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Network on Water Technology in Asia and Pacific

Angat Water Transmission Improvement Project
Metro Manila, The Philippines

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Summary

Metro Manila also called the National Capital Region (NCR) is situated in the south eastern part of the Philippines. Serving as the main economic culture and educational center, the region is a densely populated metropolitan area. The Angat Water Transmission Improvement Project (AWTIP) was designed to ensure secured and sufficient raw water supply to meet the current and future demands of the rapidly growing population of Metro Manila. The project focuses on the construction of a new 6.3 km tunnel (no. 4), intake structures at the Ipo dam and connecting structures of the transition basins, new aqueduct (no. 6)., rehabilitating and retrofitting of existing tunnels and aqueducts. The project is expected to restore the water transmission capacity of the Angat transmission system which currently operates about the 30% below its design capacity. Given the rapidly growing population of a highly populated Metro Manila, the project would ensure that a maximum capacity of 4.65 million m^3/d of raw water is transmitted from the Angat dam at maximum efficiency. In addition, the execution of the project is expected to build the technical capacity of the staffs of the Metropolitan Waterworks and Sewerage System (MWSS), who are the primary administrators of the project. The project features social and economic aspects that are targeted towards improving the livelihood and health conditions of source community's programs and indigenous people. The project also has in place environmental safeguards that aim at reducing and mitigating direct and indirect impacts on the biotic and abiotic parts of the environment. The total project costs USD 134 million. USD 123.3 million of the project cost is donor funded by a loan facility from the Asian Development Bank. The remaining, however is counter-funded by the government of the Philippines. The project when completed would ensure the supply of sufficient water to meet the projected water demands of the inhabitants of Metro Manila and other cities that depend on water from the Angat water transmission system. Thus, it serves as an important step towards the Philippine government's commitment to meeting sustainable development goals (SDG 6), which urges countries to ensure available and sustainable water and sanitation for all.

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Acronyms and Abbreviations

ADB	Asian Development Bank
AGWTIP	Angat Water Transmission Improvement Project
BAC	Bid Award Committee
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
HIV	Human Immuno Virus
MWCI	Manila Water Company Inc
MWSI	Maynilad Water Services Inc
MWSS	Metropolitan Waterworks and Sewerage System
NPV	Net Present Value
STD	Sexually Transmitted Diseases
USD	United States Dollar
WVF	West Valley Fault

1 Introduction

Metro Manila is located between the Manila Bay to the west and Laguna de Bay to the east. It is one of the most densely populated metropolitan cities in the Philippines. With a population of over 12.8 million inhabitants occupying 636 km^2 land area and an annual population growth rate estimated at 1.58 % annually by the 2015 population census, the city has experienced rapid population growth and urbanization over the past decade (POPCEN, 2015). Rapid population growth has placed enormous pressure on existing infrastructure, social facilities and social services of the metropolitan city. Contributing about 36.5% of the total GDP of the Philippines, Metro Manila is a major center of consumption, productivity and employment, positioned as a strategic economic hub of the country. However, Metro Manila is faced with the common urban problems and challenges that confront rapidly urbanizing cities. Adequate and steady water supply is critical for improving health and sanitation and to promote sustainable urban development of the Metropolitan area. Water security to Metro Manila, comes off as a potential disaster preparedness strategy because of the potential seismic activity associated with the area. Metro Manila harbors the active West Valley Fault (WVF), which runs through the Central Metro Manila Area.

Figure 1 Geographical location map of Metro Manila (Source: Google)

The franchise to potable water supply, distribution management and expansion to the western and eastern parts of Metro Manila has been transferred to the Manila Water Company Inc. (MWCI) and Maynilad Water Services Inc. (MWSI) since the passing of the Republic Act 8041 into Law in 1997. The law enabled the partial devolution of water utility services from the state-owned Metropolitan Waterworks and Sewerage Systems (MWSS) to the two private companies up to 2037 on a performance-based concession contract. However, the MWSS is responsible to ensure uninterrupted and adequate potable water supply and distribution for domestic and other purposes through the concessionaires. This is to be done using just and equitable rates to for the approximately 16 million residents of 37 cities and municipalities within greater Metropolitan Manila. Water supply to Metro

Manila was estimated to be approximately 4.147 million m^3/d reaching about 14.9 million consumers (91% coverage) in 2016. However, water demand is projected to increase by about 55 % due to the growing needs for domestic water, manufacturing and thermal electricity generation. Recent projections on bulk water demand is expected to increase to more than 4.5 million m^3/d by the year 2020. The demand for water is expected to increase by 38% in 2025, to 6.16 million m^3/day (ADB, 2015).

To meet the service performance targets, concessionaires are expanding their water supply coverage in the Metro Manila service area. However, to achieve this target, it is very necessary to restore the Angat raw water transmission line to full design capacity. Projected future water demands can be met by ramping up the raw water supply and subsequent increment in water treatment capacity. About 97% of water supply to Metro Manila comes from the Angat Dam, located in the nearby province of Bulacan, while the remaining is sourced from deep wells within Metro Manila. The Angat water transmission line is fraught with challenges that make water conveyance inefficient and inadequate. Due to the leaky aqueducts and the old age of the major components of the raw water transmission line, the Angat transmission line operates 30% less of its design capacity which amounts to about 800,000 m^3 of raw water losses per day. The current state of the transmission lines has been found to be non-compliant with structural and seismic requirements and standards. The Angat reservoir which supplies raw water to the Angat transmission line also allocates water to other stakeholders for irrigation (Bulacan and Pampanga province) and for hydro power generation. Thus, improving the efficiency of the Angat raw water transmission line is very crucial to ensure maximum conveyance of allocated water from the Angat reservoir. Occasionally, heavy siltation in the reservoir and droughts by the perennial El Nino lowers the effective reservoir capacity which results in limiting the amounts of water allocated to users like the the MWSS through the Angat transmission line. The results of the occurrence of any of such constrains affects water supply to Metro Manila. Improving the transmission efficiency of the existing lines as well and constructing additional transmission lines to help restore the Angat line to full design capacity have been identified as necessary solutions to improve water security of Metro Manila.

The implementation of the Angat water transmission improvement project is expected to ensure secured water supply to the inhabitants within the MWSS service area. Feasibility reports by the Asian Development Bank (ADB) technical team have noted civil construction works such as construction and rehabilitation of new and existing tunnels, retrofitting of aqueducts are necessary to salvage the Angat raw water transmission line and restore it to full design capacity. The project was deemed necessary to meet the projected future water demands of the swelling Metro Manila population. Primarily, the project involves the rehabilitation of aqueduct number 5, to improve its transmission capacity to 6.22 million m^3/day; and the remaining four aqueducts resulting in a potential transport capacity to 6.45 million m^3/day. The implementation of the project will also bring about the operationalization of an integrated water safety, risk and asset management plan. The general overview and objective of the project is shown in Table 1.

Table 1: Overview of the Angat Water Transmission Improvement Project (ADB, 2016)

Items		Description
Project Name	:	Angat Water Transmission Improvement Project
Type	:	Water supply infrastructure improvement
Donor Name	:	Asian Development Bank
Project rationale and objectives	:	i. Help restore the full design capacity of the Angat systems and thus ensure the sustainable provision of the water supply distribution system, and ii. Mitigate the risk of a total loss of water supply to Metro Manila and portions of Cavite and Rizal provinces. iii. To improve the reliability and security of the raw water transmission system through partial rehabilitation of the transmission system from Ipo to La Mesa as well as the introduction of water safety, risk and asset management plans
Project Fund	:	USD 123.30 million. Counterpart funding by the Philippine Government: USD10.7 million
Project Duration	:	June 2016-December 2021. Expected completion date on 31 December, 2021

2 Technical and Technological Brief

Raw water transmission to water treatment plants servicing the eastern and the western parts of Metro Manila under the MWSS service area, operated by the two concessionaires comes from the Angat Dam. Raw water flows from the Angat dam to the Ipo dam, which is subsequently connected to the Bigte settling basin by three tunnels. From the Bigte settling basin, the raw water is conveyed through five aqueducts to the La Mesa portal/reservoir before being supplied to the water treatment plants. The Angat water transmission improvement project (AWTIP) is expected to complete the construction of (i) an intake structure at Ipo reservoir; (ii) a new tunnel no. 4, approximately 6.3 kilometers long and with a finished internal span of approximately 4 meters, (iii) a new transition basin at Bigte, (iv) connection of the new transition basin at Bigte to the existing transition basin no. 3 at Bigte (v) making of necessary modifications to the existing transition basin number three at Bigte. The project will also construct a new aqueduct no. 6 and perform rehabilitation and interconnection works of existing aqueduct on the five aqueducts. The execution of the AWTIP project will essentially restore to full capacity (i) aqueduct number 5, bringing its potential transport capacity to 6.22 million m^3/day; and (ii) the other four aqueducts, bringing potential transport capacity to 6.45 million m^3/day.

Figure 2 Construction work on the Angat Water Transmission Improvement Project (Source: mwss.gov.ph)

3. Financial brief

The total cost of the AWTIP was estimated to be USD134.0 million, including taxes, duties, and physical and price contingencies. The project is being funded by a loan facility of USD123.3 million granted to the Philippine government by the Asian Development Bank (ADB). The remaining project cost ($10.7 million) is to be counterpart funded by the Philippine government. The repayment period for the loan facility by the Philippine government was fixed within a 25-year term, with a grace period of 6.5 years. The maturity period for the loan is 16 years with the premium payable to ADB at 0.10% per annum. The loan repayment to ADB using a straight-line method would be serviced indirectly by the concessionaires through the MWSS. Thus, the loan would be serviced by the concessionaires essentially by passing it on to the consumers within Metro Manila.

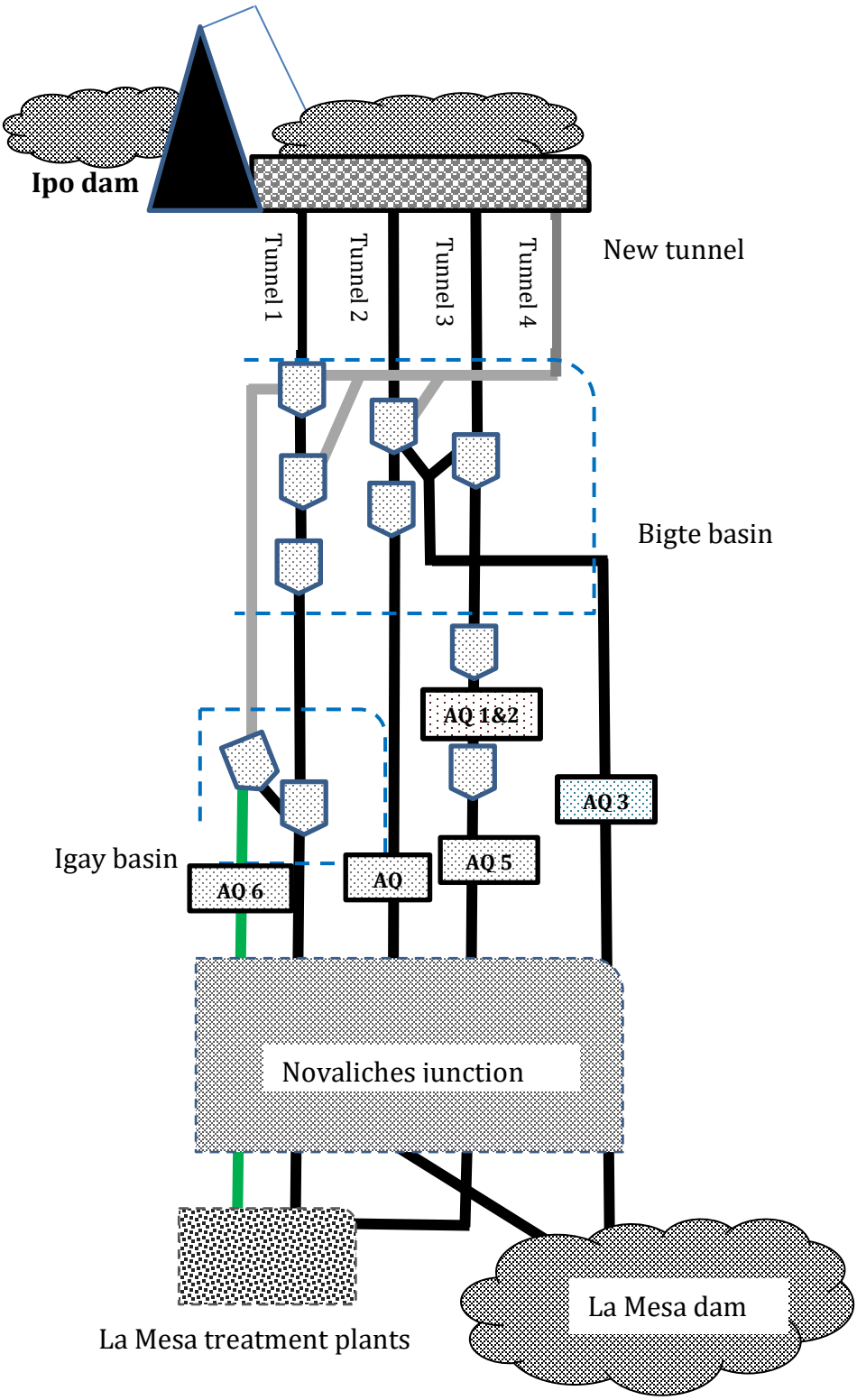

Figure 3 Metropolitan Waterworks and Sewerage System's Angat raw water transmission line with proposed works

4 Project Features

4.1 Technical and technological features

Due to leakages, the Angat transmission line transmits raw water at an estimated 30% less of potential capacity which amounts to about 4.76 million m^3/day of raw water transmitted by the three parallel tunnels and five aqueducts. The AWTIP is developing first, the tunnel 4, a 6.3 km tunnel (4 m in diameter) from Ipo dam to the Bigte portal, with accompanying intake and outlet works. The tunnel depth is to be maintained between 100 m and 150 m, with 200 m as maximum. The depth at the inlet and outlet is to be maintained to approximately 10 m and 8 m, respectively. Upon the completion of tunnel 4, it will be used for transmission of raw water while rehabilitation works on the other tunnels are carried out (refer to figure 2). This is to ensure uninterrupted transmission of water during the rehabilitation of the other tunnels. The flexibility of this design is that, it allows for subsequent rehabilitation of tunnels 1, 2 and 3, aqueduct 6 and the whole transmission system when tunnel number 4 is completed. Tunnel number 4 intake is to be located between the old and new Ipo dams in order to limit the risk of silt build-up in front of the intake areas. Construction works using modern methods involves the construction of cofferdam, installation of tunneling equipment, concrete works using shotcrete, rock dowels and structural steels. Two spoils disposal areas would be used, with one located downstream about a kilometer away from the Ipo Dam and the other one at Bigte within the property of MWSS. Works on tunnels 1, 2 and 3 would mainly involve the installation of corrosion resistant rock bolts and permanent concrete linings using shotcretes.

Figure 4 New tunnel construction using modern bored tunnel methods on the AWTIP (Source: mwss.gov.ph)

4.2 Economic and financial features

The financial and economic analyses of the project were done using the financial internal rate of return (FIRR) and economic internal rate of return (EIRR). The financial viability of the project was examined based on the project object, which aims at improving the reliability and security of the raw water transmission system for MWSS. The financial viability approach adopted considered the proposed new tunnel and other rehabilitation works as an integral part of the water transmission improvement of the existing system. No additional raw water is to be supplied to the system other than that which the original design capacity could support. Based on this, the failure rate approach which compares the "with" and "without" project scenarios were used. The "without-project" scenario stipulates that, the probability of failure in water supply increases under current conditions overtime. Following this assumption, the possible revenue loss is compared with the project cost. The FIRR, the financial net present value (FNPV) and the weighted average cost of the of capital were calculated to be USD 68.33 million and 5.72%, respectively. With these projected indicators, the Angat Water transmission improvement project was considered financially viable.

Again, the economic viability of the Angat water transmission improvement project was tested using the "with" project and "without" project scenarios. Using the "with" project scenario, the economic value of the total project cost was translated using the domestic price numeraire by converting the foreign exchange and labour costs to their economic shadow prices. Economic analysis of the project was done over a 25-year period according to ADB guidelines for water projects although the project life is expected to last 100 years. Taxes were considered as transfer costs and thus excluded from the analysis. The project does not add up on the raw water allocation from the Ipo dam. The original water right allocation of 46 m^3/s is maintained in the analysis. Using the "without" project cost approach, the resource cost savings were calculated as the product of lost billed volume and the weighted average cost of economic water supply price for domestic and non-domestic consumption from alternative private water suppliers. However, with this scenario, the residential water consumption under the alternative water suppliers was lowered to 40% of the total water demand, because it was assumed that consumers will tend to limit the use of water due to relatively higher costs charged by the alternative suppliers. The economic NPV was computed to be USD13.27 million using an economic hurdle rate of 12% and an EIRR of 15.42%. The economic indicators of the AWTIP shown in table 1, shows a positive NPV and an economic internal rate of return, EIRR that exceeds the economic hurdle rate (12.0%). The project was thus considered economically viable. In summary, the project is considered financially and economically viable. A sensitivity analysis of the project further proves the project continues to remain viable under conditions of a 10% increase and or decrease in project investment which may result from increment in both foreign exchange and project component cost or decrease in benefits in the event of decrease in failure rate or the flow rate.

Table 2. Financial and economic base indicators for the AWTIP (ADB, 2016)

	Net Present Value (in USD million)	**Internal Rate of Return (%)**	**Hurdle Rate (%)**
Financial Indicators	67.71	5.72	2.03
Economic indicators	26.06	15.42	12.00

Given the track record of the MWSS, which is a government owned cooperation in managing previous donor funded projects, the AWTIP will be governed by the MWSS. To reduce the risks and delays with the project to the procurement of goods and services, the MWSS will oversee all general procurements related to the project using bid and award committee (BAC) which include the procurement of designing and constructing tunnels, appurtenant structures, and ancillary facilities and recruiting supervision consultants. Technical working groups of the MWSS would also be engaged in regular training on the procurement policies and guidelines of ADB.

4.3 Social and environmental features

The Angat water transmission improvement project was designed with careful considerations given to the social and environmental impacts that the implementation of the project may bring about. The AWTIP is located in the province of Bulacan, about 50 km north of Manila near Norzagaray city which has a population of about 150,000. Norzagaray city has several cement industries and is an easily accessible area by road. The project site is situated within the property of the MWSS along Bigte, Norzagaray. Mitigation measures have been incorporated in the project design to limit and or prevent significant impact on the environment and the societies close to the project site. Source community prioritization in terms direct project benefits comprises the engagement of communities close to the project sites in employment for constructions as part of civil works on the project. This strategy is to promote the development of non-technical local skills as well as to promote community level participation, ownership and local content. Arrangements have been made with the concessionaires as to ensure water supply to urban poor communities and source communities as priority. Uninterrupted water supply to the service areas has been ensured by the flexibility incorporated in the design and construction works on the transmission line. Relevant safeguard measures have been detailed in the various project safeguard documents developed for approval by the ADB. The project was classified as category C for involuntary resettlement, B for environmental impact, because of the minimal or no involuntary resettlement impacts on indigenous people. A category B rating of the project for indigenous peoples means that it is likely to have limited impacts on indigenous peoples and that an indigenous people plan, including assessment of social impacts, is required.

The social and gender dimensions considered by the project include strategies to promote poverty reduction in communities within the project scope. These were done by identifying the needs and priorities of population groups, conducting in-depth analyses of gender issues in the source communities and other affected communities. To mitigate potential social risks to source

communities, plans have been designed to provide public awareness on business opportunities and benefits that come with the project implementation. Also 50% quota has been allotted to source community residents to be engagement for unskilled jobs and civil works on the project. As part of the projects social risk impact mitigation strategies, training of source communities and awareness campaigns to promote knowledge on HIV/AIDS, STD's, alcohol and drug use impacts would be carried out regularly. These activities are to be carried out where major construction works will be located. Consultations have also been made with affected communities and other stakeholders, and agreements on safeguard measures have been developed to mitigate the environment impacts on the Ipo watershed, ancestral domains including spoils disposal areas located downstream of the Ipo dam and at Bigte. Since the project will involve constructions/diggings at intake point, tunneling activities and movement of construction machinery and equipment, temporal damming, and temporary sites and quarters, it is anticipated that there would be increased activity in the source communities and vehicular traffic by heavy duty vehicles because of the movement of equipment and people. Moreover, exhaust emissions internal combustion vehicles, machines and equipment are anticipated. Moreover, disruption of the aquatic habitat of the river are also envisaged. Conversion of vegetated areas (e.g. the ancestral domains) are some of the possible environmental impacts of the project. However, as part of the conditions for the approval of the loan facility by the ADB, environmental and social monitoring safeguard reports are to be submitted semi-annually.

5 Project Benefits

The Angat Water Transmission Improvement Project was formulated to salvage the deteriorated condition of the raw water transmission sytem of the MWSS. Due to the old age of the transmission system, raw water losses during conveyance to the treatment plants limits the amount of water available for treatment and onward supply to the consumers within the MWSS service area. Though the concessionaires have been reported to have met their service obligations and set to increase coverage (i.e. 40 cm^3/s, 3.4 million m^3/day by 2035), concerns about the sufficiency of the raw water supply to meet the rapidly growing demands within the next decade was uncertain, given the fixed water allocation from the Ipo dam. The amount of water loss due to leakages reduces the water carrying capacity of the transmission line by 30%. In the event of serious breakdown, the effects will adversely impact the economy of Metro Manila and the Philippines at large.

The AWTIP project seeks to ensure secured, reliable and sufficient water supply to Metro Manila which has been identified as a potential seismic zone. The benefits of providing adequate water supply to meet the demands of the consumers in highly populated area as Metro Manila is the mitigation of water related health and sanitation hazards. Water security for the Metro Manila population has the potential of positively impacting the economy by improving the productive capacity and livelihood of the area since it's a major economic hub. The comparatively higher cost of obtaining water from alternative private suppliers (usually from bore-hole and tankers) may limit access to water by many household, which may reduce household sanitation. The project thus comes as needed remedy, with benefits to ensure reliable and adequate water supply that will help meet the water consumption demands of Metro Manila now and in the future as well as improving the productive capacities of the inhabitants of the Metropolitan area.

Despite the records of previously managing donor funded projects, one of the risks faced by the MWSS in implementing the AWTIP project is the inadequacy of staff capacity to manage the project. To mitigate the risk of project failure, the project has a human resource development component that aims to provide capacity building to the staff of the MWSS. Over the project life, the MWSS staff will be receive trainings to build capacity and develop skills to be able to implement, manage and supervise works and services associated with the project. The technical working groups and the BAC will receive specialized trainings to be able to execute international competitive bidding particularly in design–build contracts and the procurement of implementation assistance consultants in compliance with ADB standards and procedures. Trainings will also be provided to the MWSS staffs on the gender dimensions on the project. The project implementation and coordination staffs will be trained on gender awareness promotion, and implementation of the communication strategy with regard to livelihood opportunities and awareness of health-related risks. Clearly, the project enables capacity building and skill transfer to the staffs of the MWSS to equip them for similar programs in the future.

6 Implementation status of the project

Following the signing of the USD123.3 million loan agreement with the ADB in March 2016, the MWSS has taken proactive steps to ensure the implementation of the AWTIP. Tenders were subsequently opened for public bidding and contract was awarded to Cooperativa Muratori & Cementisti – CMC di Ravenna Societa Cooperativa for the design and construction of the Angat Water Transmission Improvement Project. The project was commissioned at the Ipo Dam in Norzagaray, Bulacan in May 2016 by the former president H.E Benigno Aquino III and the officials of the ADB to mark the official inception of the project. Initial site preparation for civil construction works was initiated. Civil construction works and preparatory works on building the tunnel 4 using modern tunnel boring method were also initiated. Detailed engineering design of the Project has been completed and a total of USD 10,146,723.68 mobilization fee and progress billing was accessed from the ADB and payed to the contractor (CMC di Ravenna) by the MWSS (MWSS, 2016). The contractor's mobilization, design services have been completed and construction services initiated. As of June 2017, project implementation progress report indicated the initial construction phase of the project had been started and the following components of the project initial construction phase were in various stages of construction or completion:

1. Facilities for the client's office
2. Outlet portal general site facilities
3. Permanent access road to IPO dam
4. Outlet portal area
5. Tunnel boring method excavation – preparatory works

According to project works estimation, the tunnel 4 is expected to become operational in 2019. The tunnel boring phase is reported to be ahead of original schedule due to the modern tunnel boring technology being used which cuts the usual tunneling time by half year. Social monitoring report indicted the possible relocation of three (3) families who are residing within the MWSS portion of

land that will be affected by the construction of the access road at the Ipo area. Compliance with the standards to ensure safe passage of students going to school during construction and stipulated provision of employment and livelihood were partially adhered to (MWSS, 2017). However, grievance redress mechanisms have been put in place to steer the project to achieve the desired impact and also ensure maximum compliance.

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