus	LC
76	Pied Bushchat	Saxicola caprata	LC
77	Small Niltava	Niltava macrgrigoriae	LC
78	Crimson Sunbird	Aethopyga siparaja	LC
79	Thick-Billed Flowerpecker	Diacaeum agile	LC
80	Plain-Colored Flowerpecker	Diacaeum concolor	LC
81	Purple Sunbird	Nectarina asiatica	LC
82	Grey Tit	Parus major	LC
83	Himalayan Black-Lored Tit	Parus xanthogenys	LC
84	Olive Backed Tree Pipit	Anthus hodgsoni	LC
85	Paddy Field Pipit	Anthus rufulus	LC
86	Grey Wagtail	Motacilla cinera	LC
87	White Wagtail	Motacilla alba	LC
88	Citrine Wagtail	Motacilla citreola	LC
89	Scaly Breasted Munia	Lonchura punctulata	LC
90	White Rumped Munia	Lonchura striata	LC
91	Black Headed Munia	Lonchura Malacca	LC
92	White-Browed Wagtail	Motacilla maderaspatensis	LC
93	House Sparrow	Passer domesticus	LC
94	Eurasian Tree Sparrow	Passer montanus	LC
95	Baya Weaver	Ploceus phillippinus	LC
96	Red Jungle Fowl	Gallus gallus	LC
97	Kalij Pheasant	Lophura leucomelanos	LC
98	Buff-Spotted Flameback	Chrysocolaptes lucidus	LC
99	Grey Headed Woodpecker	Picus canus	LC
100	Lesser Yellownape	Picus chlorolophus	LC
101	Greater Yellownape	Chrysophlegma flavinucha	LC
102	Fulvous-Breasted Woodpecker	Dendrocopos macei	LC
103	Black Necked Grebe	Podiceps nigricollis	LC
104	Red-Breasted Parakeet	Psittacula alexandri	NT
105	Rose Ringed Parakeet	Psittacula krameri	LC
106	Slaty-Headed Parakeet	Psittacula himalayana	LC
107	Red-Vented Bulbul	Pycnontus cafer	LC
108	Himalayan Bulbul	Pycnontus leucogenys	LC
109	Black Crested Bulbul	Pycnonotus flaviventris	LC
110	Brown Crake	Amaurornis akool	LC
111	Ruddy Breased Crake	Porzana fusca	LC
112	Water Cock	Gallicrex cinerea	LC
113	Painted Snipe	Rostratula bengalensis	LC
114	Temminck's Stint	Calidris temminckii	LC

No.	Species Name	Scientific Name	IUCN Category
115	Common Snipe	gallinago gallinago	LC
116	Green Sandpiper	Tringa ochropus	LC
117	Chestnut Bellied Nuthatch	Sitta castanea	LC
118	Velvet Fronted Nuthatch	Sitta frontalis	LC
119	Wall Creeper	Tichdroma muraria	LC
120	Asian Barret Owlet	Glaucidium cuculoides	LC
121	Brahminy Myna	Sturnus pagodarum	LC
122	Common Myna	Acridotheres tristis	LC
123	Jungle Myna	Acridotheres fuscus	LC
124	Chestnut-Tailed Starling	Sturnus malabaricus	LC
125	Common Starling	Sturnus vulgaris	LC
126	Spot-Winged Starling	Saroglossa spiloptera	LC
127	Common Tailorbird	Orthotomus sutorius	LC
128	Common Chiffchaff	Phylloscopus collybita	LC
129	Yellow Bellied Warbler	Abroscopus superciliaris	LC
130	White-Crested Laughingthrush	Garrulax leucolophus	LC
131	Large Neck-Laced Laughing Thrush	Garrulax pectoralis	LC
132	Puff-Throated Babbler	Pellorneum ruficeps	LC
133	Rusty-Cheeked Scimitar-Babbler	Pomatorhinus erythrogenys	LC
134	White-Browed Scimitar-Babbler	Pomatorhinus schisticeps	LC
135	Black-Chinned Babbler	Stachyris pyrrhops	LC
136	Spiny Babbler	Turdoides nipalensis	LC
137	White-Bellied Yuhina	Yuhina zantholeuca	LC
138	Jungle Babbler	Turdoides striatus	LC
139	Oriental White Eye	Zosterops palpebrosus	LC

Source: THE IUCN RED LIST OF THREATENED SPECIES
Note: DD…Data Deficient, LC…Least Concern, NT…Near Threatened, VU…Vulnerable, EN…Endangered, CR…Critically Endangered, EW…Extinct In The Wild, EX…Extinct, NE…Not Evaluated, ND…Not Data

B8.2.9 Land Acquisition

Of the four candidate sites selected in the comparison of alternatives (see B8.4.2), three (Hemja, West, and East) are privately owned land, so land acquisition will be required in consultation with the landowners. According to the data provided by the Bureau of Land, approximately 68,000m^2 of the total land area of the proposed West WWTP is privately owned, and land acquisition is required.
As shown in Figure B8-7, the West WWTP site is located approximately 2 km from the current domestic airport and the Central WWTP site is approximately 2 km from the new international airport. The Central WWTP will be located in the old waste disposal site. Due to the proximity of the West and Central sewage treatment plants to the airport, discussions were held with the Civil Aviation Authority of Nepal (CAAN) to determine the location of the proposed facilities (coordinates, elevations, location maps) and to submit a summary of the proposed facilities. The proposed treatment plant sites are located in the vicinity of the airport. Since these potential treatment sites are not within the 2% slope takeoff/landing range and 14.28% slope cone range as stipulated in the Civil Aviation Law, and are at a lower elevation than the runway, there will be no height restrictions or other issues under the Civil Aviation Law with respect to the construction of the facility.

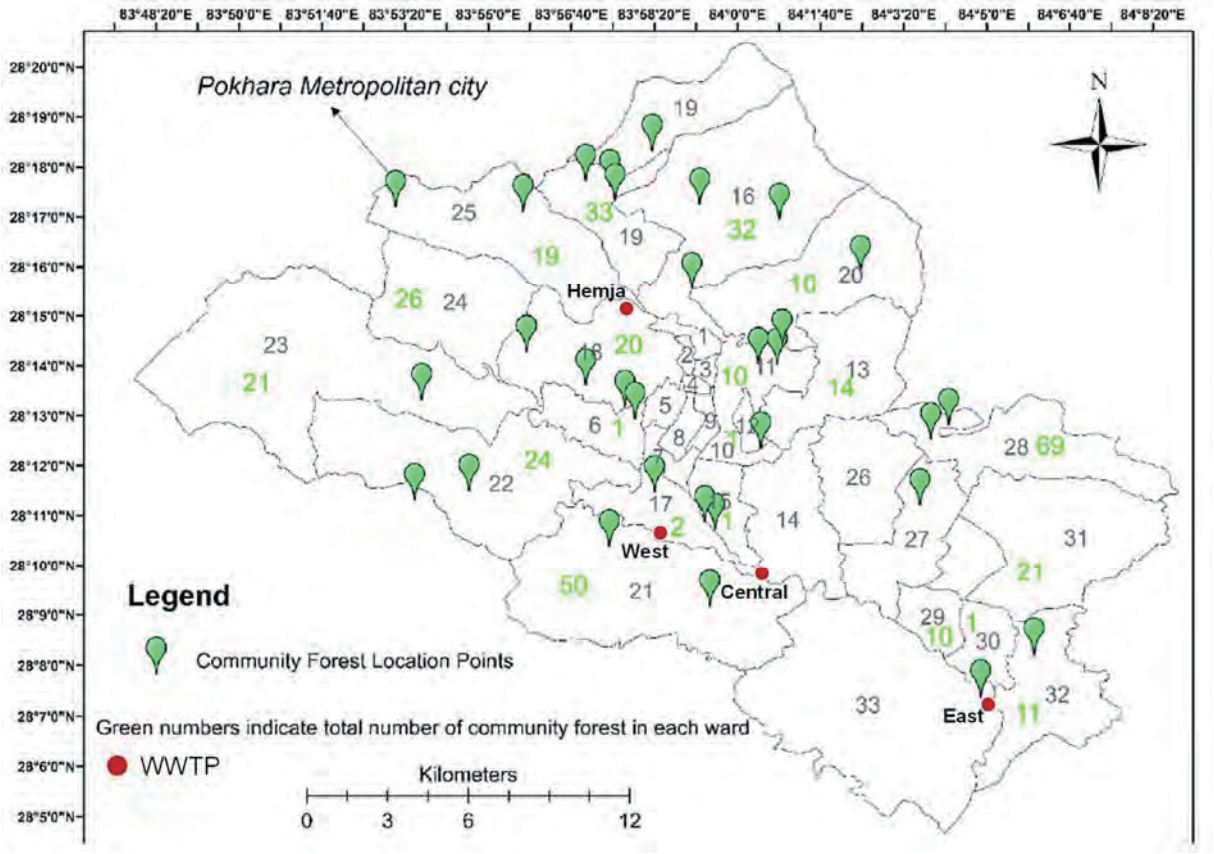


Source: Survey Department, 2021

Figure B8-7 Location Map of Proposed Airport and Treatment Plant

B8.2.10 Community Forestry

Community forestry is practiced in many forests around the Pokhara Basin Lakes Complex. Community forests are defined by the Forest Act as national forests managed by user groups. There are 376 community forests in PMC, covering an area of 11,376.09 ha, managed by user groups of 33,904 households. In PMC, forests around urban areas have become valuable due to the increasing migration to the municipality. Community forests play a particularly important role in preventing landslides and landslides. In the existing sewerage improvement plan, one community forest has been identified that will be affected by the project, covering an area of 13.25 ha. As mitigation measures, the project will need to implement replacement planting for trees that need to be cut down, and hand over the trees to community forestry groups and local residents after 5 years.



Source: Survey Department, 2021

Figure B8-8 Community Forest Location Map

B8.2.11 Ethnicity

As shown in the table below, Pokhara is a city of mixed ethnic groups; Brahman-Hill, with 26.48% of the population, is the most populous in Pokhara, while Chhetri is the most populous caste/ethnic group in Nepal as a whole. In addition, the Jalari tribe lives on the shores of Lake Phewa, where they engage in traditional fishing.

Table B8-10 Population by Caste/Ethnicity in PMC, 2021

No.	Caste/Ethnicity	Total Number	Ratio
1	Chhetri	77,381	15.08%
2	Brahman-Hill	135,896	26.48%
3	Magar	52,733	10.28%
4	Tamang	13,648	2.66%
5	Newar	24,081	4.69%
6	Kami	42,710	8.32%
7	Gurung	76,774	14.96%
8	Danmai/Dholi	18,642	3.63%
9	Others	71,245	13.88%
	Total	513,110	100%

Source: Census 2021

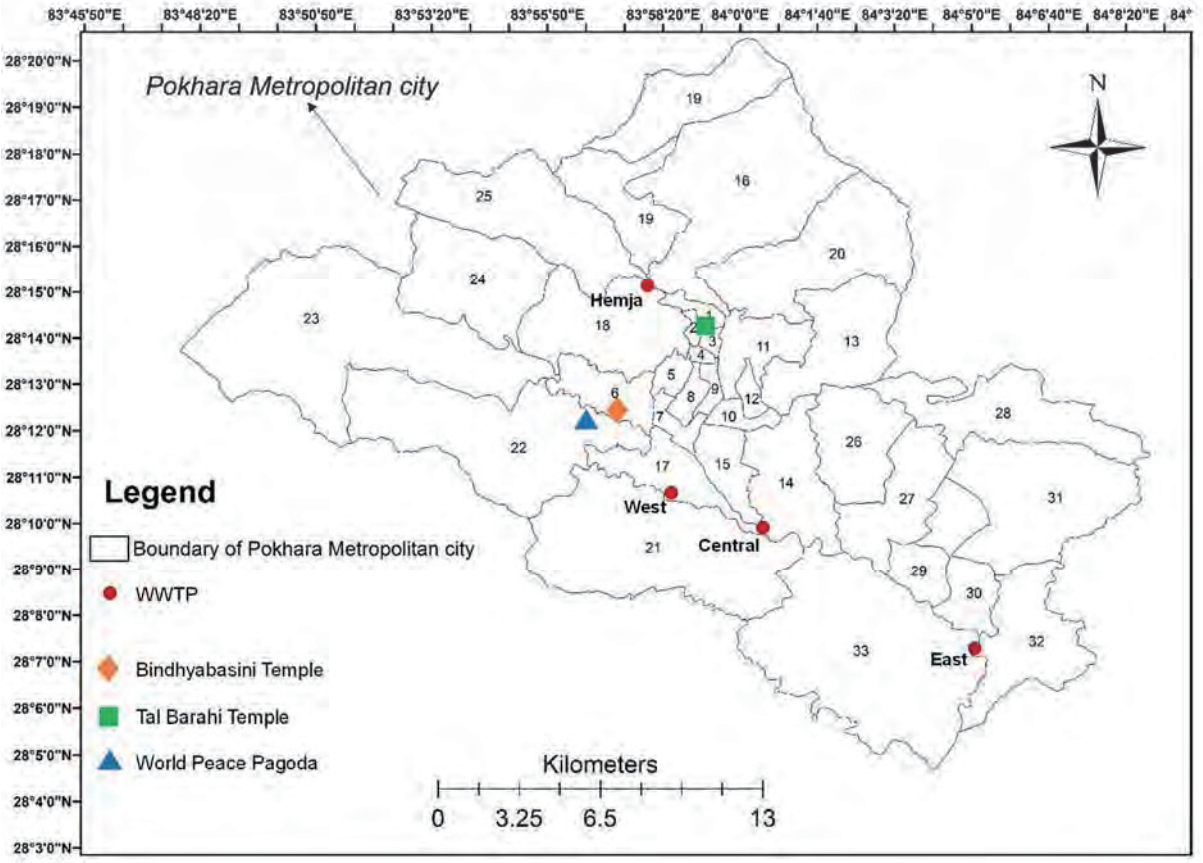
B8.2.12 Cultural Heritage

Below is a summary of the main cultural and historical heritage sites in PMC, with their locations shown in Table B8-11 and Figure B8-9. PMC is world famous as a tourist destination, and there are cultural and historical heritage sites within the municipality. Although these are well away from the proposed WWTP site currently under consideration, consideration should be given to the area around the Bindubasini Temple if pipe installation in the old city is to take place. However, there are no designated areas for cultural heritage protection.

Table B8-11 Overview of Cultural and Historical Heritage in the Pokhara City

No.	Cultural and Historical Heritage	Location	Constructed Year	Remarks
1	Tal Barahi Temple	Samll island in Phewa Lake	Unknown	Hindu Temple
2	Bindhyabasini Temple	Old City	Unknown	Hindu Temple
3	World Peace Pagoda (Shanti Stupa)	Listing of Ananda Hill in the southern part of Lake Phewa	1973	Pagoda

Source: JICA "Preparatory Study Report for Pokhara Water Supply and Sewerage Improvement Project, Nepal" (2016)



Source: JET

Figure B8-9 Location of Cultural and Historical Heritage in the Pokhara City

B8.2.13 Water Pollution

Organic pollution and fecal coliform contamination are increasing and eutrophication is becoming a problem in Pokhara due in part to the lack of sewerage and sewage treatment systems.

B8.2.14 Waste

Waste collection and treatment in Nepal is regulated by the Solid Waste Management Act, 2011, which states that local governments are responsible for waste collection, treatment, and disposal. The sludge from the on-site treatment facility is collected by a private company that has obtained business rights from the city of Pokhara, and is sun-dried at the Pokhara municipal waste disposal plant. However, leachate treatment and effluent quality control at the disposal site are inadequate, and effluent with COD exceeding 400 mg/L is discharged into the river.

B8.2.15 Potential Site for WWTP

The location of the WWTP was also compared for 10 candidate sites in Pokhara City. The results showed

that the construction of plants at 1. LEKNATH GADI GHAT, 5. POKHARA LANDFILL SITE, 8. POKHARA POWERHOUSE EAST SIDE HILL, and 10. POKHARA YAMDI (HEMJA) were more suitable than the other sites.

B8.3 Strategic Environmental Assessment

B8.3.1 Impact Indicator

In conducting the Strategic Environmental Assessment (SEA), JET have summarized the environmental indicators that are affected during the planning phase of the project. The main environmental indicators to be considered during the SEA process for sewage treatment projects are listed below.

- Protected areas and other sensitive areas
- Biodiversity hotspots and critical habitats
- Wildlife corridors and habitats
- Availability of land and water resources
- Competition for water resources
- Expansion of settlements
- Land use planning, including infrastructure development and socio-economic activities
- Pollution prevention (air, water, soil, noise)
- Climate change vulnerability and greenhouse gas emissions

The SEA objectives and indicators for each item are shown below.

Table B8-12 SEA Objectives for each Item

Item	General Objectives of SEA	Specific Objectives of SEA	Indicators
Water Quality	Maintenance and conservation of surface and groundwater quality	・ Pollution reduction of surface water and groundwater	・ Changes in water quality
Soil	Protection and sustainable use of forests and agricultural lands	・ Reduce erosion of land degradation ・ Protect forests and agricultural lands	・ Change in area of agricultural and forest land ・ Area of land at risk of erosion
Air Quality	Improvement of air pollution levels	・ Air pollutant concentrations below standards	・ Change in air pollutant concentrations
Ecosystem	Protection and conservation of landscapes and biodiversity	・ Conserve biodiversity ・ Preserve natural values and landscape	・ Impact on the area of nature conservation areas ・ Impact on endangered plant and animal species
Cultural Heritage	Protection of cultural heritage	・ Protection of cultural heritage ・ Protection of historic buildings and archaeological sites	・ Impact on cultural heritage of historical and archaeological value
Waste	Sustainable waste management	・ Promotion of sewage treatment ・ Reduction of adverse effects on public health ・ Improving the quality of life in the region ・ Sustaining rural populations ・ Protecting communities from adverse impacts of water	・ The increase in the number of sewage water treatment facilities and the increase in the efficiency of wastewater treatment to the required level ・ The incidence of diseases that can be attributed to the polluted drinking water ・ The increase in the number of households attached to the public sewage system (%) ・ The number of displaced households due to the activities

Item	General Objectives of SEA	Specific Objectives of SEA	Indicators
			in the water management sector
Social Development	Improvement of people's health	・ Reducing adverse effects on the health of the population ・ Improving quality of life ・ Avoidance of adverse impacts in local communities	・ The incidence of diseases due to the polluted drinking water ・ The increase in the number of households attached to the public sewage system (%) ・ The number of displaced households
Institutional Development	Strengthening institutional capacity for environmental protection	・ Improve environmental protection services, monitoring and control	・ Development of wastewater management system ・ Strengthening of institutions in the wastewater management sector ・ The number of institutions in the monitoring system
Economic Development	Promotion of economic development	・ Support economic development ・ Promote local employment ・ Reduce cross-border environmental impacts of hydroelectric facilities	・ The percentage of wastewater management sector employees with an income above the average income in the country ・ The number of developmental programs for environmental protection in the water management sector

Source: JET

In addition, the main issues and benefits that may arise from the sewage treatment project are listed below.

Table B8-13 Main Issues and Benefits that May Arise from the Sewage Treatment Project

Phase	Issue	Benefit Effects
No.1	Physical and Chemical Environment	
Under Construction	▪Change in Land use ▪Landscape disturbances and Hinderance ▪ Risk of slope failure ▪ Increase in noise level and vibration ▪Management of excavated soil and demolition waste ▪Management of solid waste including worker's waste ▪Impact on local water bodies and soil ▪Traffic management ▪Stockpiling of construction materials ▪Wastewater and seepage management ▪Waste disposal ▪Spoil of petroleum products, paints, and other chemicals ▪Degradation of the access road ▪Air Pollution ▪Soil and Water pollution ▪Odor Pollution ▪Pressure in local resources and physical infrastructures	―
In Operation	▪Management of solid wastes generated by the project ▪Pressure on public utilities (water supply,	▪Improvement in water discharge quality ▪Reduction in Soil and ground water contamination from control of leachate of

Phase	Issue	Benefit Effects
	electricity, telephone, etc.) ▪Health and safety impact ▪Traffic management ▪Degradation of the access road ▪Air Pollution ▪Water pollution ▪Soil and ground water contamination ▪Noise pollution ▪River pollution from effluent discharge ▪Sludge management ▪Transportation of sludge	septic tank
No.2	Biological Environment	
Under Construction	Impact on existing vegetation of the alignment ▪Loss of vegetation cover and forest resources ▪Impact on wildlife habitats ▪Degradation of wetlands	―
In Operation	―	▪Increase planned greenery ▪Improvement in natural environment
No.3	Socio-economic Environment	
Under Construction	▪Land acquisition and involuntary resettlement ▪Loss of private land and damage to existing facilities ▪Child exploitation ▪Labor and wage issue ▪Gender Equality and social exclusion ▪Social conflicts ▪Nightlife disturbances ▪Aesthetic values ▪Occupational health and safety of workers ▪Health and sanitation ▪Impact on local service ▪Finding of goods of archaeological values during construction ▪Impact on livelihood ▪Pressure on basic facilities and social services ▪Disturbance to local transportation ▪Disturbance to socio-economic system and cultural values	▪Employment opportunity ▪Increment in economic activities ▪Establishment of new shops, restaurants, and taverns ▪Enhancement in technical skills and knowhow
In Operation	Regular monitoring and checkup ▪Social conflict ▪Occupational health and safety of workers	Well wastewater management ▪Positive effects on aquatic animals by improving water quality in lakes and rivers ▪Increase in tourism and tourism-related business ▪Increase sanitation and hygiene ▪Increase in natural beauty ▪Reduction in waterborne diseases

Source: JET

B8.3.2 Anticipated Business Components

The project components anticipated for this project are shown in Table B8-14.

Table B8-14 Summary of Business Components

Category	Business Components	Summary
off-site treatment	Construction of sewage treatment plants	New facility construction with land acquisition
	Construction of pumping stations	Construction of new facilities with land acquisition
	Construction of sewage culverts	Installation of pipes (trunk lines, sub-trunk lines, installation pipes, etc.) to be connected to the sewage treatment system
on-site treatment	Construction of on-site treatment facilities	Installation of individual or small-scale facilities: septic tanks, septic tanks, etc.
	Construction of sludge treatment facilities	Construction of new facilities for treatment and reuse of sludge from septic tanks, etc., with land acquisition

Source: JET

B8.3.3 Comparative Study of Alternatives

(1) Development Zone

This MP covers the entire city of Pokhara and seeks to introduce wastwater treatment measures through either sewerage or on-site treatment. In view of the impact on the natural and social environment, a comparative study of alternatives was conducted for the classification of sewerage and on-site treatment areas, as shown in the table below. As a result, we propose the Urban Area as the sewerage area and the other areas as on-site treatment areas as the most effective proposal for this MP.

Table B8-15 Comparison of Alternatives

Item	Proposal not to Implement the Project	Alternative 1 This MP	Alternative 2 All in sewerage area	Alternative 3 All in on-site area
Outline	Do not implement the Project	The urban area is designated as the sewerage area, and the other areas are designated as on-site treatment Areas.	The entire city of Pokhara shall be designated as a sewerage area.	The entire city of Pokhara shall be designated as an on-site treatment area.
Cost	There will be no costs associated with sewer maintenance.	Since the sewer improvements are only in areas with high population concentrations, the sewer area and on-site treatment area can be developed with a smaller budget than Alternative 2.	The construction of sewage systems throughout Pokhara City will require a huge amount of money for the burial of sewage pipes, construction of pumping stations, and construction of sewage treatment plants.	There will be costs associated with on-site treatment, such as the installation of septic tanks, but these costs will be lower than those associated with the development of sewerage areas.
Technical	-	Because sewerage zones can be established based on topographical features, areas that are technically difficult to serve with sewerage systems can be designated as on-site treatment zones. This reduces technical barriers.	The development of sewage systems in undulating areas requires the construction of many pumping stations and involves difficulties in the design of pipe lines. In addition, sufficient land may not be available for the construction of sewage treatment plants due to the increased number of facilities. Therefore, construction on sites that are not sufficiently suitable for construction entails technical difficulties.	Many septic tanks and household wastewater treatment tank will need to be maintained, and each household will be required to properly maintain them. Therefore, the technical difficulties related to maintenance and management guidance are greater than in other proposals.
Impact on the natural environment	Environmental water quality deteriorates as	-Environmental water quality will be improved as a result of sewage	-Environmental water quality will be improved due to sewage treatment.	- Environmental water quality improves with sewage treatment.

Item	Proposal not to Implement the Project	Alternative 1 This MP	Alternative 2 All in sewerage area	Alternative 3 All in on-site area
	population increases.	treatment. -By limiting the construction of sewage pipes and culverts to the Urban Area, the environmental impact during construction will be minimized. - There are concerns about the environmental impact of constructing a sewage treatment facility covering the Urban Area.	-Environmental impacts from construction of sewage culverts would be citywide. -Environmental impacts from construction of a sewage treatment facility covering the entire city would be greater than Alternative 1.	However, it is essential that the residents understand that each household will be responsible for proper treatment. - Environmental impact during construction will be limited to the area around the installation site.
Impact on the social environment	There is concern about the increase in waterborne diseases and their impact on tourism due to the deterioration of environmental water quality as a result of population growth.	-Improved environmental water quality will reduce waterborne diseases and preserve tourism resources such as Lake Phewa. -Sewerage connection and maintenance costs will be incurred by each household. - Construction of a sewage treatment facility covering the Urban Area will be necessary, which will require Land Acquisition and Resettlement.	-Improved environmental water quality will reduce waterborne diseases and preserve tourism resources such as Lake Phewa. - Sewerage connection and maintenance costs will be incurred by each household. - Land Acquisition and Resettlement is larger than Alternative 1 because it would require construction of a WWTP covering the entire city area.	- Improved environmental water quality will reduce waterborne diseases and preserve tourism resources such as Lake Phewa. - Each household will have to pay for installation/renewal of on-site treatment facilities and sludge withdrawal. - No need to acquire land for land acquisition as it will be installed at each house.
Assessment	Not recommended	This proposal is recommended because it is considered efficient and has little impact on the natural and social environment.	Not recommended as it is considered to have the greatest environmental and social impact.	Not recommended because understanding of residents in each house is essential and it is considered to take time for the effect to be manifested.

Source: JET

(2) Comparative Study of Alternatives for Sewerage Areas

A comparative study of alternatives was also conducted for the demarcation of the sewerage area. The proposal to divide the entire sewerage area into one area and construct a treatment plant in one location is technically difficult due to topographical aspects such as the rivers that exist in the area. In addition, if the area is divided into eight zones, it will be necessary to acquire land for eight treatment plants, and this is not recommended because it will not be easy to acquire land for the treatment plants and to accommodate the relocation of residents. Therefore, from technical and social aspects, it is appropriate to divide the project into four zones.

Table B8-16 Comparative Study of Alternatives for Sewerage Areas

Item	Alternative 1 1 zoning	Alternative 2 4 zoning	Alternative 3 8 zoning
Summary	Proposal to treat sewage in downtown Pokhara at a single sewage treatment plant.	Proposal to treat sewage in downtown Pokhara at four sewage treatment plant.	Proposal to treat sewage in downtown Pokhara at eight sewage treatment plant.
Cost	Economies of scale since only one facility would be required.	Economies of scale since four facilities would be required.	Economies of scale since eight facilities would be required.
	○	○	△
Technical	Considering the topography of Pokhara, it is difficult to collect sewage from the entire city of	Although it is possible to collect sewage from eight areas to the treatment plant, pumping up will	While it is possible to collect sewage from the four areas to the treatment plant, some pumping

Item	Alternative 1 1 zoning	Alternative 2 4 zoning	Alternative 3 8 zoning
	Pokhara in one facility due to the gradient. Sewage needs to be pumped up at many locations.	be necessary in some areas.	up will be required.
	×	○	○
Environment	Although only one land development site would be required, a large area of land would be needed and the impact of land development and tree trimming could be significant.	No large tracts of land are needed, but tree trimming and other impacts will occur due to land development in four locations.	Large areas of land would not be required, but tree trimming and other impacts would occur due to land development in eight locations.
	△	△	△
Social	Although only one site will be needed for land acquisition, a large area of land will be required, and the impact on site selection and resettlement may be severe.	Land needs to be acquired for four sites, and there are concerns about the impact on land acquisition and resettlement.	It is not easy to secure land for 8 sites, and the impact on land acquisition and resettlement may be severe.
	×	△	×
Evaluation	Not recommended because the technical hurdles are very high and practical implementation would be difficult.	Technically feasible, and the environmental and social impacts are not serious, so it is recommended.	Technically feasible, but not recommended due to significant impacts on site selection, land acquisition , and resettlement.
	×	○	△

Source: JET

(3) Potential WWTP Sites

The location of the sewage treatment plant was also compared for 10 candidate sites in Pokhara City. The results showed that the construction of facilities at 1. LEKNATH GADI GHAT, 5. POKHARA LANDFILL SITE, 8. POKHARA POWERHOUSE EAST SIDE HILL, and 10. POKHARA YAMDI (HEMJA) were more suitable than the other sites from economic and environmental social aspects.

Table B8-17 Study of Alternatives for Potential WWTP Site

Location Name	Owner	Economic	Location	Technical	Environmental and Social Considerations	Evaluation
1. LEKNATH GADI GHAT	Individual	Land acquisition is relatively easy because it is agricultural land and resettlement does not occur.	Adjacent to a river and within 1 km to a major highway.	The land is a large area of about 6 hectares and there are no technical obstacles.	There is no forested land, so tree removal will be minimal. Although land acquisition is necessary, resettlement is not expected.	The site is best suited for a wastewater treatment plant in the East District because resettlement is not expected and the impact on tree removal will be minimal.
2. LENATH WEST OF PATNERI	Individual	The land is being developed as residential land, and compensation will be expensive due	Adjacent to a river and within 1.7 km of a major highway.	The site is a large area of about 9 ha and there are no technical obstacles.	There is no forest land, so tree clearing will be minimal. The area is being developed as a	The site is developed as a residential area, and its use is not easy considering

Location Name	Owner	Economic	Location	Technical	Environmental and Social Considerations	Evaluation
		to resettlement.			residential area, and land acquisition and resettlement will occur.	the acquisition of land and relocation of residents.
3. LEKNATH SOUTH OF PATNERI	Individual	The land is being developed as a residential area, and compensation will be expensive due to resettlement.	Adjacent to a river and accessible to a main trunk road within 1 km.	The land area is about 6 ha and there is no technical difficulty.	In addition to the presence of forest land and the expected tree cutting, the area is being developed as a residential area, and land acquisition and resettlement are expected.	The site is being developed as a residential area, and its use is not easy considering the acquisition of land and relocation of residents.
4. LEKNATH LAME AAHAL FOREST	PMC	The state has already done a detailed design of the bus parking lot, and construction of the facility will be difficult.	Adjacent to a major trunk road and a river.	The land is about 5 ha in area, and although the land is somewhat small, there are no technical obstacles.	Part of the site is forested, and tree felling will occur. There is no private land, and resettlement will not occur.	The state has already done a detailed design of the bus parking lot, so it is not realistic to use the site.
5. POKHARA POWERHOUSE EAST SIDE HILL	Individual	Land acquisition is relatively easy because it is agricultural land and resettlement is minimal.	Adjacent to a river and less than 2 km from a main trunk road.	Land of about 9 ha, but the flat area is divided and may need to be connected by pipes.	Although part of the site is forest land, tree cutting related to the construction of facilities is limited. Resettlement is expected to occur, albeit on a small scale.	While land acquisition and minor resettlement would occur, this is the most realistic of the possible West sites.
6. POKHARA POWER HOUSE EAST SIDE	PMC	Although the land is PMC land, it is located at the bottom of a cliff, so the cost of building an access road and reinforcing the slope will be significant.	Adjacent to a river and about 1.4 km to a main trunk road. An access road to the cliff bottom needs to be developed.	Located along a river below a cliff, flood control measures and reinforcement of the slope will be necessary.	No tree cutting or resettlement is expected, but there is concern about the impact of drainage on water intake facilities downstream. There is also a risk of flood damage.	The site is not recommended from a safety standpoint due to its location at the bottom of a cliff, which makes the construction of an access road expensive and increases the risk of

Location Name	Owner	Economic	Location	Technical	Environmental and Social Considerations	Evaluation
						flooding.
7. POKHARA POWERHOUSE WEST SIDE	Individual	Compensation is expensive because the land is being developed as a residential area and resettlement will occur.	The distance to the river is about 240m. It is also about 1.5 km to the main trunk road.	The site is a coherent land of about 3 ha, and the land is narrow, requiring ingenuity in the layout of facilities.	No tree felling is expected, but resettlement will occur.	The site is developed as a residential area, and it is not easy to use the site in consideration of land acquisition and resettlement.
8. POKHARA LANDFILL SITE	PMC	The land is PMC land, and resettlement will not occur, so land acquisition is not required.	Adjacent to a river, and about 5 km from a main trunk road.	Excluding the area of the former disposal site, the land area is about 3-4 ha, which is rather small.	Partial tree trimming will occur, but not on a large scale. Resettlement will not occur.	The site is appropriate as a potential site for a sewage treatment plant in the Central region because it does not require land acquisition or resettlement.
9. POKHARA SITE MILITARY AREA	Government of Nepal	Eminent domain is not permitted because the land is military land.	Adjacent to a river and about 4-5 km from a major highway.	The land is about 9 ha in size and there are no technical obstacles.	Tree felling is expected, but not on a large scale. There is no private land, and resettlement will not occur.	The site is not realistic as a candidate construction site because it is a military site and it is difficult to obtain a site.
10. POKHARA YAMDI (HEMJA)	Individual	Resettlement will occur, albeit on a small scale. The amount of coverage is relatively inexpensive due to the flood-prone nature of the area.	Adjacent to a river and a major road.	The land is small, about 2 ha, but the scale of the facility is small because the volume of treatment is small compared to other treatment areas. However, flood control measures are necessary.	Tree felling will occur in some areas, but only to a limited extent. In addition to resettlement, there is a risk of flood damage due to the low land near the river.	Although it is not positively recommended considering resettlement and flood risk, there are no other suitable candidate sites in Hemja.

* Four sites in gray hatching were selected as final candidate sites.
Source: JET

B8.4 Scoping

Scoping was conducted for the five project components envisioned in this MP WWTP, sludge treatment facility, on-site treatment facility, pump station, and sewage pipeline culvert for each of the project characteristics and existing environmental and social conditions in the target area, and for the possible impact items.

Table B8-18 Scoping Result

Impact items				Selection status					Reason for selection
				Sewage treatment facilities	Sludge treatment facilities	On-site treatment facilities	Pumping stations	Sewage culverts	
Pollution Control	1	Air pollution	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** Temporary deterioration of air quality and generation of dust and dirt are expected due to the operation of construction equipment. **During Operation:** Air pollution is not a particular consideration, as the pump motors at the facility run on commercial electricity supplied at all times.
			During operation						
	2	Water pollution	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** Increased wastewater loads associated with construction and land development are expected. **During Operation:** While improved sewage treatment is expected to improve the quality of wastewater discharged to public water bodies, water quality is expected to deteriorate if treatment is not adequate.
			During operation	✓	✓	✓	✓	✓	
	3	Waste	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** Construction waste (industrial waste) and general waste is expected to be generated at the construction site. **During Operation:** Sludge will be generated from the treatment facility. General waste will be generated by the operation manager, etc., but there is no significant impact as it is handled together with normal general waste disposal.
			During operation	✓	✓	✓			
	4	Soil and underground pollution	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** There is a possibility of soil contamination due to oil spills from construction equipment. **During Operation:** Leakage of untreated water may cause soil and groundwater contamination.
			During operation	✓	✓	✓	✓	✓	
	5	Noise and Vibration	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** Noise and vibration are generated by the operation of construction equipment for construction. **During Operation:** Noise may be generated from pumps/motors installed at treatment facilities and pumping stations.
			During operation	✓	✓	✓	✓		
	6	Land subsidence	Before and during construction						No work or other activities that would cause land subsidence are anticipated.
			During operation						
	7	Bad odor	Before and during construction						**Before Construction:** At the time of construction implementation, it is unlikely that materials associated with the

Impact items				Selection status					Reason for selection
				Sewage treatment facilities	Sludge treatment facilities	On-site treatment facilities	Pumping stations	Sewage culverts	
			During operation	✓	✓	✓	✓		generation of odors, such as human waste and hydrogen sulfide, will be generated. **During Operation:** There is the potential for odors associated with the operation of the facilities.
	8	Bottom sediment	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** In all projects, it is anticipated that runoff soil from land development and construction activities will be deposited in rivers and wetlands. **During Operation:** Proper treatment of sewage is expected to improve the bottom sediment environment of rivers and lakes.
			During operation						
Natural (physical) environment	9	Protected areas	Before and during construction	✓	✓	✓	✓	✓	The target area is located in a Ramsar wetland. **During Construction:** Wetland and ecosystem degradation associated with land development and construction work is a concern. **During Operation:** Proper treatment of sewage is expected to improve wetland and lake environments.
			During operation						
	10	Ecosystems	Before and during construction	✓	✓	✓	✓	✓	The target area is located in a Ramsar wetland. **During Construction:** There is concern about the degradation of protected areas and ecosystems due to land development and construction work. **During Operation:** Proper treatment of sewage is expected to improve wetland and lake environments.
			During operation						
	11	Hydrology	Before and during construction						**Under Construction:** Large amounts of wastewater from construction are not anticipated. **During Operation:** Depending on the volume of water discharged to the collective treatment facility, hydraulic alteration may occur.
			During operation	✓	✓				
	12	Topography, geology	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** In both projects, land alteration (including reclamation) due to construction work is anticipated. **During Operation:** No excavation or large-scale pumping is anticipated that would affect the topography and geology.
			During operation						
Social Environment	13	Land acquisition, Involuntary resettlement	Before and during construction	✓	✓	✓	✓	✓	**Before Construction:** Land acquisition on privately owned land will occur. Resettlement may also occur. **Under Construction/During Operation**: No new land acquisition is anticipated after the start of construction.
			During operation						
	14	Poor peoples	Before and during construction	✓	✓	✓	✓	✓	The Jalari ethnic group living on the lakeshore, who make their living from traditional fishing, may need to be considered as a poor group. In formulating the plan, sufficient consideration must be given to ensure that the poor are not disadvantaged.
			During operation	✓	✓	✓	✓	✓	
	15	Minority peoples,	Before and during construction	✓	✓	✓	✓	✓	Pokhara is a city with a diverse ethnic mix, and the extent of the impact on minorities and indigenous peoples is unknown at this

Impact items				Selection status					Reason for selection
				Sewage treatment facilities	Sludge treatment facilities	On-site treatment facilities	Pumping stations	Sewage culverts	
		Indigenous peoples	During operation	✓	✓	✓	✓	✓	time. If there are minorities or indigenous peoples to be protected, planning should be done with due consideration.
	16	Local economy, such as employment and means of livelihood	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** It is assumed that the construction work will create opportunities for private companies to receive orders and for residents to be employed, thereby revitalizing the local economy, but the extent of this impact is unknown. **During Operation:** While the operation of the facility is expected to create jobs, the impact on fishermen due to sewage drainage and the impact on users due to community forest cutting may occur.
			During operation	✓	✓	✓			
	17	Land use and local resource use	Before and during construction	✓	✓				Impacts to local resources used by local residents as a result of the construction and operation of treatment facilities need to be avoided or minimized. If they cannot be completely avoided, appropriate compensation should be provided based on a socioeconomic study of the area.
			During operation	✓	✓				
	18	Water use	Before and during construction						**During Operation:** Proper treatment of sewage is expected to improve the water environment of rivers and lakes, and is assumed to have a positive impact on the living environment of residents.
			During operation						
	19	Existing social infrastructure and social services	Before and during construction	✓				✓	**During Construction:** If the pipe culverts are to be laid under the road, there is a possibility of disruption to road traffic. In addition, one of the WWTPs will be located near an airport, which will require consultation with CAAN. **During Operation:** The amount of waste sludge will increase, which may put pressure on the capacity of waste disposal sites.
			During operation	✓	✓				
	20	Social organizations such as social capital and local decision-making bodies	Before and during construction						Pokhara City, especially the Phewa Lake area, has a thriving tourism industry. Through stakeholder consultations in the development of this MP, it is expected that the activities of NGOs and citizen groups will be activated, and mutual communication regarding lake environmental conservation will be promoted.
			During operation						
	21	Uneven distribution of damages and benefits	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** Although the project aims to contribute to the improvement of the water environment, the noise, particulate matter, and construction vehicles driving through the area may cause significant damage to the residents of the proposed construction site and other affected residents. **During Operation:** In areas where there is a switch from on-site treatment to sewage systems, this could put pressure on the sludge processors' operations. In addition, regional differences in systems may cause
			During operation	✓	✓	✓	✓	✓	

Impact items				Selection status					Reason for selection
				Sewage treatment facilities	Sludge treatment facilities	On-site treatment facilities	Pumping stations	Sewage culverts	
									uneven distribution of benefits.
	22	Regional fragmentation	Before and during construction	✓	✓	✓	✓	✓	**During Construction and Operation:** Although there is a possibility that conflicts of interest may arise within the community regarding the low or no benefits from the improvement of the sewage system, the extent of such conflicts is unknown.
			During operation	✓	✓	✓	✓	✓	
	23	Cultural heritage	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** There is a possibility of construction around the Bindhyabasini Temple, a cultural heritage site located in the Old City, but the extent of the impact is unknown at this time. **During Operation:** The water discharged from the facility will be discharged into the river and is not expected to affect the cultural heritage.
			During operation						
	24	Landscape	Before and during construction	✓	✓	✓	✓	✓	Pokhara City is a tourist destination and is dotted with scenic spots. **During Construction:** Depending on the location of the facility, the operation of heavy construction equipment could impact the landscape. **During Operation:** The installation of the structure will change the landscape, but the extent of the impact is unknown.
			During operation	✓	✓	✓	✓	✓	
	25	Gender	Before and during construction						It is expected that the social participation of women's groups will be promoted and their activities will be activated with regard to the formulation of the MP and subsequent business plans and the conservation of the water environment of Lake Phewa.
			During operation						
	26	Children's rights	Before and during construction						**During Operation:** Improvements to the sewage treatment system are expected to improve the living environment for children.
			During operation						
	27	Infectious disease such as HIV/AIDS	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** There is concern about the impact of HIV/AIDS and other infectious diseases due to the influx of construction workers. **During Operation:** Proper treatment of sewage is expected to reduce the risk of waterborne diseases.
			During operation						
	28	Labor environment	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** The working environment of construction workers needs to be taken into consideration. **During Operation:** There is also a risk of acid deprivation and gas poisoning during maintenance, and the working environment for workers must be carefully considered.
			During operation	✓	✓	✓	✓	✓	
	29	Accidents	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** In any of these projects, there is a possibility that accidents may occur during construction work. **During Operation:** Accidents associated with facility operation (e.g., accidents
			During operation	✓	✓	✓	✓	✓	

Impact items				Selection status					Reason for selection
				Sewage treatment facilities	Sludge treatment facilities	On-site treatment facilities	Pumping stations	Sewage culverts	
									caused by work equipment, falls during work, etc.) are expected to occur.
Others	30	Climate Change	Before and during construction	✓	✓	✓	✓	✓	**During Construction:** CO_2 emissions are expected to increase due to the operation of heavy machinery.
			During operation	✓	✓				**During Operation:** The water treatment process is expected to generate greenhouse gases (methane and nitrous oxide).

Source: JET

Based on the scoping results, the proposed TORs for environmental and social considerations in the envisioned projects are organized in this MP as shown in Table B8-19 below. In implementing each project, it is necessary to implement environmental and social considerations based on local laws and regulations, referring to the following environmental and social items and evaluation methods.

Table B8-19 TOR of Environmental and Social Consideration Survey

Environmental items	Survey Items	Survey Method
Air pollution	・ Confirmation of environmental standards, etc. (Environmental standards in Nepal, etc.) ・ Location of residences, schools, hospitals, etc. in the vicinity of the project site ・Exhaust gas from heavy construction equipment	・Existing document survey ・Field survey ・ Confirmation of construction work, type of construction equipment, type of pumps, etc.
Water pollution Bottom sediment	・ Confirmation of environmental standards, etc. (Nepalese effluent standards, etc.) ・Water quality of rivers, lakes, etc. ・Water quality of rivers, lakes, etc. ・Status of use of river water, etc.	・Existing document survey ・ Confirmation of the surrounding environment through on-site surveys and interviews ・Confirmation of the construction work, wastewater volume and water quality conditions due to the use of the facility.
Waste	・Construction waste disposal methods ・Sludge treatment methods	・Interviews with relevant organizations ・Similar Case Study
Soil and underground pollution	・Measures to prevent oil leakage during construction ・ Measures to prevent leakage of untreated water	・Confirmation of the nature of the work, construction method, duration, type of construction machinery and equipment, and location of operation and storage. ・Confirmation of facility operation and maintenance methods
Noise and Vibration	・ Confirmation of environmental standards, etc. (Nepalese environmental standards, etc.) ・ Location of residences, schools, hospitals, etc. in the vicinity of the project site ・Noise sources during construction	・ Confirmation of the surrounding environment through field surveys, interviews, and literature review ・ Confirmation of construction work, type of construction equipment, type of pumps, etc.
Bad Odor	・Odor emission from facilities ・ Location of residences, schools,	・Confirmation of odor generation by similar facilities, on-site survey

Environmental items	Survey Items	Survey Method
	hospitals, etc. around the project site	
Protected areas, Ecosystems	・Location of protected areas around the facility ・Habitat of valuable species	・Confirmation of plant and animal species and vegetation through literature review ・Field survey and interviews
Hydrology	・Impact on drainage destination	・Confirmation of the flow rate at the discharge site (river, etc.) ・Confirmation of the contents of the construction work, the amount of wastewater and water quality due to the use of the facility
Topography, geology	・Impact of land alteration due to construction in progress	・Topographical and geological survey, calculation of excavation and fill volume ・Field survey and interviews
Land acquisition, Involuntary resettlement	・Confirmation of Land Acquisition and Resettlement scale ・Confirmation of land use status and land acquisition method of the candidate site ・If resettlement is required, prepare RAP.	・Confirmation of relevant legal systems ・Field surveys and interviews ・Survey on resettlement plan based on the country system and World Bank safeguards, etc. (population census, property site survey, household livelihood survey, etc.)
Minority peoples, Indigenous peoples	・Confirmation of existence of indigenous peoples' residential areas and living conditions	・Document review and interviews
Local economy, such as employment and means of livelihood	・Impact of treated wastewater on fishery and agricultural workers, etc.	・On-site survey and interviews
Land use and local resource use	・Impact on local resources (tourism, community forests, etc.)	・On-site survey and interviews
Existing social infrastructure and social services	・The presence or absence of residences, schools, hospitals, etc. in the vicinity of the project site ・Remaining capacity of the waste disposal site where the sludge will be disposed of ・Impact on the new international airport	・On-site survey and interviews ・Confirmation of construction plan
Uneven distribution of damages and benefits	・Damage to nearby residents during construction ・Management of sludge processors	・On-site survey ・Literature review and interviews
Regional fragmentation	・Possible conflicts between sewerage area and out-of-district residents	・On-site survey and interviews
Cultural heritage	・Impact during construction for the installation of pipelines	・Confirmation of scope and process of construction
Landscape	・Landscape of the proposed facility construction site	・On-site survey and interviews
Infectious disease such as HIV/AIDS	・Working environment for workers during construction and operation	・Confirmation of construction plan and facility operation plan, and Interviews
Labor environment	・Working environment for workers during construction and operation	・Confirmation of construction plan and facility operation plan, and Interviews
Accidents	・Details of accidents that may occur during construction and operation	・Details of accidents that may occur during construction and operation, and study of countermeasures
Climate Change	・Greenhouse gas emissions during construction ・Greenhouse gas emissions from the	・Number and type of vehicles and heavy equipment to be used for construction ・On-site survey and interviews

Environmental items	Survey Items	Survey Method
	sewage treatment process	・Confirmation of the scale of the facility, treatment methods, effective use of the greenhouse gases generated, etc.

Source: JET

B8.5 Stakeholder Meeting

(1) Consultation with Key Stakeholders

In order to formulate an MP and implement the project, it is important to consult with various stakeholders, consider the opinions received, and reflect them as necessary. Therefore, consultations were conducted mainly with government agencies, local community representatives, and NGOs. Below are the key stakeholders consulted during the SEA process of this MP and their main opinions.

Table B8-20 Results of Consultation with Key Stakeholders

Content	Main Opinions
PMC	
Director of each Ward (33Wards in total)	・ We recognize that sewage management is a very important issue and welcome the efforts of this MP. ・ The facility should be designed to prevent odor problems. ・ When acquiring land for a site, compensation based on current laws and regulations is essential.
PMC Mayor and staff (technical and other positions)	・ We recognize that sewage management is a very important issue. ・ Public land is preferable for facility construction due to cost issues. ・ The facility should be designed to prevent odor problems.
Government Organization	
Ministry of Energy, Water Resource, and Water Supply, Gandaki Province	・ No projects related to sewage treatment have been implemented in Pokhara City. ・ The city recognizes that sewage management is a very important issue, but the cost of implementation is prohibitive.
Ministry of Physical Infrastructure, Urban Development and Transport Management, Gandaki Province	・ The city recognizes that sewage management is a very important issue, but the cost of implementation is prohibitive.
NWSC, Pokhara	・ Although Phewa Lake Waste Water Management was previously planned, there are currently no projects related to sewage treatment in Pokhara City. ・ The city recognizes that sewage management is a very important issue, but the cost of implementation is prohibitive.
MoWS, Pokhara	・ Although sewage management is recognized as a very important issue, it has not been implemented to date because of the huge costs involved in its implementation. ・ Sewage treatment requires a coordinated effort by government, private companies, citizens, and NGOs.
NGO etc.	
International Nepal Fellowship (INF)	・ No sewage treatment projects have been implemented in Pokhara City.
Local Initiatives for Biodiversity, Research and Development (LI-BIRD),	・ No sewage treatment projects have been implemented in Pokhara City, but bamboo plantations have been carried out in wetlands to prevent water pollution.
Private Sludge Extraction Company	・ For sewage treatment, it is important for the government, private companies, and citizens to work together.

Source: JET

Also detailed below are the details of the discussions with each stakeholder.

Table B8-21 Record of Discussions with Each Ward Wardens

Ward	Name	Title	Gender	Date and time	Location	Opinion
1	Sarada Parajuli	Ward 1 Chairman	Female	1 March 2022 13:00-14:00	Ward office	・ Fecal sludge directly mixed up into the Seti River from the slum area. ・ Ward office-built drainage (1 km) from Simpani to Nepal Bank. ・ No sewerage-related planning. ・ No organization working for sewerage management. ・ The PMC should be responsible for sewerage management. ・ A suitable site should be selected for sewerage pipeline and treatment plant to overcome other environmental issues. ・ People would be ready to pay monthly tariffs if they get facilitated for sewerage management problems. **[Response on the implementing organization/Reflection on the plan]** ・ A consideration of the operation and maintenance system of the sewerage will be conducted. ・ Four candidate sites will be selected from environmental and social perspectives.
2	Rameshwor Malla	Ward 2 Chairman	Male	27 February 2022 10:00-11:00	Chairman residence	・ No sewerage-related planning. ・ No organization is working for sewerage management. ・ The municipality should be responsible for sewerage management. ・ A suitable site should be selected for the sewerage pipeline and treatment plant to overcome other environmental issues. ・ People would be ready to pay monthly tariffs if they get facilitated for sewerage management problems. **[Response on the implementing organization/Reflection on the plan]** ・ A consideration of the operation and maintenance system of the sewerage will be conducted. ・ Four candidate sites will be selected from environmental and social perspectives. ・ Consider the price and collection method of sewer fees.
3	Rabindra Bahadur Praju	Ward 3 Chairman	Male	27 February 2022 13:00-14:00	Chairman residence	
4	Shankhar Bastola	Ward 4 Secretary	Male	28 February 2022 14:30-15:30	Ward office	
5	Bishnu prasad Sharma	Ward 5 Secretary	Male	1 March 2022 15:00-16:00	Ward office	
6	Kul Raj Paudyal	Ward 6 Secretary	Male	14 February 2022 10:30-11:30	Ward office	・ Exist a problem in Phewa Lake [6 drainages (carrying sewerage on it) mix into the lake including Firke river (Firke touches 2, 5, 7, and 6 wards)]. ・ Sewerage runoff in monsoon season causes bad smelling and the spreading of disease. ・ A suitable site should be selected for the sewerage pipeline and treatment plant to

Ward	Name	Title	Gender	Date and time	Location	Opinion
						overcome other environmental issues. ・ The municipality should be responsible for sewerage management. ・ People would be ready to pay monthly tariffs if they get facilitated for sewerage management problems. **[Response on the implementing organization/Reflection on the plan]** ・ A consideration of the operation and maintenance system of the sewerage will be conducted. ・ Four candidate sites will be selected from environmental and social perspectives. ・ Prevent wastewater runoff by improving sewage systems. ・ Consider the price and collection method of sewer fees.
7	Ram Chandra Baral	Ward 7 Chairman	Male	2 March 2022 13:00-14:00	Ward office	・ No sewerage-related planning. ・ No organization working in Pokhara for sewerage. ・ PMC should be responsible for sewerage management. ・ To overcome the problem, sewerage management project is required in Pokhara ・ People would be ready to pay monthly tariffs if they get facilitated for sewerage management problems. **[Response on the implementing organization/Reflection on the plan]** ・ A consideration of the operation and maintenance system of the sewerage will be conducted. ・ Four candidate sites will be selected from environmental and social perspectives. ・ Consider the price and collection method of sewer fees.
8	Rudranath Baral	Ward 8 Chairman	Male	2 March 2022 10:30-11:30	Ward office	
9	Jhankanath Poudyal	Ward 9 Secretary	Male	2 March 2022 15:20-16:30	Ward office	
10	Rajkumar Gurung	Ward 10 Chairman	Male	28 February 2022 12:00-13:00	Ward office	
11	Mohan Prasad Bastola	Ward 11 Chairman	Male	28 February 2022 10:00-11:00	Ward office	
12	Ran Bahadur Karki	Ward 12 Chairman	Male	1 March 2022 10:00-11:00	Ward office	
13	Lek Bahadur Tamang	Ward 13 Chairman	Male	27 February 2022 16:00-17:00	Kundahar	・ No sewerage-related planning. ・ No organization for sewerage management. ・ The municipality should be responsible for sewerage management. ・ A suitable site should be selected for the sewerage pipeline and treatment plant to overcome other environmental issues. ・ People would be ready to pay monthly tariffs if they get facilitated for sewerage management problems.
14	Prem Bahadur Karki	Ward 14 Chairman	Male	27 February 2022 10:30-11:30	Ward office	

Ward	Name	Title	Gender	Date and time	Location	Opinion
15	Ram Chandra Poudyal	Ward 15 Chairman	Male	27 February 2022 13:00-14:00	Ward office	**[Response on the implementing organization/Reflection on the plan]** ・A consideration of the operation and maintenance system of the sewerage will be conducted. ・Four candidate sites will be selected from environmental and social perspectives. ・Consider the price and collection method of sewer fees.
16	Mehar Man Thapa	Ward 16 Chairman	Male	3 March 2022 9:30-10:30	Ward office	
17	Tirtha raj Adhikari	Ward 17 Chairman	Male	27 February 2022 14:30-15:30	Ward office	
18	Ran Bahadur Thapa	Ward 18 Chairman	Male	7 March 2022 10:00-11:00	Ward office	
19	Shobha Mohan Poudyal	Ward 19 Chairman	Male	3 March 2022 11:00-11:30	Ward office	・Much problem exists in this ward regarding fecal sludge management, especially in rainy seasons. (Little Angeles School to Sundar-fit) ・Sewerage management planning could not be implemented in this ward because of fund. ・The PMC should take responsibility for sewerage management planning and implementation. ・People would be ready to pay monthly tariffs for sewerage management. **[Response on the implementing organization/Reflection on the plan]** ・A consideration of the operation and maintenance system of the sewerage will be conducted. ・Prevent wastewater runoff by improving sewage systems. ・Consider the price and collection method of sewer fees.
20	Sim Bahadur Gurung	Ward 20 Chairman	Male	7 March 2022 11:30-12:30	Ward office	・No sewerage-related planning ・No organization is working for sewerage management. ・The municipality has provisioned of Septic tank during building construction. ・As per the settlement pattern, appropriate sewerage management should be planned. ・People would be ready to pay for sewerage management services. **[Response on the implementing organization/Reflection on the plan]** ・A consideration of the operation and maintenance system of the sewerage will be conducted. ・Sewerage improvement plans are expected to be implemented in the Pokhara urban area,
21	Khag Raj Acharya	Ward 21 Chairman	Male	3 March 2022 13:30-14:00	Ward office	
22	Ram Prasad Poudel	Ward 22 Secretary	Male	7 March 2022 13:30-14:30	Ward office	
23	Sher Bahadur Kuwal	Ward 23 Secretary	Male	7 March 2022 15:00-15:30	Ward office	

Ward	Name	Title	Gender	Date and time	Location	Opinion
24	Om Prasad Subedi	Ward 24 Chairman	Male	6 March 2022 14:00-15:00	Ward office	with on-site treatment in rural areas. ・ Consider the price and collection method of sewer fees.
25	Dal Bahadur Kuwar	Ward 25 Person	Male	1 March 2022 12:30-13:30	Ward office	
26	Narayan Baral	Ward 26 Chairman	Male	22 March 2022 15:00-16:00	Ward office	
27	Purna Kumar Gurung	Ward 27 Chairman	Male	22 March 2022 13:00-14:00	Ward office	
28	Nirmal Diyali	Ward 28 Chairman	Male	27 February 2022 14:30-15:30	Ward office	
29	Chet Bahadur Gurung	Ward 29 Chairman	Male	27 February 2022 11:00-12:00	Ward office	
30	Rajendra Poudyal	Ward 30 Secretary	Male	23 March 2022 14:00-14:30	Ward office	
31	Kamal Bahadur Thapa	Ward 31 Chairman	Male	23 March 2022 15:00-15:30	Ward office	
32	Dharma Bahadur Basnet	Ward 32 Person	Male	23 March 2022 16:00-16:30	Ward office	
33	Dilli Ram Giri	Ward 33 Chairman	Male	7 March 2022 16:00-17:00	Ward office	

Source: JET

Table B8-22 Record of Discussions between Chairman and new Chairman Regarding the Potential Site of the Sewage Treatment Plant (WWPT)

Name	Title	Gender	Date and Time	Location	Opinion
Akkal Bahadur Karki	Ward Chairman, Ward 32, PMC	Male	14 July 2022	Ward office	・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free. ・ The candidate land of treatment plant of ward 32 is a private land which belongs to Mr. Ranabhat. ・ Other lands are also available in the vicinity of proposed site (may cost around Rs 9800 per m^2) nearby Gagan Higher Secondary School. But need to take action as soon as possible with the help of PMC otherwise these lands wouldn't be available in the future. ・ Long term vision for sewerage management is required. ・ In this ward due to the expansion of the marketplace, sewerage system shall be required at around 10 years. ・ Compensation (as per current rules and guidelines) should be made. **[Response on the implementing organization/Reflection on the plan]** ・ Installation of covering facilities for odor reduction will be considered. ・ A master plan by 2050 will be prepared. ・ Private land will be acquired through consensus building.
Radhika Kumari Shahi	Ward Chairman, Ward 17, PMC	Female		Ward office	・ Candidate sites exist in east and west side of the Powerhouse. ・ An access road is recently opened at the west side of powerhouse to planned to make a playground. ・ Another candidate site (East of powerhouse) is located near to the Dumsali bridge. In this site care should be taken of probable flood from the Seti River. This site is a private land and belongs to Sriram Bharati. ・ In the vicinity of this site, public land is also exists which may be available to the project. ・ No settlement near to this candidate site. ・ Land near to the site may cost around Rs 16700 per m^2. Near the powerhouse the land is very costly around 5 lakhs per hand (Which is around 10 million for 10m X 20 m size of land) ・ This project is very essential for the development of PMC and should go into implementation as soon as possible. **[Response on the implementing organization/Reflection on the plan]**

Name	Title	Gender	Date and Time	Location	Opinion
					・ Consider the impact of flooding from the Seti River and consider facility layout. ・ Identify the land surrounding the project site and consider the location of access roads. ・ Plan to implement the project in a systematic manner, taking into account the necessary procedures.
Motilal Timsina	Ward Chairman, Ward 25, PMC	Male		Ward office	・ This project is extremely necessary to manage wastewater. ・ Surrounding the candidate site there are a Restaurant and residential area. So, the treatment plant should be smell free. ・ Necessary to complete this project with a sustainable approach. ・ The proposed treatment plant site is a private land owned by Mr. Palikhe and others. ・ Compensation (as per current rules and guidelines) is extremely necessary. **[Response on the implementing organization/Reflection on the plan]** ・ Installation of covering facilities for odor reduction will be considered. ・ Consensus will be reached to acquire the land for the site. ・ The amount of compensation will be set according to Nepalese rules and guidelines and JICA guidelines.
Dhanraj Acharya	Mayor, PMC	Male		PMC New road	・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free. ・ For treatment Plant site, as far possible, should be selected public land, since PMC could not afford for the costly land **[Response on the implementing organization/Reflection on the plan]** ・ Installation of covering facilities for odor reduction will be considered. ・ While the use of public land is preferred, private land acquisition is expected to be necessary as suitable land is not always available.
Balaram Rijyal	Administrative Officer, PMC	Male		Ward office	・ Suitable sites should be selected to minimize the environmental impact. ・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free. **[Response on the implementing organization/Reflection on the plan]** ・ Installation of covering facilities for odor reduction

Name	Title	Gender	Date and Time	Location	Opinion
					will be considered.
Sri Prasad Gurung	Ward Chairman, Ward 29, PMC	Male		Ward office	・ Patneri South site is of governmental land where we are also planning to make landfill site. In this regard, we are happy to share this land with JICA'S project so that our planning could be benefited from this project. ・ This project is extremely necessary for sewer management and should be done as soon as possible. ・ However, hydropower works are running 400 m away from the Patneri site. The Dam of this Project might affect the candidate site of Patneri. ・ There is alternative site near Bagadi river. ・ The treatment plant should be smell free. **[Response on the implementing organization/Reflection on the plan]** ・ The impact of the dam on the power plant will be considered, but is not expected to be significant. ・ With regard to alternative sites, various factors will be considered, including their area, topography, environmental and social aspects, etc. ・ The introduction of covering facilities will be considered to reduce odors.
Purna Bahadur Gurung	Ward Chairman, Ward 27, PMC	Male		Ward office	・ Patneri West Site exit private land and nearby this there are pig farms. So, this site is not suitable for WWTP. ・ I would like to suggest alternative site, very suitable in every aspect, near Bagadi river. ・ Suitable sites should be selected to minimize the environmental impact. ・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free. ・ Compensation (as per current rules and guidelines) for project-affected families is extremely necessary. **[Response on the implementing organization/Reflection on the plan]** ・ With regard to alternative sites, various factors will be considered, including their area, topography, environmental and social aspects, etc. ・ Installation of covering facilities for odor reduction will be considered. ・ The amount of compensation will be set according to Nepalese rules and guidelines and JICA guidelines.
Jagdish Panta	Administrative Officer, INF Head	Male		Head Office, Pokhara	・ Currently INF doing plantation, disaster and community health related work in Karnali Province.

Name	Title	Gender	Date and Time	Location	Opinion
	Office, Pokhara				・ No project regarding sewerage and wastewater in PMC. ・ We will communicate to JICA study team if similar project we run. **[Response on the implementing organization/Reflection on the plan]**
Lakpa Sherpa/	Previous Program Coordinator, LIBIRD, Pokhara	Female		Head Office, Pokhara	・ No any work related to sewerage. ・ Bamboo plantation has been done in Pokhara Wetland to reduced water pollution. ・ We will communicate to JICA study team if similar project we run. **[Response on the implementing organization/Reflection on the plan]**
Bharat Bhandari	Senior Staff of LIBIRD, Pokhara	Male			

Source: JET

The PMC's key stakeholders have expressed the following views.

Table B8-23 Views of PMC Key Stakeholders

Name	Title	Gender	Opinion
Akkal Bahadur Karki	Ward Chairman, Ward 32, PMC	Male	・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free. ・ The candidate land of treatment plant of ward 32 is a private land which belongs to Mr. Ranabhat. ・ Other lands are also available in the vicinity of proposed site (may cost around Rs 9800 per m^2) nearby Gagan Higher Secondary School. But need to take action as soon as possible with the help of PMC otherwise these lands wouldn't be available in the future. ・ Long term vision for sewerage management is required. ・ In this ward due to the expansion of the marketplace, sewerage system shall be required at around 10 years. ・ Compensation (as per current rules and guidelines) should be made.
Radhika Kumari Shahi	Ward Chairman, Ward 17, PMC	Female	・ Candidate sites exist in east and west side of the Powerhouse. ・ An access road is recently opened at the west side of powerhouse to planned to make a playground. ・ Another candidate site (East of powerhouse) is located near to the Dumsali bridge. In this site care should be taken of probable flood from the Seti River. This site is a private land and belongs to Sriram Bharati. ・ In the vicinity of this site, public land is also exists which may be available to the project. ・ No settlement near to this candidate site. ・ Land near to the site may cost around Rs 16700 per m^2. Near the powerhouse the land is very costly around 5 lakhs per hand (Which is around 10 million for 10m X 20 m size of land) ・ This project is very essential for the development of PMC and should go into implementation as soon as possible.
Motilal	Ward	Male	・ This project is extremely necessary to manage wastewater.

Name	Title	Gender	Opinion
Timsina	Chairman, Ward 25, PMC		・ Surrounding the candidate site there are a Restaurant and residential area. So, the treatment plant should be smell free. ・ Necessary to complete this project with a sustainable approach. ・ The proposed treatment plant site is a private land owned by Mr. Palikhe and others. ・ Compensation (as per current rules and guidelines) is extremely necessary.
Dhanraj Acharya	Mayor, PMC	Male	・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free. ・ For treatment Plant site, as far possible, should be selected public land, since PMC could not afford for the costly land
Balaram Rijyal	Administrative Officer, PMC	Male	・ Suitable sites should be selected to minimize the environmental impact. ・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free.
Sri Prasad Gurung	Ward Chairman, Ward 29, PMC	Male	・ Patneri South site is of governmental land where we are also planning to make landfill site. In this regard, we are happy to share this land with JICA'S project so that our planning could be benefited from this project. ・ This project is extremely necessary to manage wastewater. So, let's do it very soon. ・ However, hydropower works are running 400 m away from the Patneri site. The Dam of this Project might affect the candidate site of Patneri. ・ There is alternative site near Bagadi river. ・ The treatment plant should be smell free.
Purna Bahadur Gurung	Ward Chairman, Ward 27, PMC	Male	・ Patneri West Site exit private land and nearby this there are pig farms. So, this site is not suitable for WWTP. ・ I would like to suggest alternative site, very suitable in every aspect, near Bagadi river. ・ Suitable sites should be selected to minimize the environmental impact. ・ This project is extremely necessary to manage wastewater. ・ The treatment plant should be smell free. ・ Compensation (as per current rules and guidelines) for project-affected families is extremely necessary.
Jagdish Panta	Administrative Officer, INF Head Office, Pokhara	Male	・ Currently INF doing plantation, disaster and community health related work in Karnali Province. ・ No project regarding sewerage and wastewater in PMC. ・ We will communicate to JICA study team if similar project we run.
Lakpa Sherpa/	Previous Program Coordinator, LIBIRD, Pokhara	Female	・ No any work related to sewerage. ・ Bamboo plantation has been done in Pokhara Wetland to reduced water pollution. ・ We will communicate to JICA study team if similar project we run.
Bharat Bhandari	Senior Staff of LIBIRD, Pokhara	Male	

Source: JET

(2) Future Plan

Table B8-24 shows the consultations and implementation details required for future project implementation based on the MP. After completion of the MP, stakeholder consultations should be conducted with local residents as early as possible to gain their understanding of priority projects, with emphasis on priority project areas. Other ongoing stakeholder consultations on sewage management will be conducted through the PMC's public awareness activities.

Table B8-24 Upcoming Stakeholder Consultations

Phase	Stakeholder meeting	Target	Content
MP preparation phase	Seminar of MP	About 100 people including government agencies, donor officials, Ward Wardens, private companies, NGOs, etc.	A seminar will be held under the auspices of JET to inform the public about the MP and to collect opinions.
Pre-Feasibility Study Phase	Community meeting in Ward 6	Ward 6 TLOs, women's groups, youth groups, local residents, hotels, etc.	Hold public meetings regarding water environment conservation and MP-based development plans.
	Seminar to present the results of JICA projects	About 100 people including government agencies, donor officials, Ward Wardens, private companies, NGOs, etc.	Under JET support, a seminar will be held to disseminate JICA project results, including MP formulation and Pre-F/S for priority projects.
Feasibility Study Phase	Consultation for land acquisition	Landowners, land-users, etc.	Provide consultation on land acquisition for the project.
	Consultation for EIA preparation	Affected residents, etc.	Provide consultation on the project's EIA.

Source: JET

B9 Public Awareness-raising

B9.1 Purpose

In order to promote the sewerage business and proper on-site treatment, it is important to build up a trustable relationship between PMC as the service provider, and residents as the users, aiming to create the behavior change of the residents. For example, if residents show their understanding of the business activities, sewer connection and appropriate desludging will be carried out, and water pollution in Lake Phewa and surrounding ambient waters will be prevented. Also, if the amount of waste dumped into the sewage system is reduced, maintenance costs for the sewerage system will be controlled. However, such a change in the residents' behavior would take years.

For realization of the M/P, PMC will promote public participation and PR activities depending on the target groups and the implementing projects considering the social background of Pokhara City, and gradually increase and deepen the understanding and awareness of the residents regarding wastewater treatment. Through these activities, sustainable and meaningful public participation will be activated for the introduction of a sewerage system, appropriate on-site treatment, and water environment conservation in Pokhara City, and cooperation between the PMC and the residents will be fostered.

B9.2 Public Awareness Survey

B9.2.1 Survey Outline

A public awareness survey was conducted to understand the socio-economic situation regarding wastewater treatment. The survey outline is shown in Table B9-1.

Table B9-1 Outline of the Public Awareness Survey

Item	Contents
Objectives	・ To understand the actual situation of water use and wastewater discharge and to identify issues ・ To analyze people's consciousness on sewerage and wastewater management ・ To explore people's evaluation and willingness-to-pay for future sewerage system ・ To collect socioeconomic information of households (incomes, expenses, etc.)
Survey method	Some households were selected from each ward (2-16 households depending on the population), and a door-to-door questionnaire survey were conducted to a total of 213 households (162 households in the urban area, and 51 households in the rural area). In urban areas, the households were classified into high-income and low-income groups (100 and 62, respectively). In addition, another questionnaire survey was conducted by visiting a total of 10 facilities targeting companies, hospitals, and schools.
Survey period	From April 10 to May 7, 2022 (for one month)

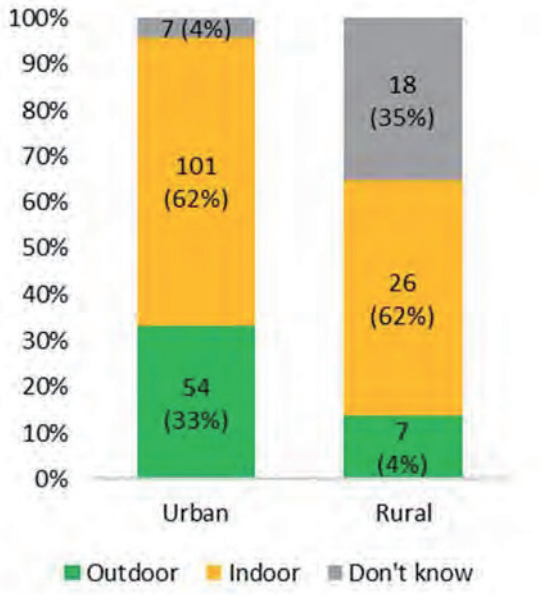
Source: JET

B9.2.2 Survey Results (Households)

Some of notable survey results for general households are shown below. For details, refer to the Appendix-12 "SOCIAL CONDITION SURVEY FINAL REPORT."

(1) Current Status of Septic Tanks and Wastewater

Figure B9-1 shows people's knowledge on the septic tank locations. Two-thirds of the households have septic tanks inside their buildings regardless of whether they are in the urban or rural areas. The remaining one-third in the urban areas answered that they installed septic tanks outside their buildings, while more than one-third in the rural areas did not know the location of their septic tanks.



Note: The result shows number of households and % in brackets.
Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

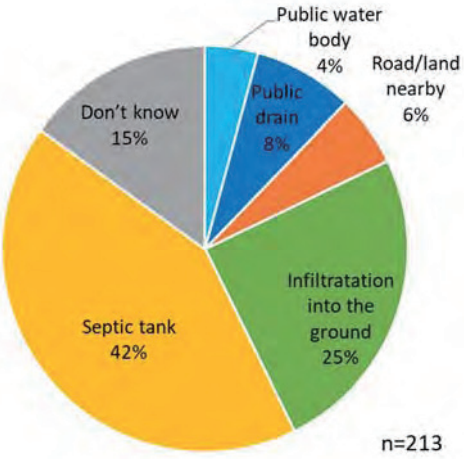
Figure B9-1 People's Knowledge on the Septic Tank Locations (Households)

Figure B9-2 shows people's knowledge on wastewater discharge locations. 42% of the households answered that gray water from kitchens and showers goes into their septic tanks, 25% that it is seeped underground, and 18% that it is discharged into public water bodies, waterways, or surrounding roads/land.

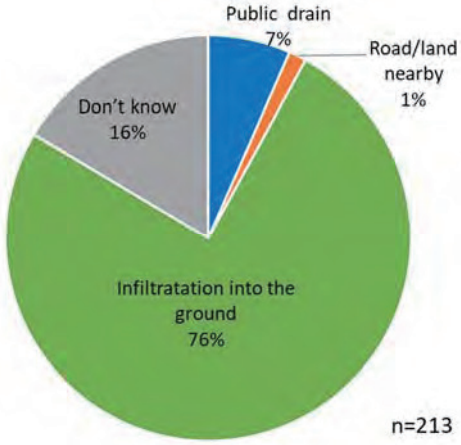
As for drainage from decomposing tanks that receive Black water (sewage), 76% of households drain to underground seepage and 8% drain to public canals or surrounding streets and land. Although the epidemic has not reached a serious level, about 10% of residents reported having been infected with cholera, dysentery, or typhoid fever.

Considering the possibility that households that answered "Don't know" might discharge the effluent underground or into public water bodies, it is assumed that most of the wastewater from septic tanks is infiltrated underground, while at least 20% of miscellaneous wastewater is discharged into public water bodies. Residents' perceptions of the destination of wastewater discharges from each household are shown in Figure B9-2. Grey water from kitchens, showers, etc. was reported by 42% of households as discharging to a septic tank, 25% to underground seepage, and 18% to public

water bodies, waterways, and surrounding streets and land.



Gray water from kitchens and showers

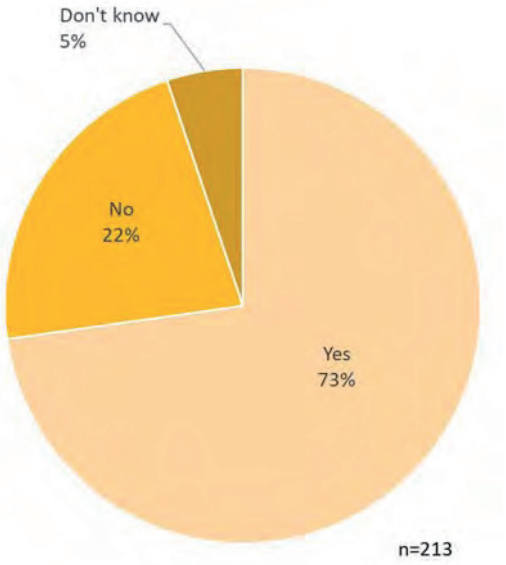


Discharge from septic tanks

Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

Figure B9-2 People's Knowledge on Wastewater Discharge Locations (Households)

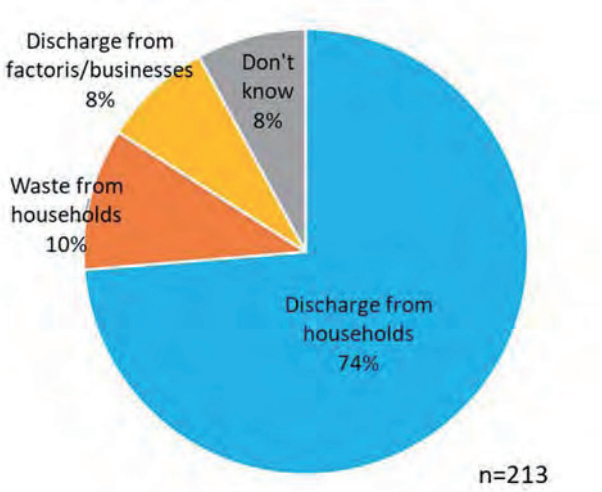
The residents were asked about the presence or absence of odors in water bodies near their houses. 73% answered that they "smell", 22% answered "no smell", and 5% answered "Don't know." Based on the result, it is highly likely that foul odors occur in most water bodies due to water pollution (Figure B9-3).



Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

Figure B9-3 Odors in Nearby Water Bodies (Households)

Figure B9-4 shows people's perception on the main causes of water pollution. 74% answered that it is caused by sewage and miscellaneous wastewater from households, 10% answered by waste, and 8% answered by wastewater from factories and commercial facilities.



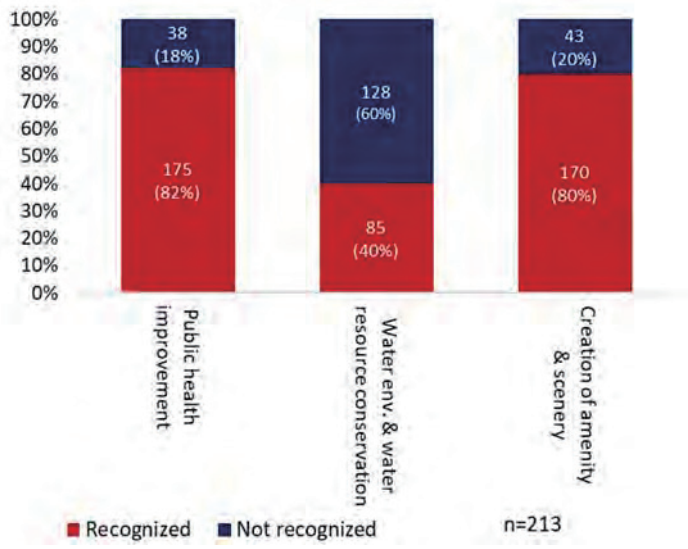
Note: The result shows number of households and % in brackets.
Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

Figure B9-4 People's Perception on the Main Causes of Water Pollution (Households)

(2) Recognition of Sewerage System

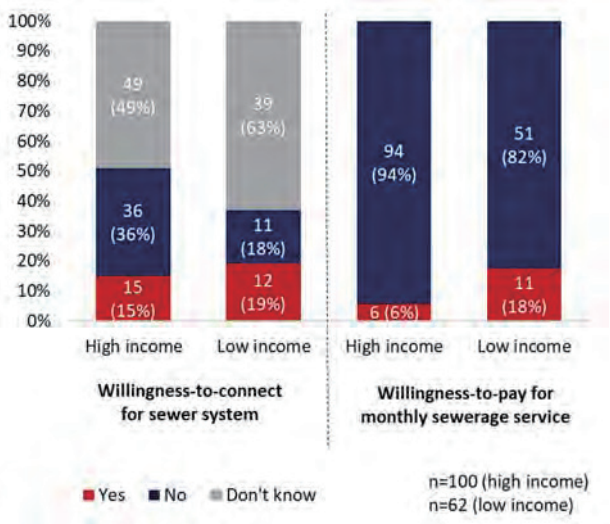
1) Roles of Sewerage System

Figure B9-5 shows people's perception on the role of sewerage system. Approximately 80 % of the residents recognize that sewerage system contributes to "improvement of public health" and "creation of landscape and amenity space," while the remaining 40% recognize that it contributes to "conservation of water environment and water resources."



Note: The result shows number of households and % in brackets.
Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

Figure B9-5 People's Perception on the Roles of Sewerage System (Households)



Note: The result shows number of households and % in brackets.
Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

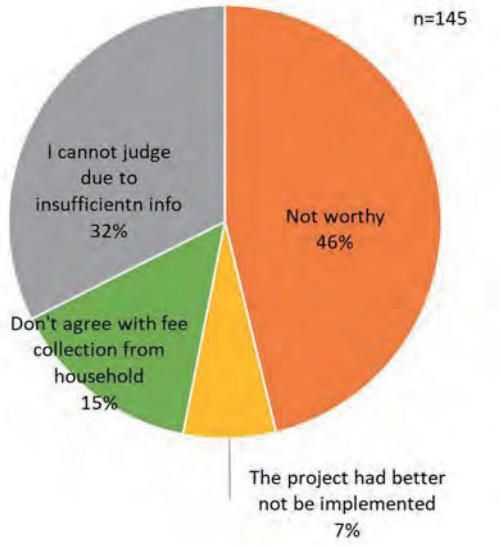
Figure B9-6 Willingness-to-connect and Willingness-to-pay for Sewerage System (Households in Urban Areas only)

(3) Willingness-to-connect and Willingness-to-pay for Sewerage System (Urban areas only)

Figure B9-6 shows the willingness of urban residents to connect to the sewerage system and pay a monthly usage fee. In urban areas, 15% of higher-income households and 19% of lower-income households, both less than 20%, indicated that they would like to be connected to the sewerage system, while 36% and 18%, respectively, indicated that they would not connect, and more than half of the households were "don't know". As for the payment of monthly sewerage fees, about 90% of the respondents answered that they "do not intend" to pay.

Of the 17 households, both high-income and low-income, that were willing to pay the amount sewer bill, the average amount they were willing to pay was 1,024 NRP/month (minimum 50 NRP/month, maximum 10,000 NRP/month).

Figure B9-7 summarizes the reasons for not wanting to pay the sewerage fee for the 145 households (94 high-income households and 51 low-income households) that did not indicate their willingness to pay the sewerage fee. The most common reason given was "not worth it (not worth it)" (46%), followed by "I am not satisfied with the fees collected from each household" (15%), "I think the project should not be implemented" (7%), and 32% said they "cannot make a decision based on this information."



Note: The result shows number of households and % in brackets.
Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

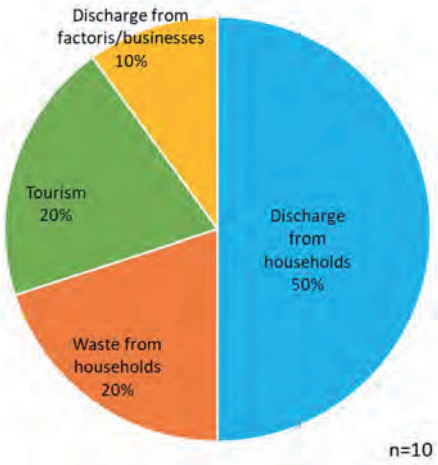
Figure B9-7 Reasons for NOT Willing to Pay (Households)

B9.3 Survey Results (Businesses etc.)

Some of notable survey results for businesses etc. are shown below. For details, refer to the Appendix-12 "SOCIAL CONDITION SURVEY FINAL REPORT."

B9.3.1 Causes of Water Pollution

Figure B9-8 shows businesses' perception on the main causes of water pollution. About half of the businesses answered that it is caused by wastewater from households, which is the same trend as that of the answers in the household survey.



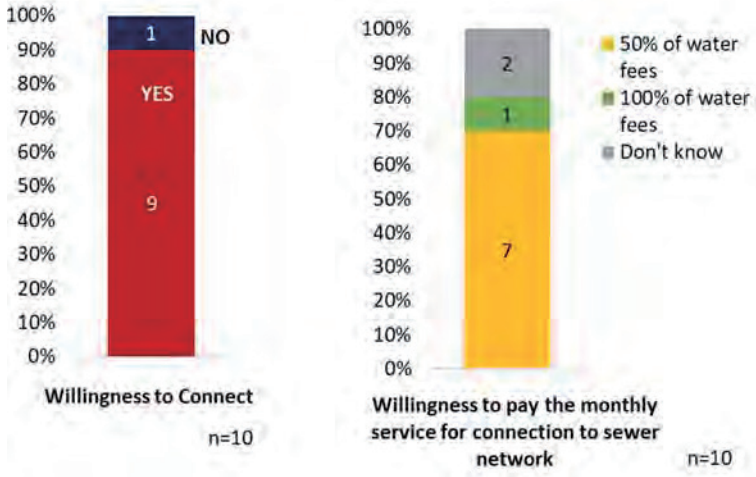
Note: The result shows number of households and % in brackets.

Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

Figure B9-8 People's Perception on the Main Causes of Water Pollution (Businesses etc.)

(1) Recognition of Sewerage

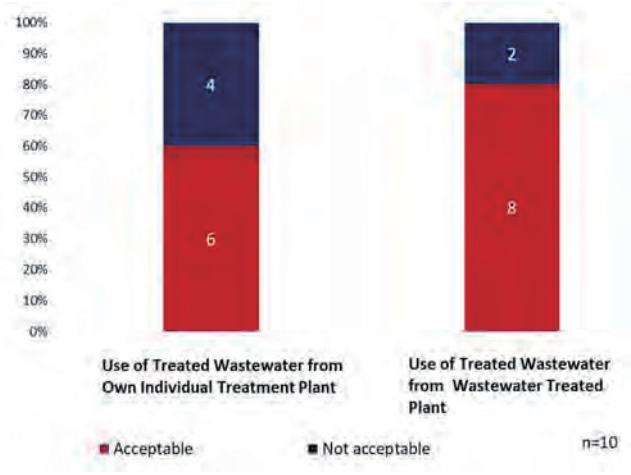
Figure B9-9 shows willingness-to-connect and willingness-to-pay (monthly) by the businesses etc. for sewerage system. Although 9 out of 10 businesses wish to connect to the sewage system, 7 facilities wish to pay about half of the water charge as the monthly sewerage user fee, and only 1 business to pay about the same amount as the water charge.



Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

Figure B9-9 Willingness-to-connect and Willingness-to-pay for Sewerage System (Businesses etc.)

(2) Treated Water Reuse



Source: Prepared by JET based on SOCIAL CONDITION SURVEY FINAL REPORT (2022)

Figure B9-10 Reuse of Treated Water (Businesses etc.)

Figure B9-10 shows the willingness of business operators and others to reuse treated water. Six facilities indicated that they would be willing to reuse treated water from their own facilities, while eight facilities indicated that they could reuse treated water from their sewage treatment plants.

B9.3.2 Summary

In most households of Pokhara City, domestic wastewater such as wastewater from kitchens and showers (gray water) and wastewater from septic tanks (black water) are eventually infiltrated into the ground, while at least 20% of the domestic water is discharged into public water bodies.

The residents recognize that domestic wastewater is a cause of water pollution in the water environment, but they do not fully understand that sewerage development contributes to conservation of the water environment and water resources. Considering the fact that more than half of the respondents answered "Don't know" on willingness-to-connect to the sewerage system, it is suggested that the information and people's knowledge about the sewerage system is insufficient. In addition, regardless of household incomes, majority of the residents are not willing to pay the user charges of the sewerage system, saying that sewerage development is not worth to pay. There is no sewerage system in Pokhara City until now, so it is vital that the residents be fully explained about the effectiveness and significance of the sewerage development, increasing their understanding and cooperation.

The businesses such as companies, hospitals, schools, etc. also believe that domestic wastewater is the main cause of water pollution. While most of the businesses etc. wish to connect to the sewage system, more than half of the respondents want the sewerage service fee to be about half the price of the water charge. It is therefore necessary for the businesses, etc., to explain more details on effects of the appropriate wastewater treatment and sewage user fees. In addition, it is confirmed that the reuse of treated water is recognized to some extent since most of the businesses etc. answer to accept it.

B9.4 Current Situation of Public Awareness Activities on Wastewater Management

Water Sanitation Law (WASH Bill) mentions public awareness raising regarding water sanitation as an obligation of local governments. An interview survey was thus conducted with the following organizations regarding the implementation status of public awareness raising in existing public services in Pokhara City and Kathmandu where the sewerage system has already been introduced.

- PMC (Social Development Section and Waste Management Section)
- NWSC Pokhara Branch
- KUKL (Administration Office and Project Implementation Division)
- FWSSMP

- Basin Management Center (BMC, subordinate to DoFSC)
- Ward # 24 office

As results of the survey, the following situations were observed regarding public awareness of existing social services.

- PMC has never conducted any public awareness-raising activities related to onsite wastewater treatment such as desludging, and practicable ideas for the activities are not known. However, the importance of public awareness raising is well recognized within the PMC even though it will be the first time for the PMC to introduce the sewage system.
- Many of the activities involving citizens in the fields of waste management and social development at PMC are conducted through a ward office with Tole Development Committees (TLOs), youth groups, women's groups, etc. TLO is an organization at a small community unit, and is registered at each ward. Currently, there are over 600 in total in Pokhara City.
- PMC does not have any department or unit in charge of PRs. Instead, information dissemination via websites and social media is carried out by the Information Officer and IT Officer under the direction of the CAO. Ward offices themselves also use social media for information disclosure.
- In NWSC headquarters, a PR officer is allocated and responsible to disseminate information to customers and business entities. Various notifications and information are provided on the website, and there is also an online “Feedback” form, and some other forms including a grievance form (for paper submission) to receive opinions from residents. In the NWSC Pokhara Branch, there is no customer service desk, but meter readers very often handle people’s inquiries when they do door-to-door visit. The Pokhara Branch receives community groups and representatives’ visit and phone calls for the Director and officers on a daily basis. Such inquiries sometimes reach up to more than 100 a day, which results in spending a considerable amount of time to respond to them. Public awareness activities for the users mainly consist of advertisements on radio and newspapers, interview articles by the media, etc., and no proactive activities have been carried out.
- KUKL accepts complaints at its branch offices, by phone and online. A registered complaint is forwarded to relevant departments for action. The KUKL's PID prepared a public awareness activity plan and is actively implemented. For environmental education at schools, the PID not only explains the projects and shows documentary videos, but also holds student contests for speeches, paintings, and essays. The PID distributes leaflets and conduct educational programs to various target groups such as women's groups and youth groups. Public hearings are held on a regular basis for residents around project facilities.
- Public awareness raising activities for the lake conservation are rarely implemented by PMC or BMC due to shortage of human resources and funds, and such activities fully depend on communities and NGOs with very limited government involvement. The BMC conducted public consultations with many stakeholders for the designation of Lake Phewa as an Important Watershed Area. Currently, Lake Phewa Protected Watershed Management Plan 2022-2027 is under preparation, and it is expected that each related agency and organization will promote their activities in line with this plan to efficiently improve the water environment. The BMC also prepared a leaflet called "Protected Phewa Watershed Area Declaration: Needs and Importance Booklet" and distributed whenever necessary.
- PMC has occasionally organized the Lake Phewa Cleanup Campaign in the last few years, and it was recently held on October 2022. In the event, various people from public offices (ward offices, polices, army etc.), TLOs, women’s groups and youth groups, NGOs, the tourism association and other business groups as well as residents joined in to clean up floating weeds and wastes, and drainage cleaning. The Sanitation Section facilitated the campaign with financial support from PMC and other organizations.





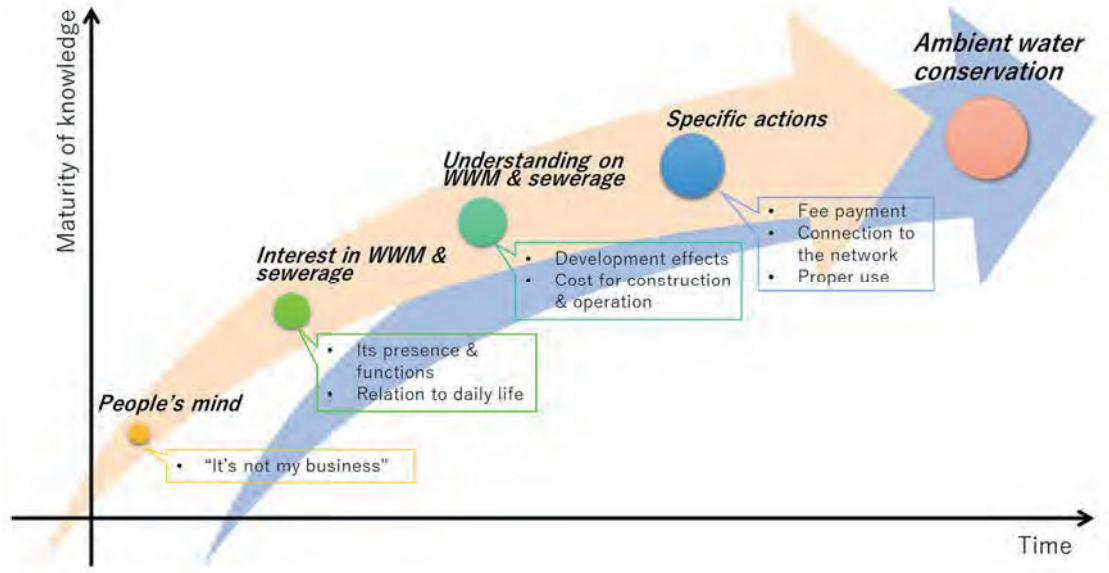
Source: PMC Facebook page

B9.5 Public Awareness Activity Plan

B9.5.1 Activity Policies

(1) Promoting an Understanding of Appropriate Wastewater Management

Implementation of the sewerage system is new to Pokhara City, so most of the residents do not have knowledge on the system, their roles, and mindset to use them. Although they have some concerns for wastewater treatment, they rarely have enough knowledge or interest to take actions. Some part of Pokhara City is registered as a Ramsar wetland site under the Ramsar Convention, and improvement of the water environment and sanitary situation around Lake Phewa will contribute not only to the resident's better lifestyles but also to the tourism value enhancement. The activities will thus emphasize on "improvement of sanitary environment," "sound water environment," and "contribution to the local economy" (especially tourism industry), and continuously provide a step-by-step detailed explanation for proper wastewater treatment (Figure B9-11).



Source: JET

Figure B9-11 Steps of the Public Awareness Raising for Wastewater Management

In particular, it is necessary for the residents to understand the followings for smooth project implementation in line with the M/P.

- Increasing wastewater and ambient water pollution associated with the economic growth
- Negative impacts caused by improper wastewater treatment
- How people's actions relate to the sewerage services and wastewater management
- Roles and efforts of the PMC, and roles of the citizens in wastewater management
- Cost of better wastewater management implementation

Regarding negative environmental and social impacts, and cost burden associated with a project implementation, information will be shared as appropriate so that ultimately the necessity of people's active participation and the polluter-pay-principle will be understood, aiming to foster people's cooperation to the projects and their voluntary activities. In addition, since the sewerage services are a new field for the PMC with no experience or little knowledge on it, the public awareness activities will help to strengthen communication skills of the PMC and other related organizations, to increase their consciousness on environmental management, and to deepen knowledge.

(2) Establishment of the Public Awareness Working Group (PAWG) and Introduction of Effective Public Awareness Methods

This M/P is a long-term plan toward 2050, so the PMC itself has to equip a mechanism to continuously plan public awareness methods and contents to be effective in accordance with each project/plan stage, types of the stakeholders, and social changes. It is also important to take into account public interests and regional social changes in the awareness raising methods and decision making based on public awareness surveys, customer satisfactory surveys, and public consultations. Therefore, "Public Awareness Working Group" (PAWG, as a provisional name) for wastewater management, with members from wastewater related departments/units such as Water Environment Division of the PMC and the O&M organization will be established as a group who discusses and plans such effective awareness raising methods for wastewater management, and implement the activities based on an annual plan. In the future, in order to ensure efficient facility development and sound business management, "Wastewater Management Committee" (WMC, as a provisional name) will be established with the PMC, community representatives, academic experts, etc.

(3) Establishment of Inquiry Desks and Grievance Mechanism

It is expected that many inquiries, including questions, provision of information and complaints, will be received from residents regarding the new efforts of wastewater management by PMC. Therefore, in order to efficiently deal with such inquiries and grievances, inquiry desks will be set up with telephone, e-mail, documents, etc., and the corresponding procedures will be formulated. In addition, since this information is also effective in improving engineering activities, the database will be created.

B9.5.2 Implementation Structure

(1) Organizational Structure of Public Awareness and PR Implementation

Currently, there is no public awareness or PR section/unit for wastewater management in PMC, so these activities shall be implemented with formulating new organizational structure depending on each implementation stage of the MP.

1) From 2023 to 2030

Until new organization for O&M of PMC's wastewater management, the PAWG shall take initiative to promote the public awareness and PR. Members of the PAWG may include officers from Sanitation Section, Health Section, Waste Management Section, Forest and Environmental Section.

2) After 2030

In addition to the PAWG, PR and Service Section (PRSS) will be established in the O&M organization, responsible for public awareness raising and PR on the sewerage services and the on-site treatment as a communication hub for citizens. The roles and responsibilities and personnel allocation (draft) of the PRSS are as follows.

Table B9-2 Roles and Responsibilities, and Personnel Allocation of PRSS

Section Name	PR and Service Section (PRSS)
Roles and Responsibilities	・ To plan and implement public awareness campaigns and PR activities at the city level ・ To provide technical supports to Ward- and community-level public awareness raising activities ・ To receive and manage complaints

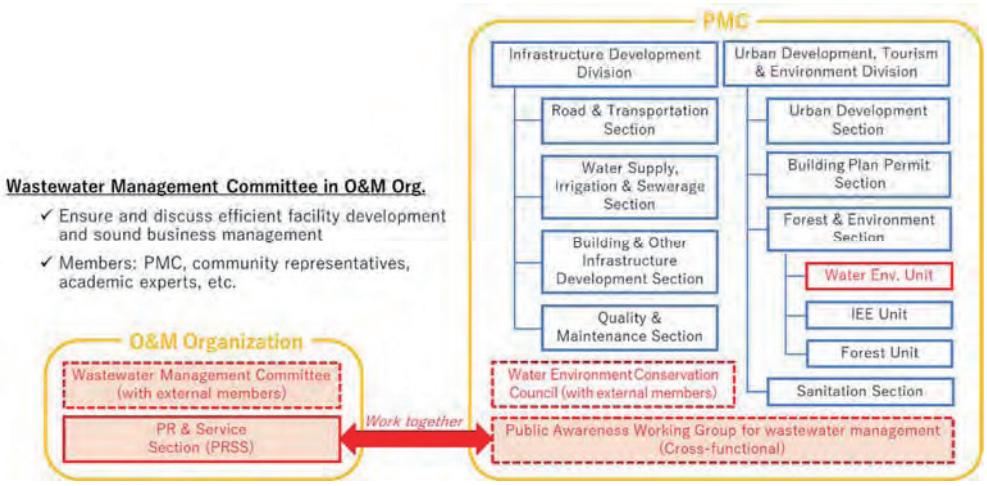
	・ To facilitate PAWG etc. ・ To disseminate information through SNS etc. ・ To conduct other activities related to public awareness raising and PR
Personnel Allocation	4 personnel (manager, staff x 2, assistant x 1)

Source: JET

The PMC does not have any departments or sections in charge of the entire PMC's public relations. Instead, information through the Internet, such as the city homepage and SNS is posted by IT Officer in accordance with requests form the departments, with the CEO's permission. The PRSS therefore will carry out the PMC and the O&M organization's internal procedures for information disclosure related to the sewerage services and wastewater management.

3) By 2050

In addition to the PAWG in PMC and the PRSS in the O&M organization, Wastewater Management Committee (WMC) shall be organized with PMC, citizen's representatives, academic experts etc. to discuss for healthy business management and efficient facility development (Figure B9-12).

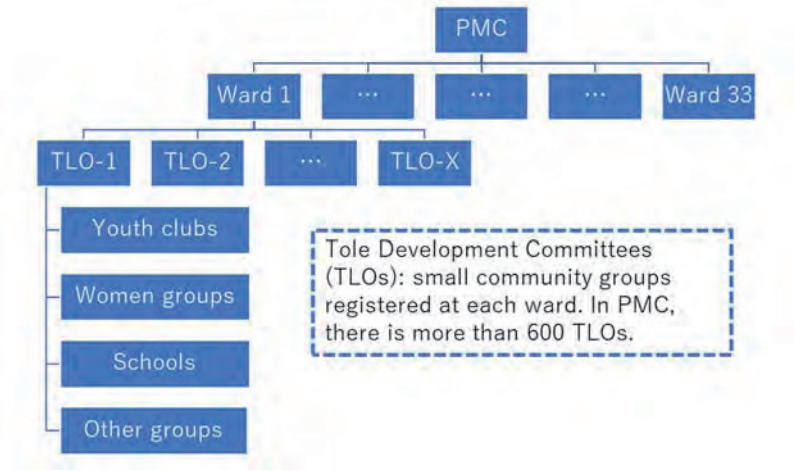


Reference: JET

Figure B9-12 Organizational Structure of Public Awareness and PR Implementation (by 2050)

(2) Public awareness Activity Implementation in Pokhara City

For introducing better wastewater management services in line with this M/P, careful attention should be paid not only to information sharing and awareness raising activities for the general public, but also to dedicated community level awareness raising for specific purposes in sewerage service and onsite treatment areas. Such area- and target-specific activities will be thus implemented through TLOs and local groups such as women's groups, youth groups, NGOs, business associations, with each ward office as a coordinator, based on an annual plan formulated by the PAWG (Figure B9-13). In parallel, the PMC and ward offices actively organize local public awareness activities and information disclosure.



Source: JET

Figure B9-13 Public awareness Activity Implementation in Pokhara City

(3) Gender Mainstreaming

When interview surveys to residents, information disclosure, public awareness raising activities, and consensus building are implemented, the following items shall be considered for gender mainstreaming actions:

- When a door-to-door survey is conducted, the interviewers shall consist of 2 people, 1 men and 1 women so that female residents can actively give their opinions. This measure could avoid gaps of the results between men and women.
- Local women's groups shall be asked to support for organizing and implementing local public awareness activities and community meetings to create comfortable environment for women.
- Community meetings targeting for women shall be held depending on local circumstances and purpose of the public awareness raising. For example, it is important for women, who often do house chores, to understand "do not litter in the toilet" and "don't discharge oils into a kitchen sink," expecting to propagate the knowledge to other household members.

B9.5.3 Activity Description

(1) Activity Overview

Table B9-3 summarizes the major activities and overviews to effectively promote public awareness and PR on wastewater management. An example of the annual activity plan is shown in Table B9-4, assuming implementation of Activity 1-8 as regular activities.

Table B9-3 Public Awareness and PR Activity Overview

Activity	Overview	Related Institution*	Frequency (Proposed)
Activity 1: Public Awareness Working Group (PAWG)	The PAWG will be established, and an annual public awareness plan will be formulated to study effective public awareness methods. Until the PRSS is established, the PAWG will promote public awareness raising. After the PRSS establishment, under the support of the PAWG, PRSS and other relevant departments/units will secure a budget and carry out activities based on this annual plan. After formulating the plan, the PAWG will hold regular follow-up meetings. The PRSS will manage PAWG.	PRSS, sewage related depts., PMC (Water Env. Division etc.)	Planning phase: as needed Follow-up phase: twice a year
Activity 2: PR through SNS and mass media	Using newspapers, radio, press releases, press conferences, SNS etc., PMC will widely seek people's understanding of the M/P and related projects, and obtain their cooperation for the	PRSS, sewage related depts., PMC (IT Officer etc.)	As needed

Activity	Overview	Related Institution*	Frequency (Proposed)
	smooth service implementation. Public communication with the project progress in a timely manner is also important in terms of safety issues during construction. Publicable information shared from other sections will be posted on SNS as needed by the PRSS and other media will be used for each event without delay.		
Activity 3: Production of leaflets etc. related to wastewater treatment	PRSS will play a major role in preparing leaflets and annual reports related to the wastewater management. The materials will be distributed at public offices such as the city hall, ward offices, schools, public meetings, door-to-door visits, etc.	PRSS, sewage related depts., PMC (Water Env. Division etc.), ward offices	Once a year (annual report), and otherwise as needed
Activity 4: Community meetings	Targeting stakeholders for wastewater treatment (community level, TLO/ward level, business entities etc.), community meetings aim to gain people's understanding and consents, and to encourage their participation and behavioral changes. Opinions and comments raised during the meetings will be reflected in the project planning and operations.	PRSS, sewage related depts., ward offices, TLOs, PMC (Water Env. Division etc.)	New service areas: at least once a month Existing service areas: 1-2 times a year
Activity 5: Billboard and poster installation	To gain understanding and cooperation for the projects, billboards and posters with a project overview, are installed at places where many people visit, such as an airport, highways, and major public facilities. This activity enables people to widely know the wastewater business. Such a billboard and posters will be prepared in line with an PR event.	PRSS	More than once a year
Activity 6: Environmental education at school	Environmental education at school, is targeted to students in middle to high grade of elementary school, and it is expected that children will grow in awareness of environmental conservation with realizing relationship between their daily lives and the environment, and their parents can also learn from them. In implementing the school education, after setting up achievable goals depending on target students, and after developing a detailed plan, the activity will be implemented in coordination with related organizations such as schools and the education board. In addition to lectures in the classroom, quiz-style interactions and drawing competitions are effective so that students can enjoy learning. At the initial stage of the activity development, PMC and PRSS together with ward offices collaboratively plan and implement the environmental education, but in the future, it will be led by ward offices.	PRSS, Ward offices, education related depts., TLOs	4 or more times a year
Activity 7: Exhibition related to the sewage services	Exhibitions related to the wastewater treatment and sewerage services will be held at facilities such as schools, libraries, and the city hall where many people frequently come and go, to promote an understanding of the mechanisms and functions of the sewage services.	PRSS, PMC (Water Env. Division etc.), ward offices	More than once a year

Activity	Overview	Related Institution*	Frequency (Proposed)
Activity 8: Study tour	Study tours are conducted for residents, the media, schools, etc., including visit to sewage treatment facilities, to deepen their understanding of the sewage services. During visiting a facility, a lecture on sewerage treatment, and the environmental conservation will be provided by the manager of the facility.	PRSS, sewage related depts.	More than once a year
Activity 9: Public awareness survey and customer satisfaction survey	Public awareness survey and customer satisfaction survey will be conducted periodically to the public, and business entities etc. to evaluate the people's understanding of the services provided, which will give opportunities to improve the service quality and directions.	PRSS	Once every 3 years
Activity 10: Establishment of Sewage Treatment Council (STC)	To ensure the efficient facility development and sound business management, "Sewerage Treatment Committee (provisional name, STC)" will be established, consisting of PMC members, community representatives, academic experts, etc.	PRSS, sewage related depts., ward offices	Twice a year
Activity 11: Establishment of inquiry desks and grievance mechanism	PMC will establish inquiry desks by telephone, e-mail, documents, etc., and set up the corresponding procedures. In addition, since this information is also effective in improving the services, the database will be created.	PRSS	-
Activity 12: Allocation of sewerage promotion staffs	Sewerage promotion workers will be allocated in the wards where the sewerage or on-site treatment promotion is prioritized. The workers will visit door-to-door to raise awareness of people on sewerage and wastewater treatment through individual communication.	PRSS, Ward offices, sewage related depts., PMC	Daily basis

* Underlined organizations indicate the responsible (management) entity.

Source: JET

Table B9-4 Annual Activity Plan of Public Awareness (example)

		Related Institution*	7	8	9	10	11	12	1	2	3	4	5	6	Remarks
Activity 1	Formulation of the annual plan by PAWG	PRSS, sewage related departments, PMC (Water Env. Division etc.)	★	Follow-up meeting				★	Annual plan formulation						
	Public awareness raising campaign (for 1 month)							★							
Activity 2	Information dissemination via SNS	PRSS, PMC (IT Staff etc.)	As needed												
	Information dissemination via radio and TV	PRSS	★					★							
Activity 3	Publication of PR magazine (annual report)	PRSS					★								
	leaflet distribution	PRSS						★							Produce and distribute the leaflets as needed
Activity 4	Sewerage Treatment Coordination Meeting	PRSS, sewage related depts., Ward offices, etc.		★						★					The business reporting, discussion, and information exchange with all wards and other related organizations
	Public consultation	PRSS, sewage related depts.						★							Hosted by PMC/O&M organization
	Community meetings by Ward office and TLOs	Ward offices, TLOs, PRSS	As needed												New service areas: at least once a month Existing service areas: 1-2 times a year
Activity 5	Poster installation	PRSS						★							Distribute to various places
Activity 6	Environmental education class (at elementary schools)	PRSS, Ward offices, PMC (education related depts.), TLOs			★			★			★			★	More than 4 times a year
	Drawing competition	PRSS, PMC (education							★						

		Related Institution*	7	8	9	10	11	12	1	2	3	4	5	6	Remarks
		related dept.)													
Activity 7	Exhibition related to wastewater treatment and sewerage services at public facilities	PRSS, PMC (Waste Env. Division etc.), related agencies							★						Display at libraries, etc.
Activity 8	Study tour	PRSS, sewage related depts.							★						

Source: JET

(2) Points to be Considered

It is assumed that following the formulation of the M/P, public awareness raising activities regarding wastewater development in Pokhara will be categorized into 4 cases, depending on the status of the development stage as shown in Table B9-5. The activity contents thus should take into account difference in the targets, and the service and development characteristics for each case or their combination.

Table B9-5 Public Awareness Raising with the Wastewater Treatment Status

Case 1:	Launch sewage and wastewater treatment services
	Basic knowledge of wastewater treatment including the sewerage services, and business policies of the PMC and the O&M organization, and the M/P will be disseminated at the time of launching the sewerage development as a new public service in Pokhara City.
Case 2:	Develop new sewerage area
	In addition to the contents of Case 1, public awareness raising will focus on the sewerage connection, the fee payment and proper use of the services to the residents, following explaining the development plan in the target area so as to gain their understanding.
Case 3:	Operate the developed sewerage area
	In addition to explaining the proper use of sewers, etc., PRSS will raise awareness about the sewerage connection and the fee payment, targeting unconnected households and/or non-paying households. Information disclosure and communication will be continued to promote mutual understanding with the residents.
Case 4:	Operate the non-sewerage area
	In addition to the contents of Case 1, PRSS will explain the appropriate introduction and operation of on-site treatment and its costs, for gaining the residents' understanding.

Source: JET

Table B9-6 3-year Plan of Public Awareness

	2023	2024	2025	Activity content
Activity 1: Establishment of PAWG				Immediately after formulating the M/P, start preparations for the establishment, implement various pilot activities from the second year and formulate an annual plan for the following year, and put the activities on track by the third year.
Activity 2: PR through SNS and mass media				At the early stage, websites (Facebook etc.) for the sewerage services will be set up to start information sharing. The M/P information will also be widely disclosed to the public through press releases, websites etc.
Activity 3: Production of leaflets etc. for sewage treatment service promotion				PR materials such as a promotion video and leaflets that simply summarize the M/P, the sewage system, and the on-site treatment, and distribute them through public facilities and various events.
Activity 4: Community meetings				After formulating the M/P, a stakeholder meeting will be held for Ward Councilors and government officials. Public awareness-raising activities will be implemented through TLOs for the residents around Lakeside, which will be the first services.
Activity 5: Installation of billboards and posters				Before starting the construction of the facilities, billboards and posters will be installed at facilities and alongside of the roads where many people come and go, to increase their understanding.
Activity 6: Environmental education at school				Environmental education will be conducted at schools in Lakeside area where the first sewerage services will be introduced, and the activity will be gradually expanded to other areas.
Activity 7: Exhibitions related to wastewater treatment and sewerage services				Exhibitions related to wastewater treatment and sewerage facilities will be held regularly at the city hall and public facilities.
Activity 8: Study tour				This activity will be implemented after the start of Pokhara's sewerage services.
Activity 9: Public awareness S surveys and customer satisfaction surveys				A public awareness survey will be conducted at the start of the services, and a customer satisfaction survey every few years.
Activity 10: Establishment of Sewage Treatment Council (STC)				This activity will be implemented after the start of the sewerage services.
Activity 11: Establishment of inquiry desks and grievance mechanism				The preparation will start before the facility construction work, and the operation will be commenced when the first sewerage service starts.

Reference: JET

B10 Wastewater Management MP and Priority Projects

B10.1 Contents of the Projects Formulated in MP

As mentioned above, This MP was planned in consideration of the City of Pokhara's intentions, such as prioritizing on-site treatment during the transitional period of sewerage development based on the current situation, and prioritizing the development of critical sewerage zones. However, particularly with regard to sewerage improvement, in light of the financial difficulty of recovering costs from fee revenues and the inadequacy of existing O&M, it is necessary to implement the project in phases while narrowing down feasible components. In addition, since there are cases where it is reasonable to introduce on-site wastewater management or community-type sewerage systems, etc., even in urban areas in light of the geographical location, it is recommended that the wastewater management plan be carefully examined based on the possibility of securing land for the introduction of various facilities and consistency with urban planning in general, and that the plan be implemented in phases.

The contents of the projects to be formulated in this MP are as shown in Table B10-1.

Table B10-1 Summary of the Projects Formulated in MP

Items	Contents	Remarks	Chapter Section
Laws and ordinances	Establishment of ordinances for sewerage and on-site facilities		B3.1
	Revision of building permission		B3.1
	Setting-up for sewerage and sludge collection tariff system		B3.1
Organization of PMC	Establishment of O&M organization for sewerage and on-site facilities	New organization in PMC	B6.1.4
	Establishment of water environment monitoring organization	Departments to monitor influent water and environmental water quality in the existing Infrastructure Development Department and Urban Development, Tourism and Environment Department , respectively	B7.3
	Establishment of an organization responsible for public awareness and PR activities of sewerage and off-site treatment	Section of Public Relations Service in charge of communication with residents in the above O&M department	B9.5.2
On-site Sanitation System	Installation of impermeable septic tank	Change from permeable to impermeable septic tank	B3.1.3
	Collection of sludge	Planned collection of sludge and procurement of vacuum cars	B3.3
	Operation of individual STP		B3.3.3
Sewerage System	Operation of separate sewage system and WWTP		B2.2
Water Environment Monitoring	Implementation of water environment monitoring		B7.4

Source: JST

B10.2 Expenses Required for Implementation of Development Projects

It is assumed that a large amount of expenses will be required to implement the development projects. Therefore, the contents and priorities of the projects to be formulated in the MP will be set based on the funds that can be procured by the Nepalese government. The project implementation schedule is shown in Figure B10-1.

(1) Individual STP

For treating sludge in the transitional period of sewerage development, the individual STP will be developed.

(2) Capacity Development on Wastewater Management

Capacity strengthening in wastewater management will be implemented over a period of three years for about 10 DWSSM and PMC staff members in the following three areas. The implementation contents are planned as follows.

- Capacity development on sewerage and on-site treatment system
- Capacity development on water environmental management
- Capacity development on public relations

(3) Stepwise Sewerage Development

1) Priority of Development

Regarding the priority of development, the highest priority area is the West sewerage zone in Ward 6 on the shore of Lake Phewa and flowing into Lake Phewa that includes the Phirke River basin as shown in Section B2.2.3. The next priority is the Central sewerage zone where is the existing main urban area, and followed by the Hemja sewerage zone and the East sewerage zone, which are expected to undergo urbanization in the future.

2) Stepwise Sewerage Development Plan

As the goal of this MP is to complete sewerage development in the entire urban area by 2050, all sewerage facilities including individual house connections are to be constructed by 2050. The West and Central sewerage zone are divided into two phases respectively because the treatment facilities and sewer network area are large scale. Figure B10-2 shows the stepwise sewerage development schedule.

(4) Costs required for the Projects formulated in MP

The approximate costs required for the Projects formulated in MP are shown in Table B10-2.

Table B10-2 Summary of Projects Formulated in MP

No.	Items	Contents	Period	Costs
1.	Construction of Individual STP	・ FS/ Basic Design ・ Detailed Design ・ Construction of Individual STP (210 m^3/day) ・ Procurement of Vacuum Cars (4 m^3×8 nos.)	2023 - 2026	777
2	Capacity Development on Wastewater Management	・ Capacity development on sewerage and on-site treatment system ・ Capacity development on water environmental management ・ Capacity development on public relations	2023 - 2025	500
3.	Sewerage Development		2024 - 2050	
3-1	・ West Sewerage Treatment Area Phase-1.1	・ WWTP (1/4 train of 72,500 m^3/day) ・ Trunk Sewer (8.5 km)	2024 – 2035	9,440
3-2	・ West Sewerage Treatment Area Phase-1.2	・ WWTP (2/4 train of 72,500 m^3/day) ・ Trunk Sewer (8.5 km)	2024 – 2035	9,440
3-3	・ West Sewerage Treatment Area Phase-2.1	・ WWTP (3/4 train of 72,500 m^3/day) ・ Trunk Sewer (15.9 km)	2028 – 2038	18,345
3-4	・ West Sewerage Treatment Area Phase-2.2	・ WWTP (72,500 m^3/day) ・ Trunk Sewer (15.9 km)	2028 – 2038	18,345
3-5	・ Central Sewerage Treatment Area Phase-1.1	・ WWTP (1/4 train of 39,000 m^3/day) ・ Trunk Sewer (8.2 km)	2032 – 2041	8,596
3-6	・ Central Sewerage Treatment Area Phase-1.2	・ WWTP (2/4 train of 39,000 m^3/day) ・ Trunk Sewer (8.2 km)	2032 – 2041	8,596

No.	Items	Contents	Period	Costs
3-7	・ Central Sewerage Treatment Area Phase-2.1	・ WWTP (3/4 train of 39,000 m^3/day) ・ Trunk Sewer (6.7 km)	2036 – 2044	9,455
3-8	・ Central Sewerage Treatment Area Phase-2.2	・ WWTP (39,000 m^3/day) ・ Trunk Sewer (6.7 km)	2036 – 2044	9,455
3-9	・ Hemja Sewerage Treatment Area	・ WWTP (4,500 m^3/day) ・ Trunk Sewer (5.6 km)	2039 – 2047	5,193
3-10	・ East Sewerage Treatment Area Phase-1.1	・ WWTP (2/4 train of 18,000 m^3/day) ・ Trunk Sewer (7.0 km)	2042 – 2050	9,928
3-11	・ East Sewerage Treatment Area Phase-1.2	・ WWTP (18,000 m^3/day) ・ Trunk Sewer (7.0 km)	2042 – 2050	9,928

Unit: million NPR
Source: JST

B10.3 Selection Policy for Priority Projects

It is proposed that the selection of priority projects to be implemented after the preparation of the MP is to be based on the following criteria.

- Urgency and promptness for development
- Beneficiary population
- Population density
- Investment efficiency
- Unit treatment cost

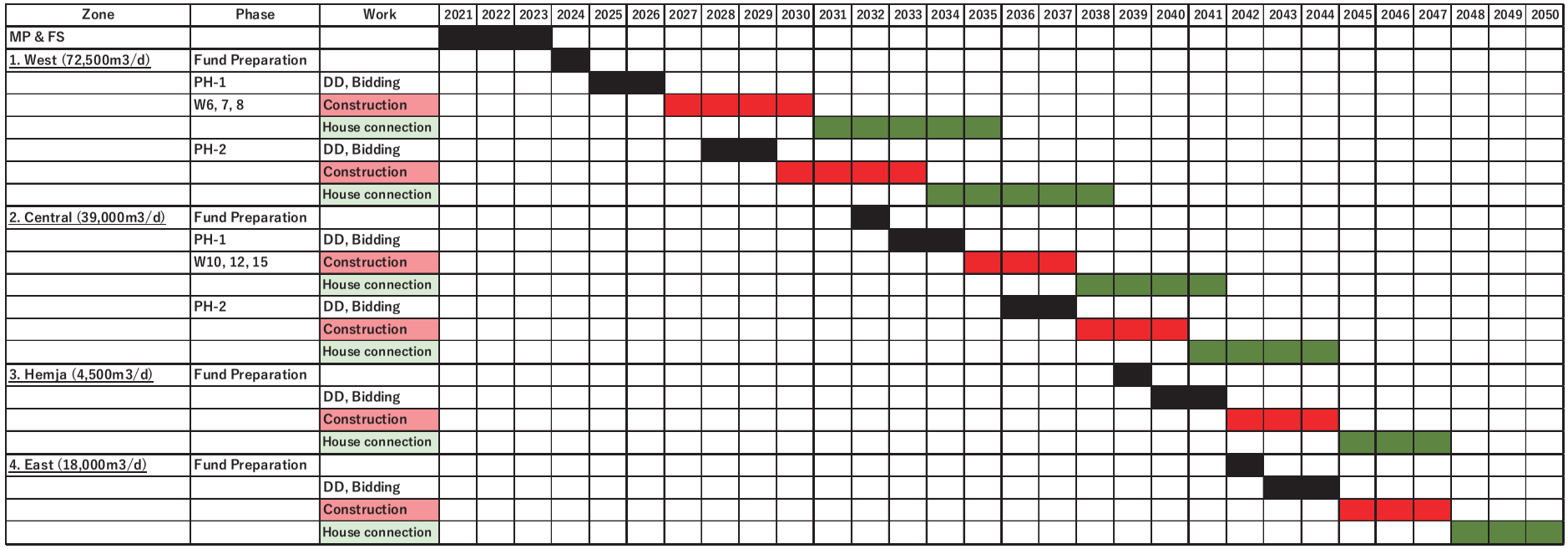
As a result, the following projects are selected to be priority projects

- Development of sewerage system in West sewerage zone
- Development of on-site sanitation under the transitional period of sewerage development
- Establishment of O&M capacities for sewerage, on-site sanitation, waster environment monitoring and public relation

Category	Item	Phase	Execution	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Master Schedule																																	
1. MP & pre-FS			DWSSM, PMC																														
2. Ordinance & Regulation	2-1 Sewerage & Sanitation	Drafting	PMC																														
		Approval by City Council	PMC																														
		Enacting	PMC																														
	2-2 Modify Building permit system	Drafting	PMC																														
		Approval by City Council	PMC																														
		Enacting	PMC																														
	2-3 Tariff & Service Charge	Drafting	PMC																														
		Approval by City Council	PMC																														
		Enacting	PMC																														
3. Organization of PMC	3-1 Sewerage and sanitation Dept	Establishment	PMC																														
		Capacity Enhance	PMC																														
	3-2 Water Environment Monitor Sec.	Establishment	PMC																														
		Capacity Enhance (manage)	PMC																														
		Capacity Enhance (Lab)	FWSSMP																														
	3-3 Public Relation Sec.	Establishment	PMC																														
		Capacity Enhance	PMC incl Wards																														
4. Improved On-site Sanitation	4-1 Start Installation of impermeable Septic tank		PMC, Citizens				◀																										
	4-2 Start Scheduled de-sludge		PMC, De-sludgers							◀																							
	4-3 Start appropriate sludge treatment		PMC, Operator							◀																							
5. Sewerage	5-1 Start house connections and service	West	PMC, Operator											◀																			
		Central																			◀											
		Hemja																										◀				
		East																												◀		
6. Scheduled Monitoring Water Env.	6-1 Start Baseline analysis & data manage						◀																										
	6-2 Start monitoring effectiveness WWM activity									◀																							
Project Schedule																																	
1. Improve Feacal sludge treatment	1-1 FS / Basic Design		PMC																														
	1-2 Detail Design		PMC																														
	1-3 Construction & Procurement of equipment		PMC																														
2. Capacity Enhancement of WWM	2-1 Start-up WWM	Sewerage & On-site sanitation	PMC																														
		Water Environment Monitor	PMC																														
		Public Relation	PMC																														
	2-2 Follow-up trainings		PMC								◀						◀			◀		◀		◀		◀		◀		◀		◀	
3. Sewerage	5-1 West	PH-1 incl. Fund preparation	PMC/DWSSM																														
* see the table of sewerage		PH-2	PMC/DWSSM																														
development schedule for detail	5-2 Central	PH-1 incl. Fund preparation	PMC/DWSSM																														
		PH-2	PMC/DWSSM																														
	5-3 Hemja	Incl. Fund preparation	PMC/DWSSM																														
	5-4 East	Incl. Fund preparation	PMC/DWSSM																														

Source: JST

Figure B10-1 Project Implementation Schedule



Source: JST

Figure B10-2 Stepwise Sewerage Development Schedule