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Melamchi Water Supply Project
Kathmandu, Nepal

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Summary

Melamchi Water Supply Project (MWSP) comes as a much needed respite from the acute shortage of drinking water in Kathmandu Valley. It comprises two major components. The first component of the project comprises a scheme that diverts 170, 000 m^3/d of water from Melamchi River in Sindhupalchowk district and transmit it to the water treatment plant in Sundarijal, Kathmandu through a 26.5 km long tunnel. The initial capacity of the treatment plant will be 170, 000 m^3/d, and will be expanded in two more phases to treat up to 510, 000 m^3/d of water. The second component of the project includes the distribution of the water through bulk distribution systems as well as improvement of existing water supply systems to supplement the water supply from Melamchi project. It also encompasses the socio-economic and environmental aspects and aims to mitigate direct and indirect impacts of the project. The total cost of the project is USD 355.4 million dollars, spread across the two abovementioned components, of which Asian Development Bank (ADB) and Government of Nepal (GoN) are the major donors. On the whole, the project is expected to provide good quality drinking water and improved sanitation facilities, which will, in turn, improve the health of the consumers. Other benefits of the project include improved technical capabilities of the personnel involved as well as heightened sense of responsibilities among consumers to promote judicious use of water resources. This project is also being seen as an important part of the country's leap towards the attainment of Sustainable Development Goal (SDG) 6, i.e. ensuring availability and sustainable management of water and sanitation for all.

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Acronyms and Abbreviations

ADB	Asian Development Bank
BDS	Bulk Distribution System
GoN	Government of Nepal
JBIC	Japan Bank for International Co-operation
JICA	Japan International Cooperation Agency
KUKL	Kathmandu Upatyaka Khanepani Limited (Kathmandu Valley Drinking Water Limited)
MDS	Melamchi Diversion Scheme
MWSDB	Melamchi Water Supply Development Board
MWSP	Melamchi Water Supply Project
NDF	Nordic Development Fund
OPEC	Organisation of Petroleum Exporting Countries
PID	Project Implementation Directorate (PID)
PMU	Project Management Unit
SDG	Sustainable Development Goal
SUP	Social Uplift Programme
USD	US Dollars
WHO	World Health Organisation

1 Introduction

The Kathmandu Valley comprises some of the most urbanised and populated cities of Nepal, including Kathmandu and Lalitpur Metropolitan City. Population growth and urbanisation have been rampant in the Valley over the past few decades, and that too in an unplanned, unchecked manner. As a consequence, several fundamental infrastructures vital to sustainable livelihood have been compromised with. One of such basic amenities that has thus been affected is the adequate supply of potable water.

Kathmandu Upatyaka Khanepani Limited (KUKL) is the responsible authority to oversee the operation and management of water supply and wastewater services in Kathmandu Valley. KUKL has the capacity to supply 151, 000 m^3/d of water, but the actual water supplies during the wet and dry season are 131, 000 m^3/d and 65, 000 m^3/d respectively. In 2016, the population of the Valley was estimated to be 3 million and it has been estimated to increase to 4 million by 2021. Based on the assumption that an individual requires 0.135 m^3/d of water, the demand for water in the year 2016 was calculated to have been 361,600 m^3/d, implying a deficit of 210, 000 m^3/d. In 2021, the water demand will be 540,000 m^3/d. This further implies more stresses in the water supply balance. The current deficit is met through intermittent supply from KUKL along with consumers' self-arrangement through groundwater extraction, private water vendors and collection from spring sources. However, neither of these present a reliable solution to address water supply shortages. Worse still, heavy extraction of groundwater has resulted in depletion of the water table as well as drying up of spring sources.

The Melamchi Water Supply Project (MWSP) has long been considered the most viable, long-term option to ease the chronic water shortage situation in Kathmandu Valley. The project, on the whole, comprises two sub-components that aim to divert raw water (170, 000 m^3/d) into the treatment plant, distribute treated water to the consumers and promote activities to mitigate the socio-environmental impacts of the project. Details of MWSP has been summarised in Table 1.

Table 1: Overview of the water supply project (ADB, 2014)

Items		Description
Project Name	:	Melamchi Water Supply Project
Type	:	Water Supply/ Water Treatment
Donor Name	:	i. Asian Development Bank (ADB), ii. Government of Nepal (GoN), iii. Japan Bank for International Cooperation (JBIC)/ Japan International Cooperation Agency (JICA), iv. Nordic Development Fund (NDF)
Project rationale and objectives	:	i. To alleviate the chronic shortage of potable water in Kathmandu Valley and provide a sustainable, long-term solution for providing good quality drinking water ii. To provide a reliable, affordable, consumer-oriented and sustainable potable water supply and sanitation services in the Kathmandu Valley.

Project Fund	:	Total: USD 355.4 million Sub-project I: USD 274.4 million Subproject II and III: USD 81 million
Project Duration	:	2013 (extended due to various causes); expected to finish by 2017-18

2 Technical and Technological Brief

2.1 Technical description of Melamchi Diversion Scheme (MDS)

The raw water from Melamchi, Sindhupalchowk is being diverted from the site through the construction of headworks diversion tunnel and temporary cofferdams. The diversion tunnel, as shown in Figure 1, is approximately 26.3 km long, excavated by drill and blast method, in order to divert 170, 000 m^3/d of raw water to Sundarijal outlet. The designed tunnel is of 'D' shape and its cross section area is 12.7m^2. As evident from the overview of the MWSP shown in Figure 2, the raw water is transferred through the tunnel and is then sent to a treatment plant via a pipeline of 1.6m diameter, approximately 235 m long, before sending to the bulk distribution system (BDS). In addition, adits of 18.4 m^2 cross-sectional area were excavated from portals at ground level to the diversion tunnel at Ambathan, Gyalthum and Sindhu. There is also an arrangement of gate valves at portals and spillway/bypass flushing system to Bagmati River downstream. Other additional construction works comprise the construction of tunnel flushing system at Ambathan adit, and river training and intake at Ribarma with de-sanding basin. This project also includes the construction of about 43 km of access roads and upgrading of about 29 km of existing roads making project sites (Adit points) easier/accessible to visit round the year.

Figure 1: Excavation of tunnel to divert raw water from Melamchi (Melamchi Water Supply Development Board, 2013)

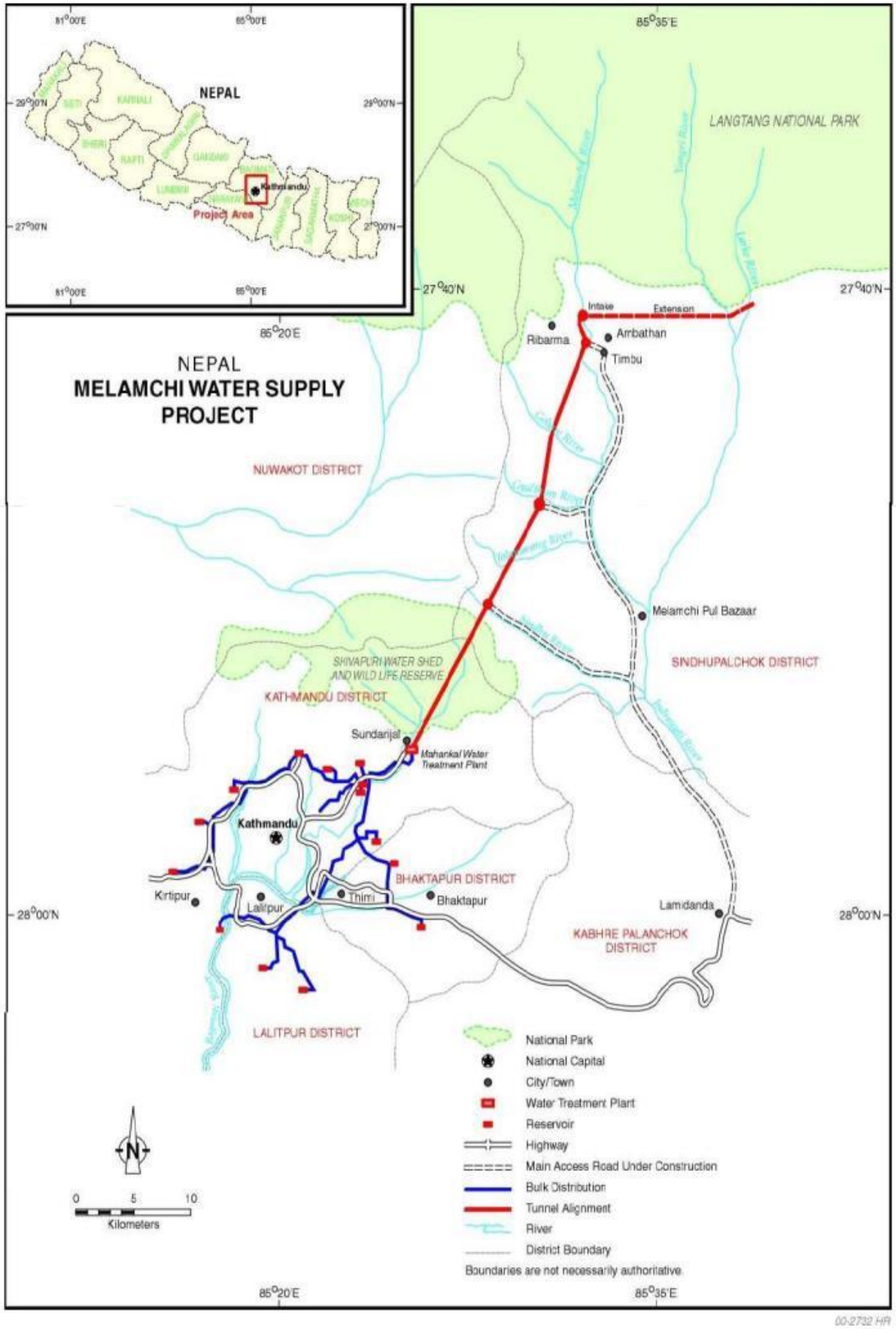

Figure 2: Overview of MWSP, Source: (Shrestha, 2014)

2.2 Melamchi Water Treatment Plant, Sundarijal

An aerial view of the location of the treatment plant is shown in Figure 3. It is located near Mahankal, a village on the left bank of the Bagmati River about 12km northeast of Kathmandu city. It is located at an elevation of 1400m which enables the distribution of water by gravity flow to existing and newly constructed water reservoir tanks. It is designed to treat 170, 000 m^3/d of water. It will be expanded up to 510, 000 m^3/d in three phases.

The water treatment process is conventional in nature comprising pre-treatment, sedimentation, lime dosing, rapid sand filtration and disinfection as shown in Figure 4.

The water is first collected in a regulation basin from which it is passed on to the aerator for pre-treatment. Then, alum and lime are added to the water in a chemical dosing facility. Water is then passed on to a flocculation tank where colloids are removed. After this, water is passed on to a sedimentation tank to remove suspended solids. The sludge from the sedimentation tank is removed periodically, compacted in a thickener and is disposed of in sludge lagoons. On the other hand, water is treated on a rapid sand filtration tank. A backwashing mechanism is provided in the filtration unit to facilitate periodic cleaning. The treated water is stored in a clear water tank where it is disinfected using chlorine. Finally, it is passed on to the BDS which comprises 54 km of mostly gravity-fed mains for bulk water transmission, ranging from 300 mm to 1400 mm diameter. The water is then distributed to the consumers from various distribution network laid across the Valley.

Figure 3: Aerial view of Melamchi Water Supply Campsite and Treatment Plant in Sundarijal, Kathmandu (Google Maps)

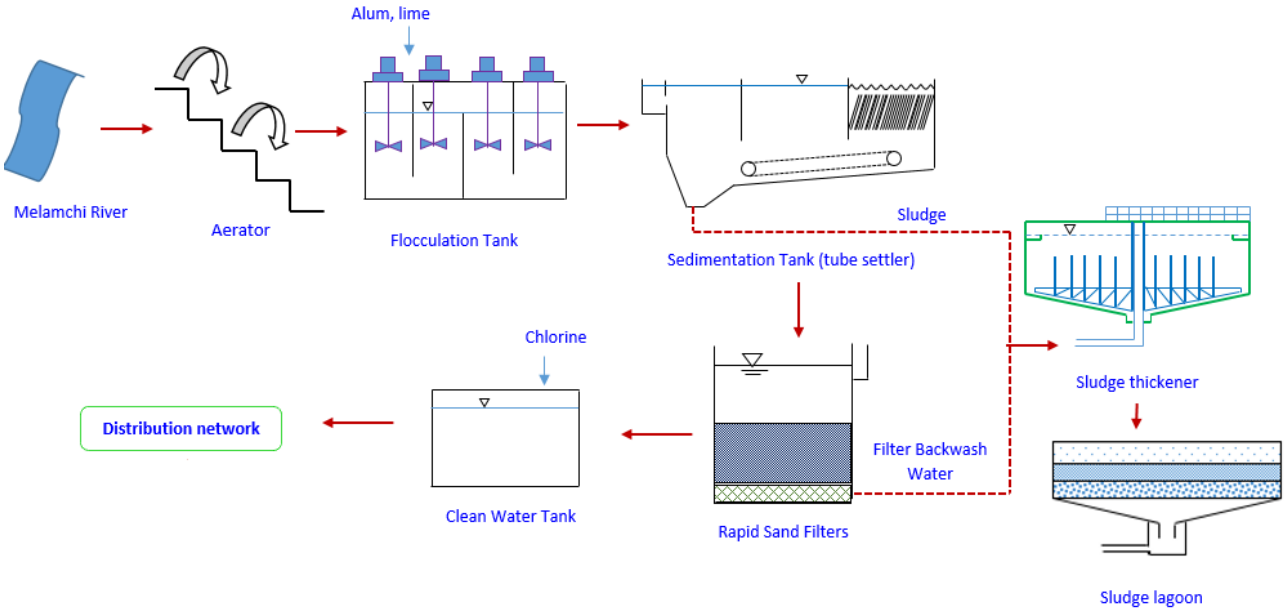

Figure 4: Water treatment mechanism in Melamchi WTP

3 Financial brief

MWSP was initially estimated to cost USD 317.32 million. However, an additional fund worth USD 38.1 million was negotiated in 2014 between the GoN and ADB; thus the revised estimated cost of the project is USD 355.4 million. As shown in Table 2, subproject I, i.e. the MDS, has been allotted majority of the budget share - USD 274.4 million. The remaining budget, USD 81 million, is allotted for the treatment and distribution of water, as well as for the enhancement/mitigation of the sociocultural and environmental features of the project. ADB and GoN are the major contributors with 45.60% and 29.10% contributions to the total budget. Other organisations such as JICA, JBIC, NDF and OPEC have also sanctioned loans to the project, each with 5.10%, 13.40%, 2.90% and 3.90% contributions to the total cost.

Table 2: Contributions of major donors in MWSP (ADB, 2014)

Institution	Contribution/loan the amount for MWSP in USD	Subproject I	Subproject II
ADB	162 million	128.8 million	33.2 million
JBIC	47.5 million	47.5 million	-
JICA	18 million	-	18 million
NDF	10.5 million	10.5 million	-
OPEC	13.7 million	13.7 million	-
GoN	103.7 million	73.9 million	29.8 million
Total	**355.4 million**	**274.4 million**	**81 million**

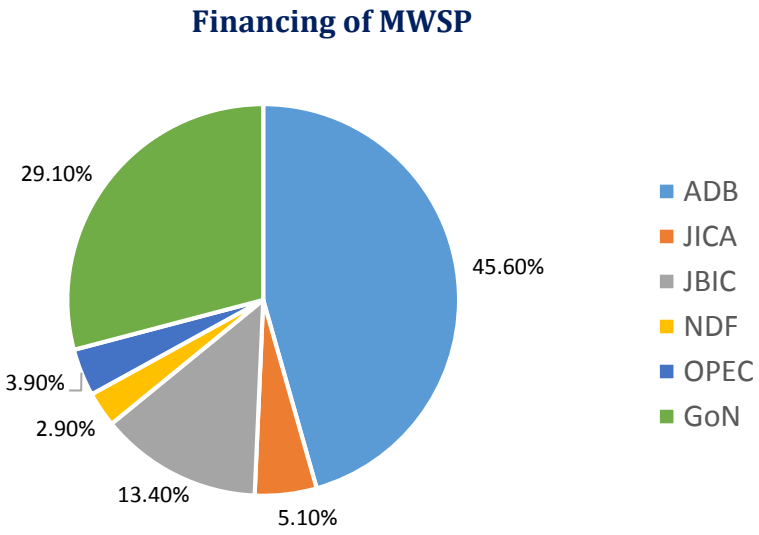

Figure 5: Financing of MWSP (ADB, 2014)

4 Project Features

4.1 Technical and technological features

The key components of the MWSP are water intake structure (headworks), water distribution tunnel, water treatment plant, bulk distribution system and water distribution network development works. The tunnel is designed for 510, 000 m^3/d capacity to bring 170,000 m^3/d water from Melamchi River in the first phase and additional 340,000 m^3/d with the implementation of a separate project later. The tunnel is being constructed using drill and blast method using the modern and efficient equipment. Permanent support works including shotcrete are being employed throughout the construction of the tunnel. Since tunnel construction is inherently a hazardous task, it is being closely supervised by the contractors to comply with adequate safety measures. For example, tunnel excavation is being done only after ascertaining the geological conditions using a probe drill, geo-radar, and other suitable techniques. In addition, an emergency response and disaster mitigation plan has been prepared and strictly enforced to minimise the risks to life and property.

Headworks intake structures include open blasting earthworks, cuts, concrete and civil works and hydraulic steel works. This also includes construction of 540m long headworks access road. The main components of the headworks of the MDS are the earthworks and rock cuts, temporary cofferdams, diversion weir, the river training works, the intake, the settling basins and the headworks diversion tunnel.

The water treatment plant is a conventional one that comprises pre-treatment, sedimentation, lime dosing, rapid sand filtration and disinfection mechanism.

4.2 Economic and financial features

The net present value of the overall project is USD225.62 million, and the estimated economic internal rate of return of the overall project including the additional financing is 18.92%. The economic internal rate of return is higher than the economic opportunity cost of capital of 12%, indicating a sufficient economic return. The results from a sensitivity analysis, which range from

17.47% to 18.92%, have been reported to be satisfactory against downside risks, including a 10% increase in capital expenditure, a 10% increase in operating costs, a 10% decrease in benefits, and a 1-year delay in project completion.

On the other hand, the estimated financial internal rate of return of the overall project including the additional financing is 7.93%; the net present value is $1.6 million. The financial internal rate of return is slightly higher than the weighted average cost of capital, estimated at 7.90%, indicating an adequate financial return. The sensitivity analysis reveals that financial viability of the project is most vulnerable to decreases in revenues. As such, KUKL will promote efforts to rationalise tariffs and enhance revenues. The future profitability of KUKL will be evaluated once the water utility provides accurate financial projections, which are a disbursement condition for the Kathmandu Valley Wastewater Management Project. Tariff levels were increased in July 2013 by more than 80% and are expected to increase further when water becomes available from the Melamchi tunnel. The government also agreed in July 2013 to shoulder KUKL's tax burden through a grant to the utility. With support from the ongoing loans, KUKL will continually work to make operational and financial improvements, including significant reductions in nonrevenue water. These elements are likely to improve financial performance soon after the completion of the MWSP.

In order to mitigate cost and time overruns caused by poor mobilisation of the contractor or procedural delays, KUKL as well as the MWSDB will closely monitor mobilisation and performance of the contractor for the Melamchi tunnel to ensure that progress stays on schedule, and will take action according to contractual provisions for any delay. Provisions for a bonus for early completion and penalties for the delays, as incorporated in the bidding documents, will be enforced. The MWSDB will prepare timelines for decisions for handing over the sites and approving designs, drawings, variations, claims, and other contractual matters; and will strictly monitor compliance with the timelines.

4.3 Social and environmental features

MWSP has several mitigation measures incorporated into the project design to establish a mechanism for regular voluntary disclosure of project-related information to citizens; ensure transparency by regularly updating the project website to inform concerned stakeholders and general public about project implementation, procurement, and safeguards activities; and establish a grievance redress mechanism to ensure quick and effective resolution.

The MWSDB, with the support of the DSC and SSDS consultants, will raise awareness and inform all stakeholders, including political parties, about the critical nature of the Melamchi tunnel in order to generate a consensus for successful implementation. In order to bring poverty alleviation and gender elements to the fore, the project has provisions to prioritise connecting all poor and socially excluded households including those headed by women to the water supply and sewerage network in the Kathmandu Valley. In addition, a social uplift program (SUP) is implemented to increase awareness and promote meaningful and widespread participation of key stakeholders. The SUP will also be implemented in Melamchi Valley and will cover five areas: buffer zone development, health, education, income generation, and community development.

As for the environmental impacts of the project, the PMU shall oversee and regularly update environmental monitoring. In particular, appropriate clauses are incorporated in the tunnel construction contract to the adverse impacts of construction. This is expected to mitigate

environmental impacts such as (i) damage to the water quality of waterways, (ii) increased erosion, (iii) deterioration of air quality at the construction site, (iv) loud sounds from blasting or machines, and (v) failure to rehabilitate land temporarily occupied by the contractor. The tunnel supervision consultant is responsible for ensuring that contractors follow contract specifications, particularly for environmental mitigation.

5 Project Benefits

On the outset, the project is expected to bring several positive impacts. To begin with, it comes as a much-required solution to the acute drinking water scarcity in the Valley. The project will distribute 0.135 m^3/d of water to 1.1 million population of the Valley. In addition, it has been discussed that if MWSP is able to tap in 510, 000 m^3/d of water, and all of the water can be distributed, then the water deficit can be met until at least 2023 (Udmale et. al., 2016). This will also improve the health of the people as the water is bound to meet the quality as guided by the WHO. This will be indicated by reduced incidence of waterborne diseases such as diarrhoea and dysentery. Furthermore, the inhabitants will have improved sanitation provisions as well as a respite from the mental, social and economic problems brought about by water shortages. To this end, the government and KUKL have committed to reform current water supply and sewerage connection policies to facilitate individual connections to the poor, socially excluded, and households headed by women. Connection fees will be reduced for poor households under these projects. The SUP under the MWSP is being implemented to promote widespread, ongoing, and meaningful participation of key stakeholders. These projects will complement KUKL's ongoing efforts to strengthen its pro-poor and gender-inclusive sanitation services. This will, thus, help attain the SDG 6. Furthermore, the project is expected to contribute to (i) transfer of technical skills from the consultants to MWSDB staff, as a result of their high level of interaction; (ii) heightened public awareness of the importance of water as an economic good, as a result of information campaigns of the public relations consultants; and (iii) raising of stakeholders' concerns on environmental and social issues, especially on the effect of hiring a management contractor on the cost of water tariffs, and on disruption of people's livelihoods and their resettlement because of land acquisition.

6 Implementation status of the project

The project has undergone several changes since its initial inception in 2000. The changes are mostly financial in nature, such as the withdrawal of major donors like NORAD and Sida, resulting in a considerable funding gap. However, the total budget was revised in 2008, and amended again in 2014, so as to carry on with the proceedings of the project. Although there was a setback due to the Nepal Earthquake in 2015 as well as other economic and political reasons, the project has seen a good progress. As of 12 June 2017, 24.5 km of the tunnel has been excavated, leaving behind only a little over 3 km of the tunnel to be constructed. The project has also seen considerate progress in other physical activities such as laying of transmission main from Sundarijal to the Mahankalchaur, demonstration area at Kusunti, construction of treatment facilities and reservoir tanks as well as distribution network improvement works. Furthermore, the socio-environmental aspect of the project has also been dealt with, with the implementation of SUP to upgrade the sewerage system in the Valley. Furthermore, efforts to support safeguard,

social upliftment program, environmental monitoring, public relation and resettlement has also been promoted (PID, 2017).

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